Gulf of Alaska Navy Training Activities
Draft Environmental Impact Statement/
Overseas Environmental Impact Statement

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Chapters 1-9
Appendices A-H

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COVER SHEET
DRAFT ENVIRONMENTAL IMPACT STATEMENT/ OVERSEAS ENVIRONMENTAL IMPACT STATEMENT GULF OF ALASKA NAVY TRAINING ACTIVITIES

Lead Agency for the EIS: U.S. Department of the Navy

Title of the Proposed Action: Gulf of Alaska Navy Training Activities

Designation: Draft Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS)

Abstract

This Draft EIS/OEIS has been prepared by the Department of the Navy in compliance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code § 4321 et seq.); the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations [C.F.R.] §§ 1500-1508); Department of the Navy Procedures for Implementing NEPA (32 C.F.R. § 775); and Executive Order 12114, *Environmental Effects Abroad of Major Federal Actions*. The National Marine Fisheries Service Headquarters is a cooperating agency on this Draft EIS/OEIS. The Navy has identified the need to support and conduct current, emerging, and future training activities in the Gulf of Alaska (GOA). Three alternatives are analyzed in this Draft EIS/OEIS. The No Action Alternative will continue training activities of the same types, and at the same levels of training intensity as currently conducted, without change in the nature or scope of military activities in the Draft EIS/OEIS Study Area. Alternative 1, in addition to accommodating training activities addressed in the No Action Alternative, would support an increase in training activities, as well as the inclusion of Anti-Submarine Warfare activities to include the use of active sonar. Alternative 1 also proposes training required by force structure changes to be implemented for new weapons systems, instrumentation, and technology as well as new classes of ships, submarines, and new types of aircraft. In addition, specific training instrumentation enhancements would be implemented, to include development and use of the portable undersea tracking range. Alternative 2 would include all elements of Alternative 1. In addition, under Alternative 2, one additional carrier strike group exercise would occur during the summer months.

This Draft EIS/OEIS addresses the potential environmental impacts that result or could result from activities under the No Action Alternative, Alternative 1, and Alternative 2. Environmental resource topics evaluated include air quality, expended materials, water resources, acoustic environment (airborne), marine plants and invertebrates, fish, sea turtles, marine mammals, birds, cultural resources, transportation and circulation, socioeconomics, environmental justice and protection of children, and public safety.

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ES EXECUTIVE SUMMARY

ES 1.1 INTRODUCTION

This Draft Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) analyzes the potential environmental effects that may result from the United States (U.S.) Navy's Proposed Action and Alternatives. The Proposed Action and Alternatives address ongoing naval training activities (one joint force exercise occurring over a maximum time period of 14 days during summer months [April through October]); proposed naval training activities of Alternative 1 that would increase the number of training activities, increase the joint force exercise to last up to 21 days, and conduct Anti-Submarine Warfare (ASW) activities; and the proposed naval training activities of Alternative 2 that would increase the number of training activities, increase the joint force exercise to last up to 21 days, conduct Anti-Submarine Warfare (ASW) activities, implement the use of a Portable Undersea Tracking Range (PUTR), add a second carrier strike group activity during the months of April through October, and conduct a Sinking Exercise (SINKEX) during each summertime exercise (a maximum of 2) in the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA).

The Proposed Action consists of Navy training activities that occur during the summer in one or two major exercises or focused activity periods. These exercises or activity periods would each last up to 21 days and consist of multiple component training activities as described in greater detail in the body of this document. During these focused activity periods, intermittent Navy Unit Level Training (ULT) could also occur. However, outside of these focused activity periods, during the other 46-49 weeks of the year, the Navy does not train within the TMAA or other areas of the GOA.

These exercises would occur within and around the GOA and State of Alaska on established training ranges and military owned/controlled lands. Training activities analyzed in this Draft EIS/OEIS include those conducted by the Navy and other U.S. Department of Defense (DoD) services supporting Navy training as discussed in the Description of Proposed Action and Activities (Chapter 2).

The geographic area covered by this Draft EIS/OEIS consists of three components: 1) the GOA TMAA; 2) U.S. Air Force (Air Force) over-land Special Use Airspace (SUA) and air routes over the GOA and State of Alaska, and 3) U.S. Army (Army) training lands. Collectively, for the purposes of this Draft EIS/OEIS, these areas are referred to as the Alaska Training Areas (ATAs) (Figure ES-1). This Draft EIS/OEIS does not involve the creation or development of new training areas on land or changes in the use of airspace over land or water. Nor does it include modifications to training areas at sea that the Navy has been using over the last ten years during exercises and training.

This Draft EIS/OEIS has been prepared by the Department of the Navy in compliance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code [U.S.C.] § 4321 et seq.); the Counsel on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations [C.F.R.] Parts [§§] 1500-1508); Department of the Navy Procedures for Implementing NEPA (32 C.F.R. § 775); and Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions* (EO No. 12114, 44 Federal Register [FR] 1957 Jan 4, 1979). This Draft EIS/OEIS satisfies the requirements of NEPA and Executive Order (EO) 12114, and will be filed with the U.S. Environmental Protection Agency and made available to appropriate federal, state, local, and other private and public entities for review and comment.

The Navy is the lead agency for the Draft EIS/OEIS and the National Marine Fisheries Service is a cooperating agency, pursuant to 40 C.F.R. §§ 1501.6 and 1508.5.

Since about 2000, the Navy has participated in a major exercise that involves Departments of the Navy, Army, and Air Force participants reporting to a unified or joint commander who coordinates the activities planned to demonstrate and evaluate the ability of the services to engage in a conflict and carry out plans in response to a national security threat. Service Secretaries and Combatant Commanders report to the Secretary of Defense. Combatant Commanders are the senior military authority for their assigned area of responsibility. The U.S. Pacific Command (PACOM[1]), based in Hawaii, has the primary warfighting mission to defend the United States and its interests in the Asia-Pacific Region. The U.S. Northern Command (NORTHCOM) has the primary responsibility for homeland defense. Each of these combatant commanders is supported by component commanders comprising forces from the Navy, Army, and Air Force. The Combatant Commanders develop exercises that train the Navy, Army and Air Force components to execute plans for situations that they identify as necessary to defend United States interest.

The TMAA is composed of 42,146 square nautical miles (nm^2) (145,482 square kilometers [km^2]) of surface and subsurface ocean training area and overlying airspace that includes the majority of Warning Area 612 (W-612). W-612 consists of about 2,256 nm^2 (8,766 km^2) of airspace (Figure ES-1). The TMAA is approximately 300 nautical miles (nm) (555.6 kilometers [km]) in length by 150 nm (277.8 km) in width and situated south of Prince William Sound and east of Kodiak Island. The TMAA's northern boundary is located approximately 24 nm (44 km) south of the shoreline of the Kenai Peninsula, which is the largest proximate landmass. The only other shoreline close to the TMAA is Montague Island, which is located 12 nm (24 km) north of the TMAA. The approximate middle of the TMAA is located 140 nm (259 km) offshore. The inland Air Force SUA consists of 46,585 nm^2 (159,782 km^2/61,692 mi^2) of airspace and the Army training land consists of 2,624 mi^2 (1,981 nm^2 or 6,796 km^2) of land area.

Training activities conducted by the Navy in the GOA are contained within the TMAA (Figure ES-2) and the exercises normally occur during the period between April and October. For Navy training activities that do occur in the inland Alaska ranges of the Air Force and Army, impacts associated with those activities have previously been analyzed and addressed in separate environmental analyses conducted by the Air Force and the Army (See Chapter 1, Section 1.6). As such, those activities are identified but not carried forward for analysis within the Draft EIS/OEIS.

The Navy's mission is to organize, train, equip, and maintain combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. This mission is mandated by federal law (Title 10 U.S.C. § 5062), which ensures the readiness of the United States' naval forces.[2] The Navy executes this responsibility by establishing and executing training programs, including at-sea training and exercises, including Anti-Submarine Warfare (ASW) activities (to include the use of active sonar), and ensuring naval forces have access to the ranges, operating areas, and airspace needed to develop and maintain skills for conducting naval activities.

[1] PACOM is a unified command which includes about 325,000 military personnel from the Army, Navy, Air Force, and Marine Corps (about 20 percent of all active duty U.S. military forces).

[2] Title 10, Section 5062 of the United States Code provides: "The Navy shall be organized, trained, and equipped primarily for prompt and sustained combat incident to operations at sea. It is responsible for the preparation of Naval forces necessary for the effective prosecution of war except as otherwise assigned and, in accordance with Integrated Joint Mobilization Plans, for the expansion of the peacetime components of the Navy to meet the needs of war."

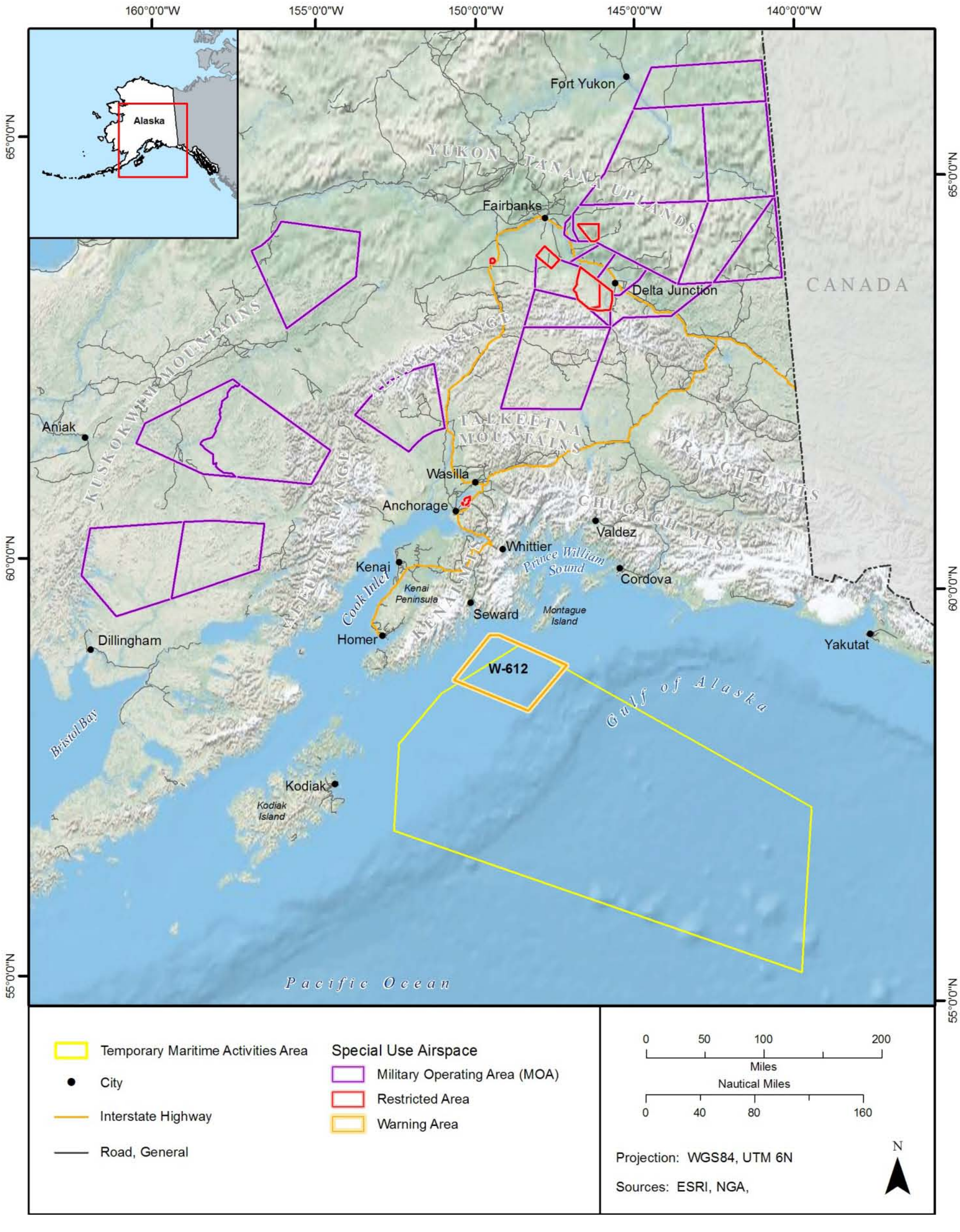

Figure ES-1: Alaska Training Areas

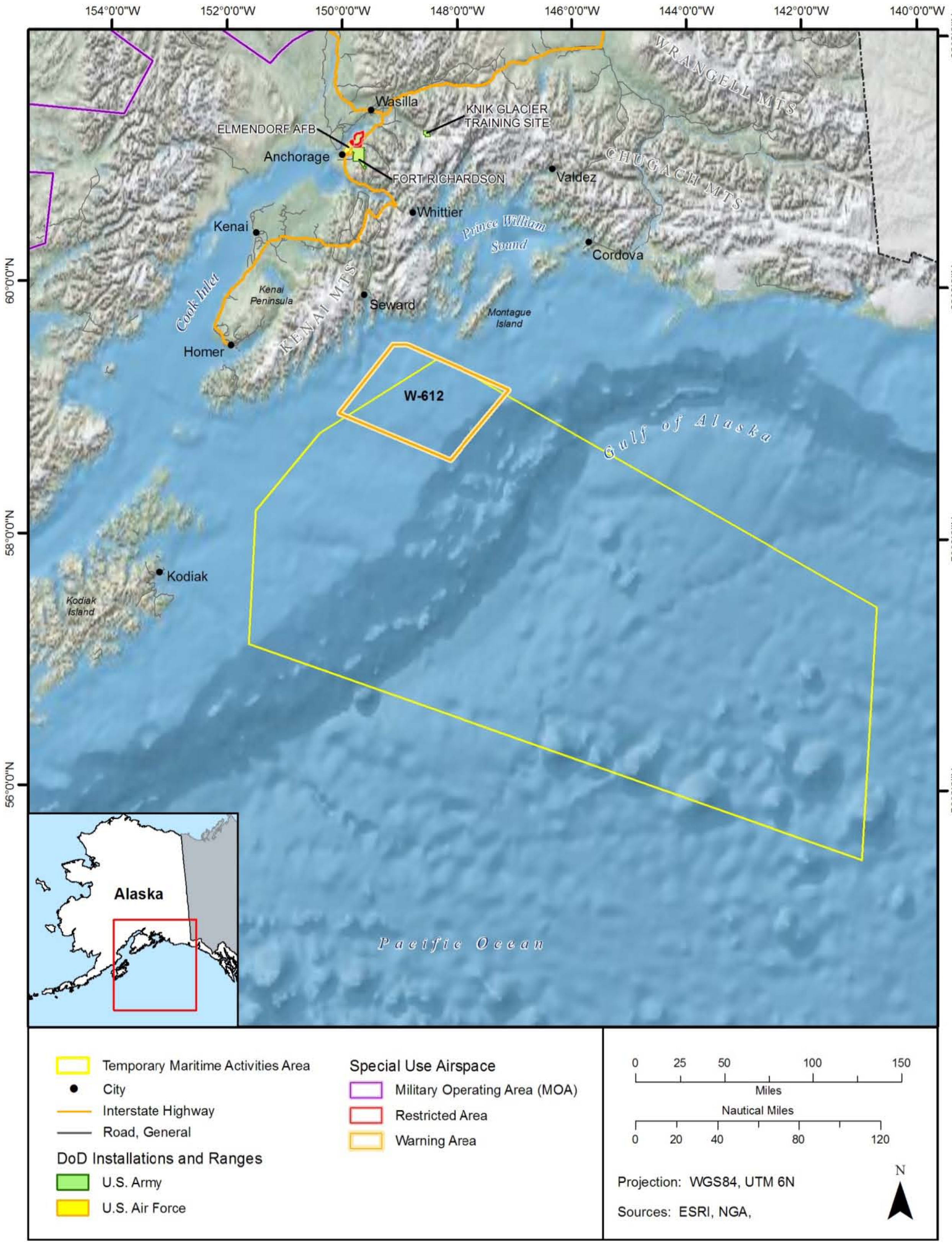

Figure ES-2: Gulf of Alaska Temporary Maritime Activities Area

The ATA plays a vital part in executing this naval readiness mandate. The training areas serve as the principal training venue for annual joint training exercises, which can involve forces from the Navy, Air Force, Army, and U.S. Coast Guard (USCG). The Navy's Proposed Action is a step toward ensuring the continued vitality of this essential naval training resource.

ES 1.2 PURPOSE AND NEED FOR THE PROPOSED ACTION

Given the vital importance of the ATA to the readiness of naval forces and the unique training environment provided by the ATA, the Navy proposes to take actions for the purpose of:

- Supporting U.S. PACOM training requirements;
- Supporting Joint Task Force Commander training requirements;
- Achieving and maintaining Fleet readiness using the ATA to support and conduct current, emerging, and future training activities; and
- Expanding warfare missions supported by the ATA, consistent with requirements.

The Proposed Action is needed to continue providing a training environment with the capacity and capabilities to fully support required training tasks for operational units participating in Joint exercises, such as the annual Northern Edge exercise. The Navy has developed alternatives criteria based on this statement of the purpose and need for the Proposed Action.

In this regard, the ATA furthers the Navy's execution of its roles and responsibilities under Title 10. To comply with its Title 10 mandate, the Navy needs to:

- Maintain current levels of military readiness by training in the ATA;
- Accommodate future increases in training activity tempo in the ATA;
- Support the acquisition and implementation into the Fleet of advanced military technology using the ATA to conduct training activities for new platforms and associated weapons systems (EA-18G Growler aircraft, Guided Missile Submarines [SSGN], P-8 Poseidon Multimission Maritime Aircraft [MMA], Guided Missile Destroyer [DDG] 1000 [Zumwalt Class] destroyer, and several types of Unmanned Aerial Systems [UASs]);
- Identify shortfalls in training, particularly training instrumentation, and address through enhancements;
- Maintain the long-term viability of the ATA as a Navy training area while protecting human health and the environment, and enhancing the quality, capabilities, and safety of the training area; and
- Be able to bring Army, Navy, Air Force, and Coast Guard assets together into one geographic area for joint training.

ES 1.3 SCOPE AND CONTENT OF THE DRAFT EIS/OEIS

Navy training activities that occur within the Air Force inland SUA and the Army training lands are analyzed under previous NEPA documentation (the *Alaska Military Operations Area EIS* [USAF 1995], *Improvements to Military Training Routes in Alaska Environmental Assessment* [USAF 2007], the *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* [Army 1999], and the *Transformation of U.S. Army Alaska FEIS* [Army 2004]). These documents are incorporated by reference which, in NEPA terms, means that the environmental effects of these activities are addressed in these documents.

Environmental effects in the open ocean beyond the U.S. territorial sea (outside of 12 nm) are analyzed in this Draft EIS/OEIS pursuant to EO 12114 and associated implementing regulations.

This Draft EIS/OEIS provides an assessment of environmental effects associated with current and proposed training activities and changes in force structure (to include new systems, platforms, and instrumentation).

ES 1.3.1 National Environmental Policy Act

The first step in the NEPA process is the preparation of a Notice of Intent (NOI) to develop an EIS/OEIS. The NOI provides an overview of the Proposed Action, Alternatives, and the scope of the Draft EIS/OEIS. The NOI for this project was published in the *Federal Register* on March 17, 2008, and in four local newspapers, (*Anchorage Daily News, Kodiak Daily Mirror, Cordova Times, Peninsula Clarion* [see Appendix G]). The NOI and newspaper notices included information about comment procedures, a list of information repositories (public libraries), the project website (http://www.GulfofAlaskaNavyEIS.com), and the dates and locations of the scoping meetings.

Scoping is the early and open public process for determining the “scope” of issues to be addressed in the Draft EIS/OEIS, and for identifying significant issues related to a Proposed Action. In April of 2008, the three scoping meetings for this Draft EIS/OEIS (held in Kodiak, Alaska [AK]; Anchorage, AK; and Cordova, AK) invited public attendance to help define and prioritize environmental issues, and convey these issues to the Navy. As a result of the scoping process, the Navy received comments from the public (see Appendix G), as well as agencies, private entities, and federally recognized Native American Tribes and Nations which have been considered in the preparation of this Draft EIS/OEIS.

Incorporating public input from the scoping process, this Draft EIS/OEIS was prepared to assess the potential effects of the Proposed Action and Alternatives on the human environment. A Notice of Availability was published in the *Federal Register*, and notices were placed in the aforementioned newspapers announcing the availability of the Draft EIS/OEIS. The Draft EIS/OEIS is now available for general review, and is being circulated for review and comment. Public meetings will be advertised and held in the same geographic venues as the scoping meetings, as well as two additional venues, to receive public comments on the Draft EIS/OEIS.

A Final EIS/OEIS will be prepared that responds to all public comments, including comments received from other federal and state agencies, on the Draft EIS/OEIS. Responses to public comments may take various forms as necessary, including correction of data, clarifications of and modifications to analytical approaches, and inclusion of additional data or analyses. The Final EIS/OEIS will then be released and available to the public.

After a review of comments received from the public, a decision among the alternatives will be made and the Office of the Assistant Secretary of the Navy (Installations and Environment) will issue a Record of Decision (ROD) no sooner than 30 days after the Final EIS/OEIS is made available to the public. The ROD will summarize the Navy’s decision, identify the selected Alternative, describe the public involvement and agency decision-making processes, and include commitments to specific mitigation measures.

Comments received from the public during the scoping process are categorized and summarized below in Table ES-1. This table is not intended to provide a complete listing, but to show the extent of the scope of comments and the variety of parties making comments. A more thorough summary of the public scoping process is presented in Appendix G of this Draft EIS/OEIS.

Table ES-1: Public Scoping Comment Summary

Category	Comment Summary
Marine Mammals	Concerns about physical and physiological effects to marine mammals from Navy activities. In particular, injuries from ship strikes and sonar, to include being disoriented, strandings, and hearing loss.
Sonar, Sound in the Water	Desires that the Draft EIS/OEIS consider alternative technologies to mid-frequency active (MFA) sonar. General feeling that MFA and other forms of sonar are not required for training and should not be conducted within the GOA.
Fish and Marine Habitat	Concerns about the effects to fish and marine mammal habitats from Navy activities to include migratory routes, feeding grounds, and breeding as well as impacts from hazardous materials and waste.
Mitigation	Concern about the Navy's training program for spotting animals. Belief that spotting marine mammals is extremely difficult, even for expert observers, and doubts that shipboard lookouts will be able to detect animals in the adverse sea conditions, especially at night. Questions about mitigating the possible adverse impacts to marine mammals from sonar. Belief that, in general, the Navy needs to aggressively consider ways to expand, improve, and employ better protective measures in future, better identify clear monitoring goals and objectives with specific parameters for measuring success, and provide a feedback mechanism for the public to view information on mitigation effectiveness and monitoring results.
Policy/NEPA compliance and Public Participation	Concern that information available during scoping was inadequate to inform commenters or that the "poster" session was not the best format. Some desired a more open forum type format, where all questions voiced could be heard by all. Request that meeting locations be expanded.
Threatened & Endangered Species	Concerns about the number of endangered species, particularly whales (seven in total), within the GOA, and designation of critical habitats.
Commercial Fishing	Concerns about the effects of Navy activities upon fish, their embryos, migration patterns, and the overall impact on the commercial fishing industry and, thus, the livelihoods of Alaskans in general.

ES 1.3.2 Executive Order (EO) 12114

EO 12114, *Environmental Effects Abroad of Major Federal Actions*, directs federal agencies to provide for informed decision making for major federal actions outside the U.S. territorial sea. This includes actions within the Exclusive Economic Zone (EEZ) of the U.S. or a foreign nation, but excludes the territorial sea of a foreign nation. The EEZ comprises areas beyond 12 nm (22.2 km) out to 200 nm (370.4 km) from shore. This Draft EIS/OEIS satisfies the requirements of EO 12114 for analysis of training activities or impacts occurring, or proposed to occur, beyond the U.S. territorial sea border and within the U.S. EEZ 12-200 nm (22.2-370.4 km) (see Table 1-1, Section 1.5).

ES 1.3.3 Coastal Zone Management Act

The *Coastal Zone Management Act* (CZMA) of 1972 (16 U.S.C. § 1451) encourages coastal states to be proactive in managing coastal uses and coastal resources in the coastal zone. The CZMA established a voluntary coastal planning program through which participating states submit a Coastal Management Plan (CMP) to the National Oceanographic and Atmospheric Administration (NOAA) Office of Ocean and Coastal Resource Management (OCRM) for approval. Under CZMA, federal actions are required to be consistent, to the maximum extent practicable, with the enforceable policies of approved state CMPs. The CZMA federal consistency determination process includes a review of the proposed federal actions by the states to determine whether it has potential direct or indirect effects on coastal zone resources or uses under the provisions of the state CMP.

The State of Alaska has an approved CMP (Alaska Coastal Management Program -"ACMP"), which is found at Alaska Statutes Annotated (AS) 46.40.020. The ACMP received federal approval from the NOAA in 1979. The Alaska Department of Natural Resources (ADNR) is the state's designated coastal management agency and is responsible for reviewing projects for consistency with the ACMP and issuing coastal management decisions under the provisions of 11 AAC Code Chapters 110 and 112. Specific statewide standards for review under the ACMP are found at 11 AAC Chapter 112,

In general, the CZMA defines the coastal zone as extending "to the outer limit of State title and ownership under the Submerged Lands Act." For the state of Alaska, CZMA coastal boundaries are determined by each individual Coastal Resource District pursuant to 11 Alaska Administrative Code (AAC) 114.220. Specific standards under the ACMP that appear applicable to proposed training activities occurring in the TMAA are 11 AAC Chapter 112 Sections 280 ("Transportation Routes and Facilities"), 300 ("Habitats"), 310 ("Air, Land, and Water Quality), and 320 ("Historic, Prehistoric, and Archeological Resources").

For the activities covered in this Draft EIS/OEIS, the Navy will ensure compliance with the CZMA through coordination with the ADNR.

ES 1.3.4 Other Environmental Requirements Considered

The Navy must comply with a variety of other federal environmental laws, regulations, and EOs. These include (among other applicable laws and regulations):

- Marine Mammal Protection Act (MMPA) (16 U.S.C. §§ 1361-1407);
- Endangered Species Act (ESA) (16 U.S.C. §§ 1531-1544);
- Migratory Bird Treaty Act (MBTA) (16 U.S.C. §§ 703-711);
- Rivers and Harbors Act (RHA) (33 U.S.C. §§ 401-426);
- Magnuson-Stevens Fishery Conservation and Management Act (MSA) for Essential Fish Habitat (EFH) (16 U.S.C. §§ 1801-1891);
- Clean Air Act (CAA) (42 U.S.C. §§ 7401-7671);
- Federal Water Pollution Control Act (Clean Water Act) (33 U.S.C. §§ 1251-1387);
- National Historic Preservation Act (NHPA) (16 U.S.C. § 470);
- EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (EO 12898, 59 FR 7269 [Feb 16, 1994]);
- EO 13045, Environmental Health and Safety Risks to Children (EO 13045, 62 FR 19885 [Apr 23, 1997]);
- Alaska Native Claims Settlement Act of 1971 (ANSCA) (43 U.S.C. §§ 1601-1629); and
- Alaska National Interest Lands Conservation Act (ANILCA) (16 U.S.C. §§ 3101-3233).

In addition, laws and regulations of the State of Alaska appropriate to Navy actions are identified and addressed in this Draft EIS/OEIS. This Draft EIS/OEIS will facilitate compliance with applicable state laws and regulations.

ES 1.4 PROPOSED ACTION AND ALTERNATIVES

ES 1.4.1 Alternatives Development

NEPA implementing regulations provide guidance on the consideration of alternatives in an EIS/OEIS. These regulations require the decision maker to consider the environmental effects of the Proposed Action and a range of alternatives to the Proposed Action (40 C.F.R. § 1502.14). The range of alternatives includes reasonable alternatives, which must be rigorously and objectively explored, as well as other alternatives that are eliminated from further consideration and from further detailed study. To be "reasonable," an alternative must meet the stated purpose of and need for the Proposed Action.

For purposes of this Draft EIS/OEIS, the No Action Alternative serves as the baseline level of operations, representing the regular and historical level of training activity necessary to maintain Navy readiness. Consequently, the No Action Alternative stands as no change from current levels of training usage. This interpretation of the No Action Alternative is consistent with guidance provided by CEQ (CEQ's 40 Most Asked Questions, Question #3; http://ceq.hss.doe.gov), which indicates that where ongoing federal programs continue, even as new plans are developed, "no action" is "no change" from current management direction or level of management intensity. The potential impacts of the current level of training within the ATA (defined by the No Action Alternative) are compared to the potential impacts of activities proposed under Alternative 1 and Alternative 2.

The purpose of including a No Action Alternative in environmental impact analyses is to ensure that agencies compare the potential impacts of the proposed major federal action to the known impacts of maintaining the status quo.

Alternatives considered in this Draft EIS/OEIS were developed by the Navy after careful assessment by subject-matter experts, including military units and commands that use the ATA, range management professionals, and Navy environmental managers and scientists. The Navy has developed a set of criteria to use in assessing whether a possible alternative meets the purpose of and need for the Proposed Action. Each of these criteria assumes implementation of mitigation measures for the protection of natural resources, as appropriate. Any alternative considered for future analysis should support or employ the following criteria:

1. Appropriate physical environment – unique and complex bathymetric/oceanographic conditions. The following attributes combine to provide a challenging environment for Navy forces to conduct ASW training:

   - Existence of a continental shelf, submarine canyons, and seamounts in the area;
   - Fresh water inputs into the GOA from multiple sources; and
   - Unique areas of upwelling and currents.

2. Proximity of Alaska land and sea training areas to each other to accommodate the joint training mission. The location of the TMAA is directly related to the location of permanent land and air training ranges in the State of Alaska, and supports the mission requirement of Alaskan Command (ALCOM)[3] to conduct joint training for Alaska-based forces and the following elements:

[3] The mission requirement of ALCOM is to integrate military activities within Alaska to maximize the readiness of theater forces, expedite deployment of forces from and through Alaska in support of worldwide contingencies, and serve as the Joint Task Force (JTF) headquarters for protection of critical infrastructure and coordination of Military Assistance to Civil Authorities (MACA).

- Ability to support ALCOM simulated combat conditions and activities;
- Infrastructure that supports a robust opposition force, which allows realistic training;
- Land-based infrastructure to support safety of naval aviation including air fields for aircraft emergency diverted landings; and
- Facilitation of Joint Task Force training in support of PACOM and NORTHCOM.

3. Availability of sufficiently sized air space and ranges that support tactically realistic joint training activities. This criterion allows for:
    - Fewer restrictions on supersonic flights;
    - Ability to conduct numerous types of training activities at the same time in relative proximity without compromising safety and training objectives;
    - Continuous, nonsegmented training, from launch to recovery; and
    - Support of the full spectrum of joint, allied, and coalition training.
4. Appropriate weather conditions for a cold-water environment suitable for maritime activities at sea, including a sea state of three or less on the Beaufort scale (defined as a moderate sea; average wave height of 2-4 feet [ft] [0.6-1.2 meters {m}]).
5. Minimal encroachments on joint training requirements that could include, but are not limited to:
    - Low interference in the electronic spectrum to allow for unrestricted use of electronic sensors and systems; and
    - Large areas with sparse populations or low to no permanent human populations.
6. Training sustainment in support of the DoD Title 10 mandate.
7. Proximity to shipping lanes for realistic training on avoiding conflicts with air and marine traffic.

Having identified criteria for generating alternatives for consideration in this Draft EIS/OEIS, the Navy eliminated several alternatives from further consideration after initial review. Specifically, the following potential alternatives were not carried forward for analysis:

- Alternative Locations
- Reduced Training
- Alternate Time Frame
- Simulated Training

After careful consideration of each of these potential alternatives in light of the identified criteria, the Navy determined that none of them meets the Navy's purpose and need for the Proposed Action. For a more detailed discussion of identified criteria and alternatives selected pursuant to the guidance of 40 C.F.R. § 1502.14(a), see Chapter 2 (Section 2.3.1); for alternatives considered but eliminated, see Chapter 2 (Section 2.3.2).

ES 1.4.2 Alternatives Considered

Three alternatives are analyzed in this Draft EIS/OEIS: 1) The No Action Alternative – continue current activities (no active sonar); 2) Alternative 1 – increase training activities to include the use of active sonar and accommodate force structure changes to include new platforms, weapon systems, and training enhancement instrumentation; 3) Alternative 2 – increase training activities to include the use of active sonar, accommodate force structure changes to include new platforms, weapon systems, and training enhancement instrumentation, and conduct one additional Carrier Strike Group (CSG) exercise during summer months (April through October), annually.

The following sections contain the detailed discussion of Alternatives carried forward for analysis in the Draft EIS/OEIS.

ES 1.4.3 No Action Alternative – Current Training Activities within the Alaska Training Areas

The Navy routinely trains in the ATA for national defense purposes. Under the No Action Alternative, training activities (no active sonar) as part of large-scale joint exercises would continue at baseline levels required to execute the joint training exercise requirements (one joint force exercise occurring over a maximum time period of up to 14 consecutive days during the summer months [April through October]). The Navy would not increase training activities above historical levels, but would continue exercises in the ATA, and specifically the TMAA, with up to one CSG or equivalent forces. Evaluation of the No Action Alternative in this Draft EIS/OEIS provides a baseline for assessing environmental impacts of Alternative 1 and Alternative 2 (Preferred Alternative), as described in the following subsections.

Training activities and exercises currently conducted in the ATA are briefly described below. Each military training activity described in this Draft EIS/OEIS meets a requirement that can be traced ultimately to requirements from the National Command Authority.[4] Training activities in the ATA stem from large-scale joint exercises, such as Northern Edge, which may involve thousands of participants and span several days. These exercises include basic individual or unit level training events of relatively short duration involving few participants that occur simultaneously with the large-scale joint exercises.

Over the years, the tempo and types of activities have fluctuated within the ATA due to changing requirements, the introduction of new technologies, the dynamic nature of international events, advances in warfighting doctrine and procedures, and force structure changes. Such developments have influenced the frequency, duration, intensity, and location of required training. The factors influencing tempo and types of activities are fluid in nature and will continue to cause fluctuations in training activities within the ATA. However, even with the fluidity of the training requirements, the “ceiling numbers” for the alternatives in the Draft EIS/OEIS will not be exceeded. Accordingly, training activity data used throughout this Draft EIS/OEIS are a representative baseline for evaluating impacts that may result from the proposed training activities.

ES 1.4.4 Description of Current Training Activities within the Alaska Training Areas

For purposes of analysis, training activity data used in this Draft EIS/OEIS are organized by Navy Primary Mission Areas (PMARs). The Navy currently trains in five PMARs in the TMAA: Anti-Air Warfare, Anti-Surface Warfare, Electronic Combat (EC), Naval Special Warfare (NSW), and Strike Warfare (STW). The Navy also conducts STW, EC, and NSW training in the Air Force SUA and Army training lands of the ATA. Although discussed in this document, these inland activities and their impacts are covered under other NEPA documentation by the Air Force and Army (USAF 1995, USAF 2007, Army 1999, and Army 2004 [refer to Sections 2.1.2 and 2.1.3]). Navy requirements will mandate ASW

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[4] National Command Authority (NCA) is a term used by the United States military and government to refer to the ultimate lawful source of military orders. The term refers collectively to the President of the United States (as commander-in-chief) and the United States Secretary of Defense.

training activities take place in the TMAA using active sonar. Summary descriptions of current training activities are outlined in Table 2-7 (Section 2.6.3). As stated earlier, the No Action Alternative is the baseline of current training area usage, thus allowing a comparative analysis between the current tempo and proposed new uses and accelerated tempo of use.

ES 1.4.5 Alternative 1 – Increase Training Activities to Include Anti-Submarine Warfare Activities and Accommodate Force Structure Changes

Under Alternative 1, in addition to training activities currently conducted, the ATA would support an increase in training activities designed to meet Navy and DoD current and near-term operational requirements. This increase would encompass conducting one large-scale joint force exercise, including ASW activities and the use of active sonar, occurring over a maximum time period of up to 21 consecutive days during the summer months (April through October). Alternative 1 would include basic individual or unit level training events of relatively short duration occurring simultaneously with the large-scale joint force exercise. Alternative 1 would also accommodate increases in training activities due to force structure changes associated with the introduction of new weapon systems, vessels, aircraft, and training instrumentation into the Fleet. Training activities associated with force structure changes would be implemented for the EA-18G Growler, SSGN, P-8 MMA, DDG 1000 (Zumwalt Class), and UASs. Force structure changes associated with new weapons systems would include new types of sonobuoys. Force structure changes associated with new training instrumentation include the use of a Portable Undersea Tracking Range (PUTR). The PUTR would require the temporary placement of seven electronics packages on the seafloor, each approximately 3 ft (0.9 m) long by 2 ft (0.6 m) in diameter. No specific locations have yet been identified, but the electronic packages would be placed in water depths greater than 600 ft (182 m) and at least 3 nm (5.5 km) from land. Depending upon the configuration of the PUTR, it could cover an area from 25-100 nm^2. This is a temporary installation (to be recovered once training is complete), so no formal restricted areas would be designated and no limitations would be placed on commercial or civilian use of the area.

ES 1.4.6 Alternative 2 (Preferred Alternative) – Increase Training Activities, Accommodate Force Structure Changes, Conduct One Additional Annual Exercise, and Conduct One SINKEX During Each Summertime Exercise

Under Alternative 2, in addition to training activities included as a part of Alternative 1 (accommodating training activities currently conducted, increasing specific training activities to include the use of active sonar, and accommodating force structure changes) the ATA would support an additional increase in training activities designed to meet Navy and DoD current and near-term operational requirements. This increase would entail the following activities:

- Conduct one additional separate large-scale joint force exercise, occurring over a maximum time period of up to 21 consecutive days during the summer months (April through October). Alternative 2 would include basic individual or unit level training events of relatively short duration occurring simultaneously with the large-scale joint force exercise..
- Conduct a SINKEX during each summertime exercise (a maximum of 2) within the TMAA. During a SINKEX, a decommissioned surface ship is towed to a deep-water location and sunk using a variety of ordnance. The SINKEX would occur, by rule, at least 50 nm (93 km) offshore.

Alternative 2 is the Preferred Alternative because it would allow the greatest flexibility for Navy exercise planners to benefit from the unique joint training environment in the ATA. Additionally, Alternative 2 fully meets the criteria identified in Section 2.3.1.

ES 1.5 SUMMARY OF EFFECTS ANALYSIS

Chapter 3 of the Draft EIS/OEIS describes existing environmental conditions for resources potentially affected by the Proposed Action and Alternatives described in Chapter 2. This chapter also identifies and assesses the environmental consequences of the Proposed Action and Alternatives. The affected environment and environmental consequences are described and analyzed according to categories of resources. The categories of resources addressed in this Draft EIS/OEIS and the location of the respective analyses are identified in Table ES-2.

In the environmental impact analysis process, the resources analyzed are identified and the expected geographic scope of potential impacts for each resource, known as the resource's region of influence (ROI), is defined. The discussion and analysis, organized by resource area, covers the TMAA, to the extent affected resources or potential impacts are present.

Analysis of potential impacts of Navy activities on marine mammals is particularly complex. Therefore, the Navy has provided a comprehensive discussion of the approach to and results of the impacts analysis relating to marine mammals in Section 3.8 Marine Mammals and Appendix D Marine Mammal Modeling.

Table ES-2: Categories of Resources Addressed and EIS/OEIS Chapter

Air Quality (3.1)	Marine Mammals (3.8)
Expended Materials (3.2)	Birds (3.9)
Water Resources (3.3)	Cultural Resources (3.10)
Acoustic Environment (Airborne) (3.4)	Transportation and Circulation (3.11)
Marine Plants and Invertebrates (3.5)	Socioeconomics (3.12)
Fish (3.6)	Environmental Justice and Protection of Children (3.13)
Sea Turtles (3.7)	Public Safety (3.14)

ES 1.6 CUMULATIVE IMPACTS

The analysis of cumulative impacts considers the effects of the Proposed Action in combination with other past, present, and reasonably foreseeable future actions taking place in the project area, regardless of what agency or person undertakes these actions. This Draft EIS/OEIS analyzes cumulative impacts associated with implementation of Navy-sponsored activities and other non-Navy activities in the region. Other activities analyzed included fishing, commercial and recreational marine traffic, ocean pollution, scientific research, and commercial and general aviation. Cumulative effects resulting from other relevant projects (such as those listed in Section 4.1.2) combined with the Proposed Action addressed in this Draft EIS/OEIS were determined to have cumulative impacts, but those impacts are less than significant.

ES 1.7 MITIGATION AND PROTECTIVE MEASURES

NEPA regulations require an EIS to include appropriate mitigation measures not already included in the Proposed Action or Alternatives (40 C.F.R. § 1502.12(f)). Each of the Alternatives, including the Proposed Action considered in this Draft EIS/OEIS, already includes protective or mitigation measures intended to reduce environmental effects from Navy activities. Measures, such as best management practices (BMPs) and Standard Operating Procedures (SOPs), are discussed in the resource-by-resource analysis, and also are addressed in detail in Chapter 5, Mitigation and Protective Measures.

As part of its commitment to sustainable use of resources and environmental stewardship, the Navy incorporates measures that are protective of the environment into all of its activities. These include employment of BMPs, SOPs, adoption of conservation recommendations, and other protective measures that mitigate the impacts of Navy activities on the environment. Some of these measures are generally designed to apply to certain geographic areas during certain times of year or for specific types of Navy training. Conservation measures covering habitats and species occurring in the ATA have been developed through various environmental analyses conducted by the Navy for land and sea ranges and adjacent coastal waters. The discussion in Chapter 5 describes mitigation measures applicable to Navy activities in the TMAA. Existing protective measures and mitigation measures are also presented in Table ES-2 for each resource section analyzed.

Table ES-3: Summary of Effects

		No Action Alternative	Alternative 1	Alternative 2
3.1 Air Quality	NEPA (U.S. Territorial Seas, 0 to 12 nm)	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to air quality would occur. • Overflights of ocean (0-12 nm) and land areas at altitudes above 3,000 ft AGL would not affect ground-level air quality.	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to air quality would occur. • Overflights of ocean (0-12 nm) and land areas at altitudes above 3,000 ft AGL would not affect ground-level air quality.	• Under Alternative 2, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to air quality would occur. • Overflights of ocean (0-12 nm) and land areas at altitudes above 3,000 ft AGL would not affect ground-level air quality.
	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)	• The No Action Alternative would maintain training activities and associated air pollutant emissions at baseline levels outside of U.S. territory.	• Outside of U.S. territory, air pollutant emissions would increase slightly, mainly from increased surface vessel and aircraft activities. • Although Alternative 1 would increase emissions of air pollutants over the No Action Alternative, emissions outside of U.S. territorial seas would not cause an air quality standard to be exceeded.	• Outside of U.S. territory, air pollutant emissions would increase substantially, mainly from increased surface vessel and aircraft activities. • SINKEX would generate a substantial portion of the air pollutants that would be emitted under Alternative 2. • Although Alternative 2 would increase emissions of air pollutants over the No Action Alternative, emissions outside of U.S. territorial seas would not cause an air quality standard to be exceeded.
	MITIGATION MEASURES: Equipment used by military organizations within the GOA, including ships and other marine vessels, aircraft, and other equipment, are properly maintained in accordance with applicable Navy and Marine Corps requirements. Operating equipment meets federal and state emission standards, where applicable. Annual emissions of criteria and hazardous air pollutants produced by the Proposed Action are well below a level that could degrade regional air quality. Therefore, no mitigation measures are required to reduce the impacts on the environment of air emissions from the Proposed Action.			

Table ES-3: Summary of Effects (continued)

		No Action Alternative	Alternative 1	Alternative 2
3.2 Expended Materials	NEPA (U.S. Territorial Seas, 0 to 12 nm)	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). No significant impacts related to expended materials will occur. • Aircraft overflights will not involve expenditures of training materials.	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). No significant impacts related to expended materials would occur. • Aircraft overflights would not involve expenditures of training materials.	• Under Alternative 2, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). No significant impacts related to expended materials would occur. • Aircraft overflights would not involve expenditures of training materials.
3.2 Expended Materials	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)	• Approximately 76,200 lb (34,600 kg) of training materials will be expended per year, with a density of 9.0 lb per nm^2 (1.2 kg per km^2) per year. • Approximately 1,870 lb (850 kg) of hazardous materials would be distributed at an estimated 0.22 lb per nm^2 (0.03 kg per km^2) per year. • Expended materials under the No Action Alternative will not have a substantial effect on the environment.	• Increase in training would deposit approximately 143,000 lb (65,000 kg) of expended materials, with a density of 16.9 lb per nm^2 (2.23 kg per km2) per year. • Approximately 4,890 lb (2,220 kg) of hazardous materials would be distributed at an estimated 0.58 lb per nm^2 (0.08kg per km^2) per year. • Expended materials under Alternative 1 would not have a substantial effect on the marine environment.	• There would be a large increase in the weight of expended materials (352,000 lb [160,000 kg]). • Hazardous materials would account for 2.9 percent (10,300 lb [4,680 kg]) per year of expended material, but density of these materials would be approximately 1.2 lb per nm^2. • SINKEX training would result in approximately 67,800 lb per year of expended materials, of which one percent would be considered hazardous. SINKEX would result in a relatively high areal density of expended materials on portions of the TMAA. • Expended materials under Alternative 2 would not have a substantial effect on the marine environment.
3.2 Expended Materials	***MITIGATION MEASURES:*** As summarized in Section 3.2.4, the alternatives would contribute small amounts of hazardous materials to the environment. Given the large size of the training area and the expected fate and transport of the constituents, hazardous materials released to the environment by the Proposed Action are not likely to be present at detectable concentrations. Current Navy protective measures, such as hazardous waste management procedures identified in Section 3.2.1.2, would continue to be implemented. No additional mitigation measures would be required under the Preferred Alternative.			

Table ES-3: Summary of Effects (continued)

		No Action Alternative	Alternative 1	Alternative 2
3.3 Water Resources	NEPA (U.S. Territorial Seas, 0 to 12 nm)	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1997, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts on water resources would occur. • Aircraft overflights would not involve expenditures of training materials, and thus would not affect water quality.	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1997, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts on water resources would occur. • Aircraft overflights would not involve expenditures of training materials, and thus would not affect water quality.	• Under Alternative 2, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1997, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts on water resources would occur. • Aircraft overflights would not involve expenditures of training materials, and thus would not affect water quality.
	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)	• Ordnance constituents and other materials (batteries, fuel, and propellant) from training devices have minimal effect or are below standards. • No long-term degradation of marine water quality.	• An estimated 26-percent increase in expended training materials would occur, compared to the No Action Alternative. • Deposition of hazardous materials (i.e., batteries, fuel, and propellant) from expended materials would be minimal (less than ½ lb per nm^2). • No long-term degradation of marine water quality would occur.	• An estimated 160 percent increase in expended training materials would occur, compared to the No Action Alternative. • Impacts from the increase in expended materials would be minimal because most expended materials (97 percent) would be inert in the marine environment. • Assuming deposition over 20% of the TMAA, the amount of hazardous materials from expended materials would be low, approximately 1.2 lb per nm^2 per year.
	MITIGATION MEASURES: Impacts on water resources resulting from the alternatives would be below thresholds that could result in long-term degradation of water resources or affect water quality. Possible impacts to water quality during normal operating conditions would continue to be mitigated by measures identified in Section 3.3.1.2, which include shipboard management, storage, and discharge of hazardous materials and wastes, and other pollution protection measures intended to protect water quality. No additional mitigation measures would be implemented because there would be no substantial impact to water quality.			

Table ES-3: Summary of Effects (continued)

		No Action Alternative	Alternative 1	Alternative 2
3.4 Acoustic Environment (Airborne)	NEPA (U.S. Territorial Seas, 0 to 12 nm)	• Current Navy activities involving aircraft overflight were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to Airborne Noise would occur. • Aircraft overflights (> 15,000 ft) over the U.S. Territorial Seas (0-12 nm) to the TMAA would have no effect on the acoustic environment.	• Current Navy activities involving aircraft overflight were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to Airborne Noise would occur. • Aircraft overflights (> 15,000 ft) over the U.S. Territorial Seas (0-12 nm) to the TMAA would have no effect on the acoustic environment.	• Current Navy activities involving aircraft overflight were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to Airborne Noise would occur. • Aircraft overflights (> 15,000 ft) over the U.S. Territorial Seas (0-12 nm) to the TMAA would have no effect on the acoustic environment.
	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)	*Surface Ship Noise* • No change from current conditions. Minor at-sea noise. No sensitive receptors present. *Aircraft Noise* • No change from current conditions. Short-term noise impacts, including sonic booms. No sensitive receptors present at sea. *Weapon and Target Noise* • No change from current conditions. Very short-term noise impacts. No sensitive receptors present at sea.	*Surface Ship Noise* • Minor localized engine noise. No sensitive receptors present. *Aircraft Noise* • Short-term noise impacts, including sonic booms. No sensitive receptors present at sea. *Weapon and Target Noise* • Very short-term noise impacts. No sensitive receptors present at sea.	*Surface Ship Noise* • Minor localized engine noise. No sensitive receptors present. *Aircraft Noise* • Short-term noise impacts, including sonic booms. No sensitive receptors present at sea. *Weapon and Target Noise* • Very short-term noise impacts. No sensitive receptors present at sea.
	MITIGATION MEASURES: In the TMAA, most Navy training takes place far out to sea, and airborne noise levels would primarily affect military personnel operating the equipment/weapon systems producing the noise. Personnel engaged in the exercise wear personal protective equipment and are not considered sensitive receptors for purposes of the EIS/OEIS analysis. No additional noise-specific mitigation measures are required.			

Table ES-3: Summary of Effects (continued)

		No Action Alternative	Alternative 1	Alternative 2
3.5 Marine Plants and Invertebrates	NEPA (U.S. Territorial Seas, 0 to 12 nm)	• Overflights would not affect marine plants and invertebrates.	• Overflights would not affect marine plants and invertebrates.	• Overflights would not affect marine plants and invertebrates.
	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)	• Expended materials and the release of munitions constituents and other materials would be distributed widely over the TMAA (1.9 items per nm^2 [0.5 per km^2]) and have minimal effects on pelagic and benthic communities. More than 97 percent of these items would be from gunshells and small caliber rounds. • Surface or near-surface explosions have the potential to kill or harm individual animals and plants in the immediate vicinity resulting in localized impacts. Given the TMAA size and using conservative estimates, 0.01 explosions would occur per nm^2 (0.003 per km^2) per year resulting in minimal effects. Benthic communities would not be affected by explosions due to water depth.	• Expended materials and the release of munitions constituents and other materials would be distributed widely over the TMAA (2.4 items per nm^2 [0.7 per km^2]) and have minimal effects on pelagic and benthic communities. More than 93 percent of these items would be from gunshells and small caliber rounds. • Surface or near-surface explosions have the potential to kill or harm individual animals and plants in the immediate vicinity resulting in localized impacts. Given the TMAA size and using conservative estimates, 0.02 explosion would occur per nm^2 (0.006 per km^2) per year resulting in minimal effects. Benthic communities would not be affected by explosions due to water depth. • Localized and temporary impacts to benthic fauna may occur from the PUTR, but no long-term impact is anticipated.	• Expended materials and the release of munitions constituents and other materials would be distributed widely over the TMAA (4.9 items per nm^2 [1.4 per km^2]) and have minimal effects on pelagic and benthic communities. More than 91 percent of these items would be from gunshells and small caliber rounds. • Surface or near-surface explosions have the potential to kill or harm individual animals and plants in the immediate vicinity resulting in localized impacts. Given the TMAA size and using conservative estimates, 0.14 explosion would occur per nm^2 (0.04 per km^2) per year resulting in minimal effects. Benthic communities would not be affected by explosions due to water depth. • Although localized and temporary impacts to the pelagic environment would occur from a SINKEX, the relatively small quantities of materials expended, dispersed as they are over a very large area, would have no adverse physical effects on marine biological resources.
	MITIGATION MEASURES: The Navy has no existing protective measures in place specifically for marine plants and invertebrates. However, marine plants and invertebrates benefit from measures in place to protect marine mammals and sea turtles that are described in full in Chapter 5. As summarized above, and in detail in Section 3.5.2, the actions proposed under the alternatives described in this EIS/OEIS would have minimal impacts on the marine plant and invertebrate communities of the TMAA. Therefore, no resource-specific mitigation measures would be required.			

Table ES-3: Summary of Effects (continued)

		No Action Alternative	Alternative 1	Alternative 2
3.6 Fish	NEPA (U.S. Territorial Seas, 0 - 12 nm)	• Overflights would not adversely affect fish populations or EFH as defined under the MSFCMA.	• Overflights would not adversely affect fish populations or EFH as defined under the MSFCMA.	• Overflights would not adversely affect fish populations or EFH as defined under the MSFCMA.
	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)	• Vessel movement, aircraft overflight, weapons firing disturbance, and expended materials would result in minimal harm to fish or EFH. Given the TMAA size and using conservative estimates, the concentration of expended materials would be 1.9 per nm^2 (0.5 per km^2). More than 97 percent of these items would be from gunshells and small caliber rounds. • Explosive ordnance use may result in injury or mortality to individual fish but would not result in impacts to fish populations. Given the TMAA size and using conservative estimates, the concentration of explosive ordnance would be 0.010 per nm^2 (0.003 per km^2). • Activities would not adversely affect fish populations or EFH as defined under the MSFCMA. • May affect ESA-listed fish species. • No effect to designated critical habitat.	• Vessel movement, aircraft overflight, weapons firing disturbance, and expended materials would result in minimal harm to fish or EFH. Given the TMAA size and using conservative estimates, the concentration of expended materials would be 2.4 per nm^2 (0.7 per km^2). More than 93 percent of these items would be from gunshells and small caliber rounds. • Explosive ordnance use may result in injury or mortality to individual fish but would not result in impacts to fish populations. Given the TMAA size and using conservative estimates, the concentration of explosive ordnance would be 0.020 per nm^2 (0.006 per km^2). • Because only a few species of fish may be able to hear the relatively higher frequencies of mid-frequency sonar, sonar used in Navy exercises would result in minimal harm to fish or EFH. • Activities would not adversely affect fish populations or EFH as defined under the MSFCMA. • May affect ESA-listed fish species. • No effect to designated critical habitat.	• Vessel movement, aircraft overflight, weapons firing disturbance, and expended materials would result in minimal harm to fish or EFH. Given the TMAA size and using conservative estimates, the concentration of expended materials would be 4.9 per nm^2 (1.4 per km^2). More than 91 percent of these items would be from gunshells and small caliber rounds. • Explosive ordnance use may result in injury or mortality to individual fish but would not result in impacts to fish populations. Given the TMAA size and using conservative estimates, the concentration of explosive ordnance would be 0.142 per nm^2 (0.041 per km^2). • Because only a few species of fish may be able to hear the relatively higher frequencies of mid-frequency sonar, sonar used in Navy exercises would result in minimal harm to fish or EFH. • Activities would not adversely affect fish populations or EFH as defined under the MSFCMA. • May affect ESA-listed fish species. • No effect to designated critical habitat.
	MITIGATION MEASURES: The Navy has no existing protective measures in place specifically for fish. However, habitats associated with fish communities benefit from measures in place to protect marine mammals and sea turtles that are described in full in Chapter 5. As summarized above and in detail in Section 3.6.2, the alternatives proposed in the EIS/OEIS would be expected to affect individual fish and have localized effects on their habitats, but would not affect communities or populations of species or their use of the TMAA. The current protective measures described in Chapter 5 would continue to be implemented, and no further mitigation measures would be needed to protect fish in the TMAA.			

Table ES-3: Summary of Effects (continued)

		No Action Alternative	Alternative 1	Alternative 2
3.7 Sea Turtles	NEPA (U.S. Territorial Seas, 0 to 12 nm)	• Aircraft overflights would occur at altitudes at or above 15,000 ft (915 m) and have no effect on leatherback turtles.	• Aircraft overflights would occur at altitudes at or above 15,000 ft (915 m) and have no effect on leatherback turtles.	• Aircraft overflights would occur at altitudes at or above 15,000 ft (915 m) and have no effect on leatherback turtles.
3.7 Sea Turtles	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)	• Activities would have temporary and spatially limited short-term impacts. • No long-term effects would occur. • No Action Alternative may affect ESA-listed leatherback turtles.	• Activities would have temporary and spatially limited short-term impacts. • No long-term effects would occur. • Alternative 1 may affect ESA-listed leatherback turtles.	• Activities would have temporary and spatially limited short-term impacts. • No long-term effects would occur. • Alternative 2 may affect ESA-listed leatherback turtles.
3.7 Sea Turtles	***MITIGATION MEASURES:*** Impacts to the leatherback turtle resulting from the alternatives proposed in this EIS/OEIS would be below thresholds that could adversely affect the continued presence of this species in the GOA or the TMAA. The comprehensive suite of protective measures and SOPs implemented by the Navy to reduce impacts to marine mammals also serves to mitigate potential impacts on sea turtles. In particular, personnel and watchstander training, establishment of turtle-free exclusion zones for at-sea explosions, and pre- and post-exercise surveys all serve to reduce or eliminate potential impacts of Navy activities on sea turtles that may be present in the vicinity. The current requirements and practices described in detail in Chapter 5 would continue to be implemented, and no further mitigation measures would be needed to protect leatherback turtles in the TMAA.			

Table ES-3: Summary of Effects (continued)

		No Action Alternative	Alternative 1	Alternative 2
3.8 Marine Mammals	NEPA (0 - 12 nm)	• Aircraft overflights of U.S. territorial seas would occur at altitudes at or above 15,000 ft (915 m) and have no effect on marine mammals.	• Aircraft overflights of U.S. territorial seas would occur at altitudes at or above 15,000 ft (915 m) and have no effect on marine mammals.	• Aircraft overflights of U.S. territorial seas would occur at altitudes at or above 15,000 ft (915 m) and have no effect on marine mammals.
3.8 Marine Mammals	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)	• Short-term behavioral responses from general vessel disturbance possible. Potential for injury or mortality from vessel collisions but occurrence is very unlikely. • Potential for short-term behavioral responses to low level overflights. No long-term population-level effects. • Extremely low probability of direct strikes from ordnance and low potential for ingestion of expended materials. • For at-sea explosions, behavioral effects modeling, indicates 102 MMPA Level B harassments from sub-TTS and/or TTS, one MMPA Level A harassment resulting from slight injury, and no exposures resulting in potential severe injury. With implementation of mitigation measures, the MMPA Level A harassments should not occur. • All seven ESA-listed species of marine mammals may be affected by one or more stressors resulting from Alternative 1 training activities. All species may be affected by exposures to at-sea explosions.	• Short-term behavioral responses from general vessel disturbance possible. Potential for injury or mortality from vessel collisions but occurrence is very unlikely. • Potential for short-term behavioral responses to low level overflights. No long-term population-level effects. • Extremely low probability of direct strikes from ordnance and low potential for ingestion of expended materials • For at-sea explosions, behavioral effects modeling, indicates 137 MMPA Level B harassments from sub-TTS and/or TTS, one MMPA Level A harassment from slight injury, and no exposures resulting in potential severe injury. Mitigation would reduce the number of these harassments. With implementation of mitigation measures the one MMPA Level A harassment should not occur. • For active sonar & other non-sonar acoustic sources, behavioral effects modeling indicates 215,053 MMPA Level B harassments from non-TTS and 446 MMPA Level B harassments from TTS. There is one predicted MMPA Level A harassment from PTS, but with implementation of mitigation measures, this MMPA Level A harassment should not occur. • All seven ESA-listed species of marine mammals may be affected by one or more stressors resulting from Alternative 1 training activities. All species may be affected by exposures to sonar emissions and at-sea explosions.	• Short-term behavioral responses from general vessel disturbance possible. Potential for injury or mortality from vessel collisions but occurrence is very unlikely. • Potential for short-term behavioral responses to low level overflights. No long-term population-level effects. • Extremely low probability of direct strikes from ordnance and low potential for ingestion of expended materials • For at-sea explosions, modeling indicates 240 MMPA Level B harassments from sub-TTS and/or TTS, four MMPA Level A harassments, and one exposure resulting in potential severe injury. Mitigation would reduce the number of these harassments. With implementation of mitigation measures, the four MMPA Level A harassments and one severe injury should not occur. Increase in at-sea explosions from SINKEX are offset by area clearance procedures. • For active sonar & other non-sonar acoustic sources, behavioral effects, modeling indicates 424,620 MMPA Level B harassments from non-TTS and 931 MMPA Level B harassments from TTS. There is one predicted MMPA Level A harassment from PTS, but with implementation of mitigation measures, this MMPA Level A harassment should not occur. • All seven ESA-listed species of marine mammals may be affected by one or more stressors resulting from Alternative 1 training activities. All species may be affected by exposures to sonar emissions and at-sea explosions.
3.8 Marine Mammals	***MITIGATION MEASURES***: The Navy intends to implement a comprehensive suite of mitigation measures that serve to reduce impacts to marine mammals that might result from Navy training in the TMAA (summarized in Sec 3.8.7 and in detail in Sec 5.1.7). In particular, personnel and watchstander training, establishment of marine mammal-free exclusion zones for at-sea explosions, and pre- and post-exercise surveys all serve to reduce or eliminate potential impacts of Navy activities on marine mammals that may be present in the vicinity. The current requirements and practices described in detail in Ch. 5 would continue to be implemented, and no further mitigation measures would be needed to protect marine mammals in the TMAA.			

Table ES-3: Summary of Effects (continued)

		No Action Alternative	Alternative 1	Alternative 2
3.9 Birds	NEPA (U.S. Territorial Seas, 0 to 12 nm)	• Due to flight altitude, behavioral responses to overflights in territorial seas are not expected. • Potential for harm to birds from aircraft strikes is extremely low and is not anticipated. • The remainder of training activities are located outside the U.S territorial seas boundary.	• Due to flight altitude, behavioral responses to overflights in territorial seas are not expected. • Potential for harm to birds from aircraft strikes is extremely low and is not anticipated. • The remainder of training activities are located outside the U.S territorial seas boundary.	• Due to flight altitude, behavioral responses to overflights in territorial seas are not expected. • Potential for harm to birds from aircraft strikes is extremely low and is not anticipated. • The remainder of training activities are located outside the U.S territorial seas boundary.
3.9 Birds	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)	• Harm due to vessel movements is unlikely. • Brief behavioral response to overflights in nonterritorial seas. Low potential for harm to birds from aircraft strikes. • Low potential for harm to birds from ordnance use in nonterritorial seas. • Low potential for harm to birds from explosives use in nonterritorial seas. • Low potential for harm from military expended materials in nonterritorial seas. • Within the TMAA, the single endangered species is the Short-tailed Albatross. Vessel movements, aircraft overflight, ordnance use, at-sea explosions, and military expended materials (entanglement) may affect, but are not likely to adversely affect, individual ESA-listed seabirds.	• Harm due to vessel movements is unlikely. • Brief behavioral response to overflights in nonterritorial seas. Low potential for harm to birds from aircraft strikes. • Low potential for harm to birds from ordnance use in nonterritorial seas. • Low potential for harm to birds from explosives use in nonterritorial seas. • Low potential for harm from military expended materials in nonterritorial seas. • No considerable harm to birds, migratory birds, bald eagles, federally listed species, or their habitat in nonterritorial seas. • Within the TMAA, the single endangered species is the Short-tailed Albatross. Vessel movements, aircraft overflight, ordnance use, at-sea explosions, and military expended materials may affect, but not likely to adversely affect, individual ESA-listed seabirds.	• Harm due to vessel movements is unlikely. • Brief behavioral response to overflights in nonterritorial seas. Low potential for harm to birds from aircraft strikes. • Low potential for harm to birds from ordnance use in nonterritorial seas. • Low potential for harm to birds from explosions and impacts in nonterritorial seas. • Low potential for harm from military expended materials in nonterritorial seas. • No considerable harm to birds, migratory birds, bald eagles, federally listed species, or their habitat in nonterritorial seas. • Within the TMAA, the single endangered species is the Short-tailed Albatross. Vessel movements, aircraft overflight, ordnance use, at-sea explosions, and military expended materials may affect, but not likely to adversely affect, individual ESA-listed seabirds.
3.9 Birds	***MITIGATION MEASURES:*** Some of the SOPs and BMPs implemented by the Navy for resource protection that are described in detail in Chapter 5 would also reduce potential effects to birds (e.g., avoidance of birds and their nesting and roosting habitats and monitoring of exclusion zones surrounding at-sea explosions prior to detonations). As summarized above and in detail in Section 3.9.2, the actions proposed in this EIS/OEIS could affect birds within the TMAA, but community- or population-level effects would not be expected under any of the alternatives. Current protective measures would continue to be implemented by the Navy, and no additional mitigation measures would be needed to protect birds or their habitats.			

Table ES-3: Summary of Effects (continued)

		No Action Alternative	Alternative 1	Alternative 2
3.10 Cultural Resources	**NEPA (U.S. Territorial Seas, 0 to 12 nm)**	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to cultural resources onshore would occur. • Aircraft overflights above 15,000 ft (915 m) altitude between the shore and the TMAA would have no impact on cultural resources.	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to cultural resources onshore would occur. • Aircraft overflights above 15,000 ft (915 m) altitude between the shore and the TMAA would have no impact on cultural resources.	• Under Alternative 2, Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to cultural resources onshore would occur. • Aircraft overflights above 15,000 ft (915 m) altitude between the shore and the TMAA would have no impact on cultural resources.
	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)	• Submerged cultural resources would not be impacted because of the type of training activities and the low density of submerged cultural resources within the area of effect.	• Submerged cultural resources would not be impacted because of the type of training activities and the low density of submerged cultural resources within the area of effect.	• Submerged cultural resources would not be impacted because of the type of training activities and the low density of submerged cultural resources within the area of effect.
	MITIGATION MEASURES: The Navy has established protective measures to reduce potential effects on cultural and natural resources from training exercises in coastal waters and for land and sea ranges. Some are generally applicable, while others apply to particular geographic areas or during specific times of year. Protective measures in other locations include avoidance of known shipwreck sites or the use of inert ordnance. Precise and accurate locations for shipwrecks in the TMAA are not known. As summarized above and in detail within Section 3.10.2, no substantial impacts on cultural resources from the proposed activities were identified. Therefore, no additional mitigation measures are necessary or appropriate.			

Table ES-3: Summary of Effects (continued)

		No Action Alternative	Alternative 1	Alternative 2
3.11 Transportation and Circulation	NEPA (U.S. Territorial Seas, 0 to 12 nm)	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to inland transportation and circulation would occur. • With the use of the Altitude Reservation (ALTRV), overflights would have no adverse impact on non-military air or marine traffic.	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to inland transportation and circulation would occur. • With the use of the ALTRV, overflights would have no adverse impact on non-military air or marine traffic.	• Under Alternative 2, Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to inland transportation and circulation would occur. • With the use of the ALTRV, overflights would have no adverse impact on non-military air or marine traffic.
	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)	• No adverse effects on commercial or general aviation would occur. Limitations are communicated to commercial airlines and general aviation by Notice to Airmen (NOTAMs). • No adverse effects on marine traffic would occur. When training activities occur within shipping or high traffic areas, these activity areas are communicated to all vessels and operators by NOTMARs published by the USCG.	• Effects on air and marine traffic would be the same as described under the No Action Alternative. No additional impacts on the Federal Aviation Administration's (FAA's) capabilities would be created as a result of proposed training increases under Alternative 1. • Marine traffic will not be affected by military operational increases. • Installation and use of the temporary PUTR will not affect air and marine traffic.	• Effects on air and marine traffic would be the same as described under Alternative 1. There are no adverse effects to air or marine traffic as a result of implementation of Alternative 2. • Marine traffic will not be affected by military operational increases. • With implementation of Letter of Instruction, range clearance procedures, and NOTMARs, SINKEX would not affect non-military transportation and circulation.
	MITIGATION MEASURES: Safety and security factors dictate that use of airspace and control of air traffic be closely regulated. Accordingly, regulations applicable to all aircraft are promulgated by the FAA to define permissible uses of designated airspace, and to control that use. The Navy provides publication of NOTMARs and other outreach information about potentially hazardous activities planned for the TMAA, for publication by the USCG. To ensure the broadest dissemination of information about hazards to commercial and recreational vessels, the Navy provides schedule conflicts along with other Coast Guard concerns via the internet. As summarized above and in detail within Section 3.11.2, no adverse effects on air or marine traffic from the proposed activities were identified. Therefore, no additional mitigation measures are necessary.			

Table ES-3: Summary of Effects (continued)

		No Action Alternative	Alternative 1	Alternative 2
3.12 Socioeconomics	NEPA (U.S. Territorial Seas, 0 to 12 nm)	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to socioeconomics would occur. • Overflights would not result in adverse effects to commercial shipping, commercial fishing, recreation, or tourism.	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to socioeconomics would occur. • Overflights would not result in adverse effects to commercial shipping, commercial fishing, recreation, or tourism.	• Under Alternative 2, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to socioeconomics would occur. • Overflights would not result in adverse effects to commercial shipping, commercial fishing, recreation, or tourism.
	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)	• No adverse impacts to commercial/recreational fishing, civilian access, or tourism would occur as a result of the No Action Alternative.	• No adverse impacts to commercial/recreational fishing, civilian access, or tourism would occur as a result of Alternative 1. • Use of the PUTR by Fleet ships and aircraft would have no socioeconomic impact to the region. • Gear placement for the PUTR on the seafloor could be incompatible with certain commercial fishing activities.	• No adverse impacts to commercial/recreational fishing, civilian access, or tourism would occur as a result of Alternative 2. • Use of the PUTR by Fleet ships and aircraft would have no socioeconomic impact to the region. • Gear placement for the PUTR on the seafloor could be incompatible with certain commercial fishing activities. • SINKEX under Alternative 2 would not result in impacts to fish populations and thus commercial fishing operations.
	MITIGATION MEASURES: Long-range advance notice of scheduled activities and times are made available to the public and the commercial fishing community via the Internet. To minimize potential military/civilian interactions, the Navy would continue to publish scheduled potentially hazardous training activities using the NOTAM and NOTMAR systems as applicable. As summarized above and in detail within Section 3.12.2, no adverse effects to socioeconomics from the proposed activities were identified. Therefore, no additional mitigation measures are necessary.			

Table ES-3: Summary of Effects (continued)

		No Action Alternative	Alternative 1	Alternative 2
3.13 Environmental Justice and Protection of Children	NEPA (U.S. Territorial Seas, 0 to 12 nm)	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to environmental justice or protection of children would occur. • No effects are anticipated from training activities and overflights; no disproportionately high and adverse effects on any low-income or minority groups would occur. • There are no population centers found within the TMAA. Therefore, no effects on children would occur as a result of implementation of the No Action Alternative.	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to environmental justice or protection of children would occur. • No effects are anticipated from training activities and overflights; no disproportionately high and adverse effects on any low-income or minority groups would occur. • There are no population centers found within the TMAA. Therefore, no effects on children would occur as a result of implementation of Alternative 1.	• Under Alternative 2, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to environmental justice or protection of children would occur. • No effects are anticipated from training activities and overflights; no disproportionately high and adverse effects on any low-income or minority groups would occur. • There are no population centers found within the TMAA. Therefore, no effects on children would occur as a result of implementation of Alternative 2.
	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)	• No permanent human population centers exist in non-U.S. territorial seas and subsistence uses occur mostly outside of the TMAA. Therefore, no impacts related to environmental justice or protection of children would occur.	• No permanent human population centers exist in non-U.S. territorial seas and subsistence uses occur mostly outside of the TMAA. Therefore, no impacts related to environmental justice or protection of children would occur under Alternative 1.	• No permanent human population centers exist in non-U.S. territorial seas and subsistence uses occur mostly outside of the TMAA. Therefore, no impacts related to environmental justice or protection of children would occur under Alternative 2.
	MITIGATION MEASURES: As summarized above and in detail within Section 3.13.2, no adverse effects to environmental justice or protection of children from the proposed activities were identified. Therefore, no additional mitigation measures are necessary.			

Table ES-3: Summary of Effects (continued)

		No Action Alternative	Alternative 1	Alternative 2
3.14 Public Safety	**NEPA (U.S. Territorial Seas, 0 to 12 nm)**	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts on public safety would occur. • Aircraft overflights would not affect public safety because aircraft are limited to flying within the ALTRV and follow FAA guidelines.	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts on public safety would occur. • Increase in aircraft overflights would not affect public safety because aircraft are limited to flying within the ALTRV and follow FAA guidelines.	• Under Alternative 2, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts on public safety would occur. • Increase in aircraft overflights would not affect public safety because aircraft are limited to flying within the ALTRV and follow FAA guidelines.
	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)	• Navy training exercises in the TMAA will not affect public safety. The Navy will issue NOTAMs or NOTMARs to notify the public of training exercises. If non-participants are in the training area, training activities will not proceed until non-participants have left the area.	• Navy training exercises in the TMAA will not affect public safety. The Navy will issue NOTAMs or NOTMARs to notify the public of training exercises. If non-participants are in the training area, training activities will not proceed until non-participants have left the area. • Impacts on public safety would be negligible, the same as under the No Action Alternative.. • Installation and use of the temporary PUTR will not affect public health or safety.	• Navy training exercises in the TMAA will not affect public safety. The Navy will issue NOTAMs or NOTMARs to notify the public of training exercises. If non-participants are in the training area, training activities will not proceed until non-participants have left the area. • There would be an increase in training tempo and new training activities, but impacts on public safety would be negligible, the same as under the No Action Alternative and Alternative 1. • With implementation of LOI, range clearance procedures, and NOTMARs, SINKEX will not affect public health or safety.
	MITIGATION MEASURES: Navy training activities in the TMAA comply with numerous established safety procedures (Fleet area control and surveillance facility safety procedures, DoD SOPs, Navy SOPs for aviation and submarine navigation safety, and general exercise safety procedures regarding surface vessels, aircraft, live and inert ordnance, sonar, electromagnetic radiation, and lasers) to ensure that neither participants nor nonparticipants engage in activities that endanger life or property (described in full in Section 3.14.1.2). As summarized above and in detail within Section 3.14.2, no substantial impacts from the proposed activities have been identified. The safety procedures followed by the Navy lower the risk that Navy training activities pose on public safety. No further mitigation measures would be required.			

ES 1.8 OTHER REQUIRED CONSIDERATIONS

ES 1.8.1 Possible Conflicts with Objectives of Federal, State, and Local Plans, Policies, and Controls

Based on an evaluation with respect to consistency with statutory obligations, the Navy's Alternatives (including the Proposed Action) for the GOA Navy Training Activities Draft EIS/OEIS do not conflict with the objectives or requirements of federal, state, regional, or local plans, policies, or legal requirements. Chapter 6, Table 6-1, provides a summary of environmental compliance requirements that may apply.

ES 1.8.2 Relationship between Short-term Uses and Long-term Productivity

The Proposed Action would result in both short- and long-term environmental effects. However, the Proposed Action would not be expected to result in any impacts that would reduce environmental productivity, permanently narrow the range of beneficial uses of the environment, or pose long-term risks to health, safety, or the general welfare of the public. The Navy is committed to sustainable range management, including co-use of the TMAA with the general public and commercial interests to the extent practicable, consistent with accomplishment of the Navy mission and in compliance with applicable law. This commitment to co-use enhances the long-term productivity of the training areas within the ATA.

ES 1.8.3 Irreversible or Irretrievable Commitment of Resources

For the Alternatives, including the Proposed Action, most resource commitments are neither irreversible nor irretrievable. Most impacts are short-term and temporary. However, implementation of the Proposed Action would require the use of fuels by aircraft, ships, and ground-based vehicles. Total fuel consumption would increase and this nonrenewable resource would be considered irreversibly lost.

ES 1.8.4 Energy Requirements and Conservation Potential

Increased training activities in the ATA for the Alternatives, including the Proposed Action, would result in an increase in energy demand over the No Action Alternative. Energy requirements would be subject to established energy conservation practices. The use of energy sources has been minimized wherever possible without compromising safety or training activities. No additional conservation measures related to direct energy consumption by the proposed activities are identified.

ES 1.8.5 Natural or Depletable Resource Requirements and Conservation Potential

Resources that would be permanently and continually consumed by project implementation include water, electricity, natural gas, and fossil fuels. Pollution prevention is an important component of mitigation of the Alternatives' adverse impacts. To the extent practicable, pollution prevention considerations are included. Sustainable range management practices are in place that protect and conserve natural and cultural resources; and allow for preservation of access to training areas for current and future training requirements, while addressing potential encroachments that threaten to impact training area capabilities.

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ACRONYMS/ABBREVIATIONS LIST

A-A	Air-to-Air
A-G	Air-to-Ground
A-S	Air-to-Surface
AAC	Alaska Administrative Code
AAMEX	Air-to-Air Missile Exercise
AAW	Anti-Air Warfare
ABR	auditory brainstem response
AC	Alaska Current
ACC	Alaska Coastal Current
ACHP	Advisory Council on Historic Preservation
ACM	Air Combat Maneuver(ing)
ACMP	Alaska Coastal Management Plan
ADAR	Air Deployed Active Receiver
ADCAP	Advanced Capability
ADCs	Acoustic Device Countermeasures
ADD	Acoustic Deterrent Devices
ADEC	Alaska Department of Environmental Conservation
ADEX	Air Defense Exercise
ADF&G	Alaska Department of Fish and Game
ADH	Acoustic Harassment Devices
ADLFP	Air Deployable Low Frequency Projector
ADNR	Alaska Department of Natural Resources
AEER	Advanced Extended Echo Range
AESA	Airborne Electronically Scanned Array
AESO	Aircraft Environmental Support Office
AFAST	Atlantic Fleet Active Sonar Training
AFB	Air Force Base
AGL	above ground level
AICUZ	Air Installation Compatibility Use Zone
AKR	Alaska Region
AMHS	Alaska Marine Highway System
ALCOM	Alaskan Command
ALTRV	Altitude Reservation
AMCC	Alaska Marine Conservation Council
AMHS	Alaska Marine Highway System
AMRAAM	Advanced Medium-Range Air-to-Air Missile
AMSP	Advanced Multi-static Processing Program
AMW	Amphibious Warfare
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interest Lands Conservation Act
AO	Arctic Oscillation
APE	Area of Potential Effect
ARG	Amphibious Ready Group
ARPA	Archaeological Resources Protection Act
ARS	Advance Ranging Source
ARTCC	Air Route Traffic Control Center
AS	Alaskan Stream
ASG	Alaska Sea Grant
ASHPA	Alaska Seamount Habitat Protection Area
ASTM	American Society for Testing and Materials
ASUW	Anti-Surface Warfare
ASW	Anti-Submarine Warfare
ATA	Alaska Training Area
ATC	Air Traffic Control
ATCAA	Air Traffic Control Assigned Airspace
ATSDR	Agency for Toxic Substances and Disease Registry
atm	atmospheres
BA	Biological Assessment
BAMS	Broad Area Maritime Surveillance
BCC	Birds of Conservation Concern
BDA	Battle-Damage Assessment
BDU	Bomb Dummy Unit
BE	Biological Evaluation
BFM	Basic Fighter Maneuvering
BMDS	Ballistic Mission Defense System
BMP	Best Management Practice
BO	Biological Opinion
BOMBEX	Bombing Exercise
BRAC	Base Realignment and Closure
BT	Bathythermograph
ºC	degrees Celsius
C4	Command, Control, Communications, & Computers
C4I	Command, Control, Communications, Computers & Intelligence
CAA	Clean Air Act
cal	caliber
CASS	Comprehensive Acoustic Simulation System
CEO	Chief Executive Officer
CEQ	Counsel on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CETAP	Cetacean and Turtle Assessment Program
CFMETR	Canadian Forces Maritime Experimental and Test Ranges
C.F.R.	Code of Federal Regulations
CG	Guided Missile Cruiser
CHAFFEX	Chaff Exercise
CH_4	methane
chl a	chlorophyll a
CIWS	Close-in-Weapon System
cm	centimeters
CMP	Coastal Management Plan
CNO	Chief of Naval Operations
CO	Commanding Officer
CO	carbon monoxide
CO_2	carbon dioxide
COMPACFLT	Commander, U.S. Pacific Fleet
COMPTUEX	Composite Training Unit Exercise
COMSUBPAC	Commander, Submarine Force U.S. Pacific Fleet
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPF	Commander, U.S. Pacific Fleet
GRAB	Gaussian Ray Bundle
CSAR	Combat Search and Rescue
CSG	Carrier Strike Group
CV	Coefficient of Variation
CWA	Clean Water Act
CZ	Coastal Zone
CZMA	Coastal Zone Management Act
dB	decibel
dBA	A-weighted decibel
DDG	Guided Missile Destroyer
DDT	Dichloro-Diphenyl-Trichloroethane
DEIS	Draft Environmental Impact Statement
DHS	Department of Homeland Security
DICASS	Directional Command Activated Sonobuoy

	System
DIFAR	Directional Frequency Analysis and Recording
DLCD	Department of Land Conservation and Development
DLQ	Deck Landing Qualification
DMV	Department of Motor Vehicles
DNL	Day-Night Average Sound Level
DNR	Department of Natural Resources
DNT	dinitrotoluene
DoD	Department of Defense
DoDD	Department of Defense Directive
DoDINST	Department of Defense Instruction
DoN	Department of Navy
DOPAA	Description of Proposed Action and Alternatives
DOT	Department of Transportation
DPS	Distinct Population Segments
DSCA	Defense Support of Civilian Authorities
DTR	Detonation Training Range
DU	depleted uranium
DVD	Digital Versatile Disk
DZ	Drop Zone
EA	Environmental Assessment
EA	Electronic Attack
EC	Electronic Combat
EDMS	Emission and Dispersion Modeling System
EER	Extended Echo Ranging
EEZ	Exclusive Economic Zone
EFD	Energy Flux Density
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EL	Energy Flux Density Level
EMATT	Expendable Mobile Anti-SubmarineWarfare Training Target
EMR	Electromagnetic Radiation
ENP	Eastern North Pacific
EO	Executive Order
EOD	Explosive Ordnance Disposal
EPA	Environmental Protection Agency
ES	Executive Summary
ES	Electronic Support
ESA	Endangered Species Act
ESG	Expeditionary Strike Group
ESU	Evolutionary Significant Unit
EW	Electronic Warfare
°F	degrees Fahrenheit
FAA	Federal Aviation Administration
FACSFAC	Fleet Area Control and Surveillance Facility
FAD	fish aggregating devices
FAO	Food and Agriculture Organization
FDNF	Forward Deployed Naval Forces
FEIS	Final Environmental Impact Statement
FFG	Fast Frigate
FGG	Guided Missile Frigate
FICON	Federal Interagency Committee on Noise
FL	Flight Level
FMC	Fishery Management Council
FMP	Fishery Management Plan
FNSB	Fairbanks North Star Borough
FONSI	Finding of No Significant Impact
FR	Federal Register
FRTP	Fleet Readiness Training Plan
ft	feet
ft^2	square feet
ft^3	cubic feet
ft/sec	feet per second
FTCA	Federal Tort Claims Act
FY	Fiscal Year
g	gram
GAO	U.S. General Accounting Office
GHG	greenhouse gases
GOA	Gulf of Alaska
GOACHPA	Gulf of Alaska Coral Habitat Protection Area
GOASHCA	Gulf of Alaska Slope Habitat Conservation Area
GUNEX	Gunnery Exercise
GWP	Global Warming Potential
H_2	hydrogen
HAPs	hazardous air pollutants
HAPCs	Habitat Areas of Particular Concern
HARM	High-speed Anti-radiation Missile
HARPS	High Frequency Acoustic Recording Packages
HC	Hydrocarbons
HCA	habitat conservation area
HE	High Explosive
HELO	Helicopter
HFA	High Frequency Active
HLX	cyclo-1,3,5-tetramethylene-2,4,6-tetranitramine
HMX	High Melting Explosive (cyclotetramethylene tetranitramine)
HLD	Homeland Defense
H_2O	water
HPA	habitat protection area
hr	hour
HRC	Hawaii Range Complex
HSMSTs	High Speed Maneuverable Surface Targets
H_xF_x	hydrogen fluoride compounds
Hz	hertz
ICAP	Improved Capability
ICES	International Council for Exploration of the Sea
ICMP	Integrated Comprehensive Monitoring Program
ICRMP	Integrated Cultural Resources Management Plan
IED	Improvised Explosive Device
IEER	Improved Extended Echo Ranging
IFH	improved flexible Hose
IFQ	Individual Fishing Quota
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
in	inch(es)
INRMP	Integrated Natural Resources Management Plan
IOC	Initial Operational Capability
IP	Implementation Plan
IPCC	Intergovernmental Panel for Climate Change
IPHC	International Pacific Halibut Commission
ISE	Investigative Science and Engineering
ISR	Intelligence, Surveillance, and Reconnaissance
IUCN	International Union for Conservation of Nature and Natural Resources
IWC	International Whaling Commission
JATO	Jet Assisted Take-Off
JTF	Joint Task Force
JTFEX	Joint Task Force Exercise
JOOD	Junior Officer of the Deck

kg	kilogram(s)
kg/cm^2	kilogram per square cenimeter
kg/m^2	kilogram per square meter
kHz	kilohertz
KLGO	Klondike Gold Rush National Historic Park
km	kilometer
km^2	square kilometer
kts	knots
L	liter
LATN	Low-Altitude Tactical Navigation
lb	pound(s)
LCS	Littoral Combat Ship
LFA	Low Frequency Active
LME	Large Marine Ecosystem
LMRS	Long-term Mine Reconnaissance System
LOA	Letter of Authorization
LOP	Letter of Procedure
LZ	Landing Zone
m	meter
m^2	square meter
m^3	cubic meter
m/sec	meters per second
MAA	Maritime Activities Area
MACA	Military Assistance to Civil Authorities
MARPOL	International Convention for the Prevention of Pollution from Ships
MBTA	Migratory Bird Treaty Act
MCBI	Marine Conservation Biology Institute
MCM	Mine Countermeasures
METOC	Meteorological and Oceanographic Operations
MEU	Marine Expeditionary Unit
MFA	Mid-Frequency Active
mg	milligrams
MI	Maritime Interdiction
mi	mile(s)
mi^2	square miles
min	minute
MI	Maritime Interdiction
MIO	Maritime Interdiction Operations
MISSILEX	Missile Exercise
MIW	Mine Warfare
mL	milliliter
mm	millimeters
MMAs	Marine Management Areas
MMA	Multimission Maritime Aircraft
MMPA	Marine Mammal Protection Act
MMR	Military Munitions Rule
MOA	Military Operations Area
MOU	Memorandum of Understanding
MPA	Maritime Patrol Aircraft
MPA	Marine Protected Area
MPPRCA	Marine Plastic Pollution Research and Control Act
MRA	Marine Resource Assessment
ms	millisecond
MSAT	Marine Species Awareness Training
MSE	Multiple Successive Explosions
MSL	Mean Sea Level
MSFCMA	Magnuson-Stevens Fishery Conservation Management Act
MTR	Military Training Routes
µg	microgram

µm	micron (micrometer)
µPa	micropascal
µPa-m	micropascal at 1 meter
µPa @ 1 m	micropascal at 1 meter
μPa^2-m	micropascal squared at 1 meter
μPa^2-s	micropascal squared in 1 second
μPa^2-sec	micropascal squared in one second
µs	microsecond
MTR	Military Training Route
N	north
N_2	nitrogen
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAS	Naval Air Station
NATO	North Atlantic Treaty Organization
NAVEDTRA	Naval Education and Training Command
NAVFAC	Naval Facilities Engineering Command
NAVFAC NW	Naval Facilities Engineering Command Northwest
NAVFAC PAC	Naval Facilities Engineering Command Pacific
NAVINSTR	Naval Instruction
NAVSEA	Naval Sea Systems Command
NAVSEAINST	Naval Sea Systems Command Instruction
NCA	National Command Authority
NEPA	National Environmental Policy Act
NEW	Net Explosive Weight
NFEA	National Fishery Enhancement Act
NH_3	ammonia
NHPA	National Historic Preservation Act
nm	nautical miles
nm^2	square nautical miles
NMFS	National Marine Fisheries Service
NMFS-OPR	National Marine Fisheries Service-Office of Protective Resources
NMS	National Marine Sanctuary
NMSA	National Marine Sanctuaries Act
NO_2	nitrogen dioxide
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NORAD	North American Aerospace Defense Command
NORTHCOM	U.S. Northern Command
NOTAM	Notice to Airmen
NOTMAR	Notice to Mariners
NOx	nitrogen oxide
NPC	North Pacific Current
NPDES	National Pollutant Discharge Elimination System
NPFMC	North Pacific Fishery Management Council
NPS	National Park Service
NRC	National Research Council
NRHP	National Register of Historic Places
NSC	Navy Safety Center
NSCT-1	Naval Special Clearance Team ONE
NSW	Naval Special Warfare
NSWC	Naval Surface Warfare Center
NSWG	Naval Special Warfare Group
N-UCAS	Navy Unmanned Combat Air System
NWR	National Wildlife Refuges

NWTRC	Northwest Training Range Complex
O_3	ozone
OCE	Officer Conducting the Exercise
OCM	Oil Content Monitor
OCS	Outer Continental Shelf
OEA	Overseas Environmental Assessment
OEIS	Overseas Environmental Impact Statement
OLF	Outlying Landing Field
OOD	Officer of the Deck
OP	Operational Procedures
OPA	Oil Pollution Act of 1990
OPAREA	Operating Area
OPNAV	Office of the Chief of Naval Operations
OPNAVINST	Chief of Naval Operations Instruction
OTB	Over the Beach
oz	ounce
PACFIRE	Pre-Action Calibration Firing
PACFLT	Pacific Fleet
PACOM	U.S. Pacific Command
PAH	polycyclic aromatic hydrocarbons
Pa•s	Pascal•seconds
Pb	lead
PBX	Plastic Bonded Explosives
PCB	polychlorinated biphenyl
PCE	Primary Constituent Element
PDO	Pacific Decadal Oscillation
PETN	pentaerythritoltrinitramine
PFMC	Pacific Fisheries Management Council
pH	alkalinity
PM	particulate matter
PM2.5	particulate matter up to 2.5 micrometers (microns)
PM10	particulate matter up to 10 micrometers (microns)
PMAP	Protective Measures Assessment Protocol
PMAR	Navy Primary Mission Area
POPs	Persistent Organic Pollutants
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
PR	Personnel Recovery
psi	pounds per square inch
PSC	Pacific Salmon Commission
PST	Pacific Salmon Treaty
psu	practical salinity units
PTS	Permanent Threshold Shift
PUTR	Portable Undersea Tracking Range
PVC	Polyvinyl Chloride
R-	Restricted Area
RA	Restricted Area
RAM	Rolling Airframe Missile
RCD	Required Capabilities Document
RCRA	Resource Conservation and Recovery Act
RDT&E	Research, Development, Test and Evaluation
RDX	Royal Demolition Explosive (cyclotrimethylene trinitramine)
RF	Radio Frequency
RHA	Rivers and Harbors Act
RL	Received level
rms	root mean square
ROD	Record of Decision
ROG	reactive organic gases
ROI	Region of Influence
RSO	Range Safety Officer
S-A	Surface-to-Air
S-S	Surface-to-Surface
SAM	Surface-to-Air Missile
SAMEX	Surface to Air Missile Exercise
SBUs	Special Boat Units
SCUBA	self-contained underwater breathing apparatus
S.D.	Standard Deviation
SDVT-1	SEAL Delivery Vehicle Team ONE
SEAD	Suppression of Enemy Air Defenses
SEAL	Sea, Air, Land
sec	second
SFA	Sustainable Fisheries Act
SFH	Strong Flexible Hose
SHPO	State Historic Preservation Officer
SINKEX	Sinking Exercise
SIP	State Implementation Plan
SLAM-ER	Standoff Land Attack Missile-Expanded Response
SMA	Shoreline Management Act
SME	Subject Matter Experts
SNS	Sympathetic Nervous System
SO_2	sulfur dioxide
SO_x	sulfur oxides
SOCAL	Southern California
SOF	Special Operations Forces
SONAR	Sound Navigation and Ranging
SOP	Standard Operating Procedure
SPL	Sound Pressure Level
SPLASH	Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific)
SRA	Source Receptor Areas
SSC	Sea Surface Control
SSG	Surface Strike Group
SSGN	Guided Missile Submarines
SSN	Fast Attack Submarine
SSTs	sea surface temperatures
STW	Strike Warfare
SUA	Special Use Airspace
SURTASS	Surveillance Towed Array Sensor System
SUS	Signal, Underwater Sound
SUW	Surface Warfare
TALD	Tactical Air Launched Decoy
TAP	Tactical Training Theater Assessment Planning
TDU	Target Drone Unit
TMAA	Temporary Maritime Activities Area
TMDL	Total Maximum Daily Load
TNT	trinitrotoluene
TPY	tons per year
TRACKEX	Tracking Exercise
TS	Threshold Shift
TSCA	Toxic Substances Control Act
TTS	Temporary Threshold Shift
TM	Tympanic Membrane
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
ULT	Unit Level Training
UME	Unusual Mortality Event
UNDS	Uniform National Discharge Standards
U.S.	United States
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
U.S.C.	United States Code

USCG	United States Coast Guard
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USFF	United States Fleet Forces
USFWS	United States Fish and Wildlife Service
USJFCOM	United States Joint Forces Command
USW	Undersea Warfare
UUV	Unmanned Underwater Vehicle
UXO	Unexploded Ordnance
VBSS	Visit Board Search and Seizure
VFR	Visual Flight Rules
VLAD	Vertical Line Array Directional Frequency Analysis and Recording
VOI	Vessel of Interest
VMC	Visual Meteorological Conditions
VTNF	Variable, Timed, Non-Fragmentation
VTS	Vessel Traffic Service
VTUAS	Vertical Takeoff and Landing Unmanned Aerial System
W-	Warning Area
W	west
XO	Executive Officer
yd	yard(s)
yr	year
ZOI	Zone of Influence

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MASTER GLOSSARY OF TERMS

Term	Definition
Acoustics	The scientific study of sound, especially of its generation, transmission, and reception.
Active sonar	Detects objects by creating a sound pulse, or ping, that transmits through the water and reflects off the target, returning in the form of an echo. This is a two-way transmission (source to reflector to receiver).
Alternative	A different method for accomplishing the Proposed Action. An alternative can consist of the same action in a different location, or a modification to the Proposed Action.
Ambient noise	The typical or persistent environmental background noise present in the ocean.
Anadromous	Species of fish that are born in freshwater, migrate to the ocean to grow into adults, and return to freshwater to spawn.
Anthropogenic noise	Noise related to, or produced by, human activities.
Anti-Submarine Warfare (ASW)	Naval operations that involves the detection, tracking and potential engagement of submarines their supporting forces, and operating bases that demonstrate hostile intent or are declared hostile by appropriate authority.
Baleen	In some whales (see Mysticete below), the parallel rows of fibrous plates that hang from the upper jaw and are used for filter feeding.
Bathymetry	The measurement of water depth at various places in a body of water; the information derived from such measurements.
Behavioral effect	Defined in this EIS/OEIS as a variation in an animal's behavior or behavior patterns that results from an anthropogenic acoustic exposure and exceeds the normal daily variation in behavior, but which arises through normal physiological process (it occurs without an accompanying physiological effect).
Benthic	Referring to the bottom-dwelling community of organisms that creep, crawl, burrow, or attach themselves to either the sea bottom or such structures as ships, buoys, and wharf pilings (e.g., crabs, clams, worms).
Bight	Refers both to a bend in the shoreline, and to the wide bay which is formed by such a bend.
Biologically important activities/behaviors	Those activities or behaviors essential to the continued existence of a species, such as migration, breeding/calving, or feeding.
Biological Opinion	A document that is the result of Endangered Species Act, Section 7 formal consultation. This document states the opinion of the Service on whether or not a Federal action is likely to adversely affect or jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat and, if so, the Service provides recommendations to minimize or avoid adverse impacts.
Cetacean	An order of aquatic mammals such as whales, dolphins, and porpoises.
Condition Code	A method for evaluating the stage of decomposition of a stranded animal or carcass. Codes range from live animals (Code 1) to skeletal remains (Code 5) (modified from Marine Mammals Ashore: A Field Guide for Strandings by J.R. Geraci and V.J. Lounsbury).

MASTER GLOSSARY OF TERMS (CONTINUED)

Term	Definition
Critical habitat	Critical habitat is defined in Section 3 of the Endangered Species Act (ESA) as (1) the specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the ESA, on which are found those physical or biological features (i) essential to the conservation of the species, and (ii) that may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species.
Cumulative impact	The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions.
Decibel (dB)	A unit used to express the relative difference in power, usually between acoustic or electrical signals, equal to 10 times the common logarithm of the ratio of the two levels. Since the decibel scale is exponential and not linear, a 20-dB sound is 10 times louder than a 10-dB sound, and a 30-dB sound is 100 times louder than a 10-dB sound.
Demersal	Living at or near the bottom of a waterbody, but having the capacity for active swimming. Term used particularly when describing various fish species.
Distinct population segment (DPS)	A vertebrate population or group of populations that is discrete from other populations of the species and significant in relation to the entire species. The ESA provides for listing species, subspecies, or distinct population segments of vertebrate species.
Endangered species	Any species that is in danger of extinction throughout all or a significant portion of its range (ESA §3[6]).
Energy flux density level (EFDL)	The energy traversing in a time interval over a small area perpendicular to the direction of the energy flow, divided by that time interval and by that area. EFDL is stated in dB re 1 μPa^2-s for underwater sound.
Epifauna	Organisms living on the surface of the sediment/sea bed/substrate.
Essential fish habitat (EFH)	Those waters and substrate that are defined within Fishery Management Plans for federally managed fish species as necessary to fish for spawning, breeding, feeding, or growth to maturity.
Evolutionary Significant Unit (ESU)	A stock that is reproductively isolated from other stocks of the same species and which represents an important part of the evolutionary legacy of the species. An ESU is treated as a species for purposes of listing under the ESA. National Marine Fisheries Service (NMFS) uses this designation.
Exclusive Economic Zone (EEZ)	A maritime zone adjacent to the territorial sea that may not extend beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured.

MASTER GLOSSARY OF TERMS (continued)

Term	Definition
Exhibiting Indicators of Distress	Animals exhibiting an uncommon combination of behavioral and physiological indicators typically associated with distressed or stranded animals. This situation would be identified by a qualified individual and typically includes, but is not limited to, some combination of the following characteristics: 1) Marine mammals continually circling or moving haphazardly in a tightly packed group – with or without a member occasionally breaking away and swimming towards the beach. 2) Abnormal respirations including increased or decreased rate or volume of breathing, abnormal content or odor. 3) Presence of an individual or group of a species that has not historically been seen in a particular habitat, for example a pelagic species in a shallow bay when historic records indicate that it is a rare event. 4) Abnormal behavior for that species, such as abnormal surfacing or swimming pattern, listing, and abnormal appearance.
Expended materials	Those munitions, items, devices, equipment and materials which are uniquely military in nature, and are used and expended in the conduct of the military training and testing mission, such as sonobuoys, flares, chaff, drones, targets, bathymetry measuring devices and other instrumentation, communications devices, and items used as training substitutes. This definition may also include materials expended (such as propellants, weights, guidance wires) from items typically recovered, such as aerial target drones and practice torpedoes.
Federal Register	The official daily publication for actions taken by the federal government, such as Rules, Proposed Rules, and Notices of federal agencies and organizations, as well as Executive Orders and other Presidential documents.
Frequency	Description of the rate of disturbance, or vibration, measured in cycles per second. Cycles per second are usually referred to as hertz, or Hz, the unit of measure.
Harassment	As defined in this document, harassment is an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering.
High-frequency	As defined in this document, frequencies greater than 10 kilohertz (kHz).
Hydrography	The characteristic features (e.g., flow, depth) of bodies of water.
Hydrophone	An underwater receiver used to detect the pressure change caused by sound in the water. That pressure is converted to electrical energy. It can then be translated to something that can be heard by the human ear. Sometimes the detected acoustic pressure is outside the human range of hearing.
Infauna	Animals living within the sediment.
Isobath	A line on a chart or map connecting points of equal depths; bathymetric contour.

MASTER GLOSSARY OF TERMS (continued)

Term	Definition
Letter of authorization (LOA)	The Marine Mammal Protection Act provides for a “small take authorization” (i.e., letter of authorization) for maritime activities, provided NMFS finds that the takings would be of small numbers (i.e., taking would have a negligible impact on that species or stock), would have no more than a negligible impact on those marine mammal species not listed as depleted, and would not have an unmitigable adverse impact on subsistence harvests of these species.
Level A harassment	Level A harassment includes any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild. Injury is identified as the destruction or loss of biological tissue. The destruction or loss of biological tissue will result in an alteration of physiological function that exceeds the normal daily physiological variation of the intact tissue.
Level A harassment zone	Extends from an acoustic or impulsive source out to the distance and exposure at which the slightest amount of injury is predicted to occur. The acoustic exposure that produces the slightest degree of injury is therefore the threshold value defining the outermost limit of the Level A harassment zone.
Level B harassment	Level B harassment includes all actions that disturb or are likely to disturb a marine mammal or marine mammal stock in the wild through the disruption of natural behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild. Unlike Level A harassment, which is solely associated with physiological effects, both physiological and behavioral effects have the potential to cause Level B harassment.
Level B harassment zone	Begins just beyond the point of slightest injury and extends outward from that point. It includes all animals that may potentially experience Level B harassment. Physiological effects extend beyond the range of slightest injury to a point where slight temporary distortion of the most sensitive tissue occurs, but without destruction or loss of that tissue. The animals predicted to be in this zone experience Level B harassment by virtue of temporary impairment of sensory function (altered physiological function) that can disrupt behavior.
Low-frequency	As defined in this document, frequencies less than 1 kHz.
Masking	The obscuring of sounds of interest by interfering sounds, generally at the same frequencies.
Mid-frequency	As defined in this document, frequencies between 1 kHz and 10 kHz.
Mitigation measure	Measures that will minimize, avoid, rectify, reduce, eliminate, or compensate for significant environmental effects.
Munitions (military)	All ammunition products and components produced or used by or for the U.S. Department of Defense, or the U.S. Armed Services for national defense and security, including military munitions under the control of the Department of Defense, the U.S. Coast Guard, the U.S. Department of Energy, and the National Guard.
Mysticete	Any whale of the suborder Mysticeti having plates of whalebone (baleen plates) instead of teeth. Mysticetes are filter-feeding whales, also referred to as baleen whales, such as blue, fin, gray, and humpback whales.

MASTER GLOSSARY OF TERMS (continued)

Term	Definition
Notice of intent (NOI)	A written notice published in the *Federal Register* that announces the intent to prepare an EIS. Also provides information about a proposed federal action, alternatives, the scoping process, and points of contact within the lead federal agency regarding the EIS.
Odontocete	Any toothed whale (without baleen plates) of the suborder Odontoceti such as sperm whales, killer whales, dolphins, and porpoises.
Onset permanent threshold shift (onset PTS)	PTS (defined below) is nonrecoverable and, by definition, must result from the destruction of tissues within the auditory system. PTS therefore qualifies as an injury and is classified as Level A harassment under the wording of the Marine Mammal Protection Act. In this EIS/OEIS, the smallest amount of PTS (onset PTS) is taken to be the indicator for the smallest degree of injury that can be measured. The acoustic exposure associated with onset PTS is used to define the outer limit of the Level A harassment zone
Onset temporary threshold shift (onset TTS)	TTS (defined below) is recoverable and is considered to result from the temporary, noninjurious distortion of hearing-related tissues. In this EIS/OEIS, the smallest measurable amount of TTS (onset TTS) is taken as the best indicator for slight temporary sensory impairment. Because it is considered no-injurious, the acoustic exposure associated with onset TTS is used to define the outer limit of the portion of the Level B harassment zone attributable to physiological effects. This follows from the concept that hearing loss potentially affects an animal's ability to react normally to the sounds around it. Therefore, the potential for TTS qualifies as a Level B harassment that is mediated by physiological effects upon the auditory system.
Ordnance	Explosives, chemicals, pyrotechnics, and similar stores (e.g., bombs, guns and ammunition, flares, smoke, or napalm).
Passive sonar	Detects the sound created by an object (source) in the water. This is a one-way transmission of sound waves traveling through the water from the source to the receiver.
Pelagic	Pelagic is a broad term applied to species that inhabit the open, upper portion of marine waters rather than waters adjacent to land or near the sea floor.
Permanent threshold shift (PTS)	Exposure to high-intensity sound may result in auditory effects such as noise-induced threshold shift, or simply a threshold shift (TS). If the TS becomes a permanent condition, generally as a result of physical injury to the inner ear and hearing loss, it is known as PTS.
Phase 1 Investigation	A Phase 1 Investigation, for the purposes of this document, will typically include the following tests and procedures (which are described in NMFS' Biomonitoring Protocols): 1) Demographics of the stranding, environmental parameters. 2) Behavioral assessment of group. 3) Live animal (physical examination, blood work, diagnostics such as AEP or ultrasound, assessment or treatment) or dead animal (External examination and external human interaction evaluation, morphometrics, photographs, diagnostic imaging including CT/MRI scans or ultrasound as appropriate and feasible, and necropsy with internal examination, descriptions, photographs and sample collection).

MASTER GLOSSARY OF TERMS (continued)

Term	Definition
Phase 2 Investigation	A Phase 2 Investigation, for the purposes of this document, will typically include the following tests and procedures (which are described in NMFS' Biomonitoring Protocols): Analyses and review of diagnostic imaging obtained in Phase I, histopathology, special stains, ancillary diagnostics (e.g., PCR for infections, gas emboli), CT of ears, additional diagnostic imaging as needed, histology of ears, case summaries, and review
Physiological effect	Defined in the EIS/OEIS as a variation in an animal's physiology that results from an anthropogenic acoustic exposure and exceeds the normal daily variation in physiological function.
Ping	Pulse of sound created by a sonar.
Pinger	A pulse generator using underwater sound transmission to relay data such as subject location.
Pinniped	Any member of a suborder (Pinnipedia) of aquatic carnivorous mammals (i.e., seals and sea lions) with all four limbs modified into flippers.
Platform	A vessel, pier, barge, etc. from which test systems can be deployed.
Predation	A biological interaction where a predator organism feeds on another living organism or organisms known as prey. The act of predation results in the ecologically significant death of the prey.
Qualified	NMFS has a rigorous set of standards and training in place to qualify stranding responders, however, since the stranding network is a largely volunteer network, there is significant variability from one area to another. In the Biomonitoring Protocol, NMFS will identify the minimum qualifications necessary for individuals to make the determinations necessary to carry out this plan. These qualifications are currently in development and will be finalized in the Biomonitoring Protocols. Not all qualified individuals (veterinarians, technicians, etc.) will be NMFS employees. However, only specific individuals (NMFS Protected Resources, HQ – senior administrators) indicated in the GOA Stranding Communication Protocol will be empowered to advise the Navy of the need to implement shutdown procedures.
Received level	The level of sound that arrives at the receiver, or listening device (hydrophone). The received level is the source level minus the transmission losses from the sound traveling through the water.
Record of Decision (ROD)	A concise summary of the decision made by the project proponent (e.g., Navy) from the alternatives presented in the Final EIS. The ROD is published in the *Federal Register*.
Resonance	A phenomenon that exists when an object is vibrated at a frequency near its natural frequency of vibration – the particular frequency at which the object vibrates most readily. The size and geometry of an air cavity determine the frequency at which the cavity will resonate.

MASTER GLOSSARY OF TERMS (continued)

Term	Definition
Shutdown Procedures	The act of the Navy ceasing operation of sonar or explosive detonations within a designated area for a designated time. The time is designated by the Restart Procedures. The designated area, for the purposes of this document, is an area within 14 nm of any live, in the water animal involved in the USE. This distance (14 nm) is the distance at which sound from the sonar source is anticipated to attenuate to approximately 140-145 dB (SPL). If this distance appears too short (i.e, the proximity of sonar use may likely be deterring the animals from returning to the open water), NMFS and the Navy will further coordinate to determine what measures are necessary to further minimize that likelihood and implement those measures as appropriate.
Scoping	An early and open process with federal and state agencies and interested parties to identify possible alternatives and the significant issues to be addressed in an EIS.
Sonobuoy	A device launched from an aircraft to determine environmental conditions for determination of best search tactics, to communicate with friendly submarines, and to conduct search, localization, tracking, and, as required, attack of designated hostile platforms. Sonobuoys provide both a deployable acoustical signal source and reception of underwater signals of interest.
Sound **Na**vigation and **R**anging (Sonar)	Any anthropogenic (man-made) or animal (e.g., bats, dolphins) system that uses transmitted acoustic signals and echo returns for navigation, communication, and determining position and bearing of a target. There are two broad types of anthropogenic sonar: active and passive.
Sound pressure level (SPL)	A measure of the root-mean square, or “effective,” sound pressure in decibels. SPL is expressed in dB re 1 μPa for underwater sound and dB re to 20 μPa for airborne sound.
Source level	The sound pressure level of an underwater sound as measured one meter from the source.
Substrate	Any object or material upon which an organism grows or to which an organism is attached.
Tactical Sonar	A category of sonar emitting equipment that includes surface ship and submarine hull-mounted active sonars.
Take	Defined under the Marine Mammal Protection Act as "harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect."
Temporary threshold shift (TTS)	Exposure to high-intensity sound may result in auditory effects such as noise-induced threshold shift, or simply a threshold shift (TS). If the TS recovers after a few minutes, hours, or days it is known as a Temporary Threshold Shift (TTS).
Threatened species	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range (ESA §3[20]).
Threshold Shift (TS)	Lower level exposures to sound levels of sufficient duration may cause permanent or temporary hearing loss; such an effect is called a noise-induced threshold shift, or simply a TS. A TS may be either permanent, in which case it is called a PTS, or temporary, in which case it is called a TTS.

MASTER GLOSSARY OF TERMS (continued)

Term	Definition
Transmission loss	Energy losses that occur as the pressure wave, or sound, travels through the water. The associated wavefront diminishes due to the spreading of the sound over an increasingly larger volume and the absorption of some of the energy by water.
Uncommon Stranding Event (USE)	A stranding event that takes place during an MTE and involves any one of the following: 1) Two or more individuals of any cetacean species (i.e., could be two different species, but not including mother/calf pairs, unless of species of concern listed in next bullet) found dead or live on shore within a two day period and within 10 miles of one another, 2) A single individual or mother/calf pair of any of the following marine mammals of concern to be designated by NMFS at a later date, or 3) A group of 2 or more cetaceans of any species exhibiting indicators of distress.

1 PURPOSE AND NEED OF THE PROPOSED ACTION

1.1 INTRODUCTION

The National Environmental Policy Act of 1969 (NEPA) (42 United States Code [U.S.C.] § 4321 *et seq.*) requires federal agencies to examine the environmental effects of major federal actions in an Environmental Impact Statement (EIS), which is a detailed public document that provides an assessment of the potential effects that a major federal action may have on the human, natural, or cultural environment. Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*, directs federal agencies to provide for informed decision-making for major federal actions outside United States (U.S.) territory in an Overseas EIS (OEIS). The U.S. Department of the Navy (DoN) is preparing this Draft EIS/OEIS (hereafter referred to as “EIS/OEIS”) to assess the potential environmental effects associated with ongoing and proposed naval activities (described in detail in Chapter 2) in the Alaska Training Areas (ATA). The Navy is the lead agency for the EIS/OEIS and Headquarters, National Marine Fisheries Service (NMFS) is a cooperating agency, pursuant to 40 CFR (Code of Federal Regulations) Section 1501.6.

Since the 1990s, the Navy has participated in a major joint training exercise that involves the Departments of the Navy[1], Army, Air Force, and Coast Guard participants reporting to a unified or joint commander who coordinates the activities planned to demonstrate and evaluate the ability of the services to engage in a conflict and carry out plans in response to a threat to national security. Service Secretaries and Combatant Commanders report to the Secretary of Defense. Combatant Commanders are the senior military authority for their assigned area of responsibility. The U.S. Pacific Command (PACOM[2]), based in Hawaii, has the primary warfighting mission to defend the United States and its interests in the Asia-Pacific Region. The U.S. Northern Command (NORTHCOM) has the primary responsibility for homeland defense. Each of these combatant commanders is supported by component commanders comprising forces from the Navy, Army, and Air Force. The combatant commanders develop exercises that train the Navy, Army, and Air Force components to execute plans for situations that they identify as potential threats to the United States. PACOM further delegates its authority to several different joint task force commanders including Commander, U.S. Pacific Fleet (PACFLT).

The exercise alternates annually between a PACOM and a NORTHCOM scenario. Because of the severe environmental conditions during the winter months, the exercises normally occur during the period between April and October. PACOM’s scenarios typically center on a major conflict that poses a threat to the United States that requires integration of Navy and Air Force assets with Army units conducting ground warfare in mountainous rural areas. The manner in which the Defense Department deploys its forces to respond to scenarios is relatively consistent, aiding a programmatic analysis at this time.

NORTHCOM’s scenarios supporting homeland defense, and the manner in which it deploys its forces, change rapidly as new needs and requirements are identified. Given this information, this comprehensive programmatic analysis cannot adequately capture the broad range of activities that may be possible in a NORTHCOM scenario. As these exercise scenarios are developed, environmental compliance needs will be evaluated for each exercise. Hence, this EIS/OEIS analyzes exercises designed to address PACOM’s

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[1] The Department of the Navy includes the United States Marine Corps. References to Navy training include Marine Corps training.

[2] PACOM is a unified command which includes about 325,000 military personnel from the Army, Navy, Air Force, and Marine Corps (about 20 percent of all active duty U.S. military forces).

requirements in Alaska. It does not address activities unique to the NORTHCOM-conducted exercises in Alaska.

The exercises have typically occurred within the ATA over a 14-day period during the April – October time frame. The ATA (Figure 1-1) is comprised of three basic components: 1) the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA); 2) U.S. Air Force (Air Force) over-land Special Use Airspace (SUA[3]) and air routes over the GOA and State of Alaska; and 3) U.S. Army (Army) training lands (to include associated airspace). An overview of the ATA is provided in Section 1.3, and a detailed discussion is provided in Chapter 2.

Modern military actions require teamwork between hundreds or thousands of people, and their various equipment, vehicles, ships, and aircraft, all working individually and as a coordinated unit to achieve success. This joint training conducted in the ATA by the services during these exercises allows for an opportunity to train Navy, USAF and USA forces simultaneously in an area of diverse terrain over large areas with relatively unconstricted air space.

The Navy's mission is to organize, train, equip, and maintain combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. This mission is mandated by federal law (Title 10 U.S.C. § 5062), which ensures the readiness of the United States' naval forces.[4] The Navy executes this responsibility by establishing and executing training programs, including at-sea training and exercises, and ensuring naval forces have access to the ranges, operating areas, and airspace needed to develop and maintain skills for conducting naval activities.

The purpose of the Proposed Action is to achieve and maintain fleet readiness using the ATA to support and conduct current, emerging, and future training activities.

The need for the Proposed Action is to enable the Navy to meet its statutory responsibility to organize, train, equip, and maintain combat-ready naval forces and to successfully fulfill its current and future global mission of winning wars, deterring aggression, and maintaining freedom of the seas.

The ATA plays a vital part in executing this naval readiness mandate. The training areas serve as a training venue for annual joint training exercises, which can involve forces from the Navy, Air Force, Army, and U.S. Coast Guard (USCG). The Navy's Proposed Action is a step toward ensuring the continued vitality of this essential naval training resource.

This EIS/OEIS assesses environmental effects associated with current and proposed training activities and force structure changes (to include new weapons systems and platforms) in the ATA. Chapter 2 describes in greater detail the alternatives, including the Proposed Action addressed in this EIS/OEIS. In summary, the Navy proposes to implement actions within the ATA to:

- Maintain baseline training activities at current levels;

[3] Special use airspace (SUA) is airspace of defined vertical and lateral limits that has been established by the FAA to segregate air activities, which may be hazardous to non-participating aircraft. Restricted areas, Military Operating Areas (MOAs), and Military Training Routes (MTRs) are examples of different types of SUA.

[4] Title 10, Section 5062 of the United States Code provides: "The Navy shall be organized, trained, and equipped primarily for prompt and sustained combat incident to operations at sea. It is responsible for the preparation of Naval forces necessary for the effective prosecution of war except as otherwise assigned and, in accordance with Integrated Joint Mobilization Plans, for the expansion of the peacetime components of the Navy to meet the needs of war."

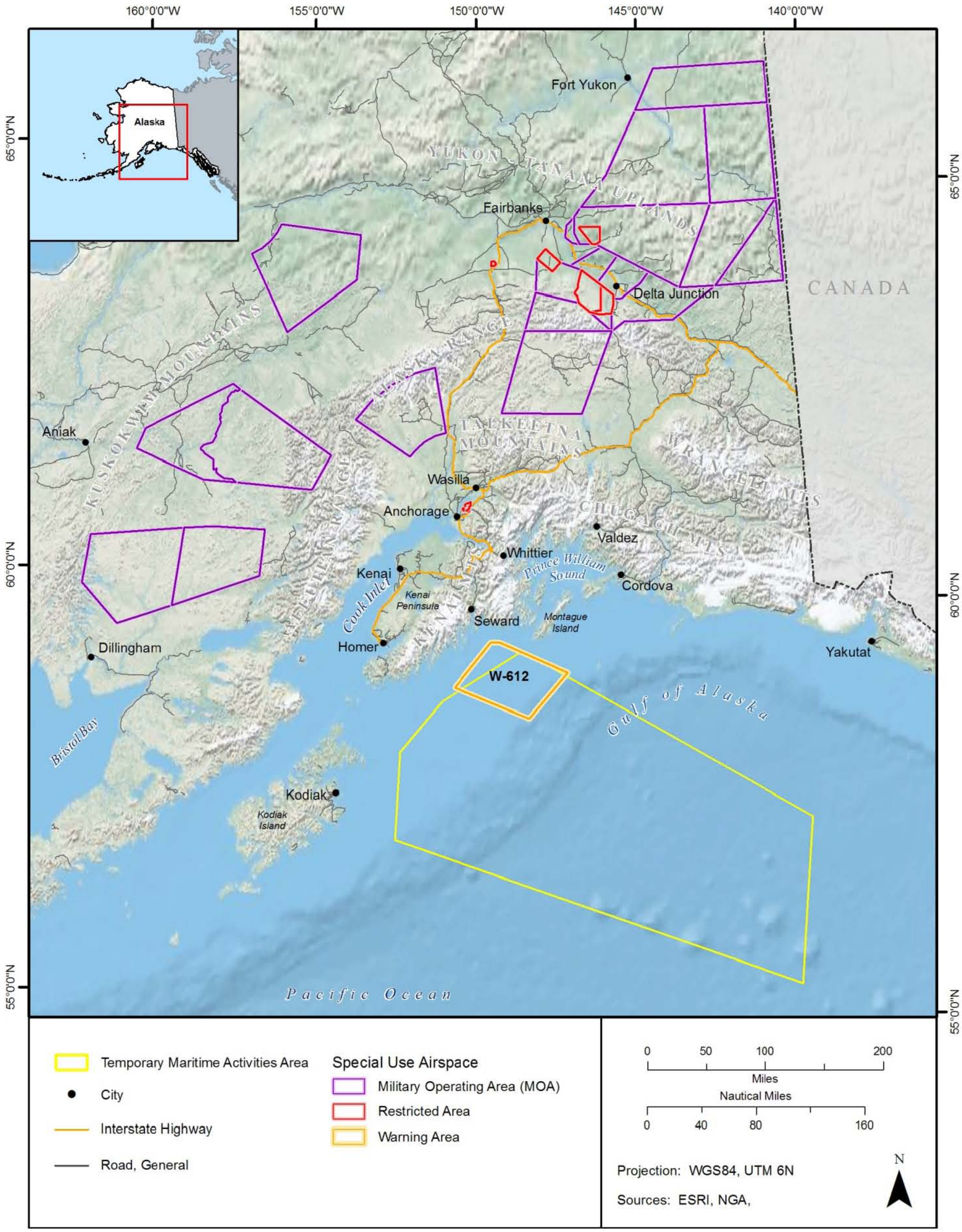

Figure 1-1: Alaska Training Areas

- Increase certain training activities from current levels in order to support the Fleet exercise requirements to include the use of active sonar; and

- Accommodate new training requirements associated with force structure changes and introduction of new weapons and systems to the Fleet.

The No Action Alternative is required by Council on Environmental Quality (CEQ) regulations as a baseline against which the impacts of the Proposed Action are compared. In this EIS/OEIS, the No Action Alternative is represented by current training activities (one joint force exercise occurring over a maximum time period of 14 consecutive days during summer months [April through October]), which provide the analytical baseline.

The Proposed Action would result in selectively focused and critical increases in training activities and levels that are necessary if the Navy is to maintain a state of military readiness commensurate with the national defense mission (conducting up to two joint force level exercises each of which could last up to 21 days between April and October).

The ATA serves as the principal training venue for annual joint exercises, which can involve forces from the Navy, Air Force, Army, and USCG, and to support required current, emerging, and future training.

The purpose of the Proposed Action is to achieve and maintain Fleet readiness using the ATA to support and conduct current, emerging and future training activities. The decision to be made by the Navy is to determine the scope and levels of training to be conducted within the ATA.

To support an informed decision, the EIS/OEIS identifies objectives and criteria for naval training activities in the ATA. The core of the EIS/OEIS is the development and analysis of different alternatives for achieving the Navy’s objectives. Alternatives development is a complex process, particularly in the dynamic context of military training. The touchstone for this process is a set of criteria that respond to the naval readiness mandate, as it is implemented in the ATA. The criteria for developing and analyzing alternatives to meet these objectives are set forth in Section 2.3.1. These criteria provide the basis for the statement of the Proposed Action and alternatives and selection of alternatives for further analysis (Chapter 2), as well as analyses of the environmental effects of the Proposed Action and alternatives (Chapter 3). Chapter 2 also discusses alternatives that were considered but eliminated because they do not satisfy the purpose and need or they fail to meet selection criteria.

This EIS/OEIS is being prepared in compliance with NEPA; the CEQ Regulations for Implementing the Procedural Provisions of NEPA (Title 40) Code of Federal Regulations [C.F.R.] Parts [§§] 1500-1508); Department of the Navy Procedures for Implementing NEPA (32 C.F.R. Part 775); and EO 12114, *Environmental Effects Abroad of Major Federal Actions*. The NEPA process ensures that environmental impacts of proposed major federal actions are considered in agency decision making. EO 12114 requires consideration of environmental impacts of actions outside the United States territorial seas. This EIS/OEIS satisfies the requirements of both NEPA and EO 12114.

1.2 BACKGROUND

The U.S. Navy routinely trains and operates in the ATA for national defense purposes. The land, air, and sea space of the ATA have provided, and continue to provide, a safe and realistic training environment for naval and joint forces.

1.2.1 Why the Navy Trains

The U.S. military is maintained to ensure the freedom and safety of all Americans both at home and abroad. In order to do so, Title 10 of the U.S.C. requires the Navy to "maintain, train and equip combat-ready naval forces capable of winning wars, deterring aggression and maintaining freedom of the seas." Modern war and security operations are complex. Modern weaponry has brought both unprecedented opportunity and innumerable challenges to the Navy. Smart weapons, when used properly, are very accurate and actually allow us to accomplish our mission with greater precision and far less destruction than in past conflicts. But these modern smart weapons are very complex to use. U.S. military personnel must train regularly with them to understand their capabilities, limitations, and operation. As stated above, modern military actions require teamwork between hundreds or thousands of people, and their various equipment, vehicles, ships, and aircraft, all working individually and as a coordinated unit to achieve success. Navy training addresses all aspects of the team, from the individual to multi-service (joint) and coalition teamwork. To do this, the Navy employs a building block approach to training. Training doctrine and procedures are based on operational requirements for deployment of naval forces. Training proceeds on a continuum, from teaching basic and specialized individual military skills, to intermediate skills or small unit training, to advanced, integrated training events, culminating in joint exercises or predeployment certification events.

The Navy's training cycle, Fleet Response Plan, ensures that naval forces achieve and maintain the capabilities to carry out the requirements of combatant commanders. The Navy implements this Plan through the Fleet Response Training Cycle. This cycle involves three basic phases: unit level training; integration training; and sustainment. The exercises that the Navy conducts in the ATA focus on maintaining and improving readiness of forces or the sustainment phase. These exercises also allow the Navy to train in a joint environment. Joint training is invaluable, as most conflicts tend to be fought jointly and the ability of the individual services to work cohesively together while maximizing and exploiting each services' own unique capabilities often times is the difference between success and failure.

To provide the experience so important to success and survival, training must be as realistic as possible. The Navy often employs simulators and synthetic training to provide early skill repetition and to enhance teamwork, but live training in a realistic environment is vital to success. This training requires sufficient sea and airspace to maneuver tactically, realistic targets and objectives, simulated opposition that creates a realistic enemy, and instrumentation to objectively monitor the events to help participants learn to correct errors.

Training areas provide controlled and safe environments that enable our forces to conduct realistic combat-like training as they undergo all phases of the graduated buildup needed for combat-ready deployment. These training areas and operating areas provide the space necessary to conduct controlled and safe training scenarios representative of those that our men and women would have to face in actual combat. The training areas are designed to provide the most realistic training in the most relevant environments, replicating to the best extent possible the operational stresses of warfare. The integration of undersea ranges and operating areas with land training ranges is critical to this realism, allowing execution of multidimensional exercises in complex scenarios. Typically, they also provide instrumentation that captures the performance of Navy tactics and equipment in order to provide the feedback and assessment that are essential for constructive criticism of personnel and equipment. The live-fire phase of training facilitates assessment of the Navy's ability to place weapons on target with the required level of precision while in a stressful environment.

Navy training activities focus on achieving proficiency in each of several functional areas encompassed by Navy operations. These functional areas, known as Primary Mission Areas (PMARs), are: Anti-Air

Warfare (AAW), Amphibious Warfare (AMW), Anti-Surface Warfare (ASUW), Anti-Submarine Warfare (ASW), Mine Warfare (MIW), Strike Warfare (STW), Electronic Combat (EC), and Naval Special Warfare (NSW). With the exception of MIW and AMW, all PMARs are conducted in the ATA and each training activity addressed in the EIS/OEIS is categorized under a PMAR.

The ATA is one of several areas (Southern California Range Complex, Hawaii Range Complex, Northwest Training Range Complex) used by the Navy for training of operational forces in the northern and eastern Pacific Ocean. As with each Navy training area, the primary mission of the ATA is to provide a realistic training environment for naval and joint forces to ensure that they have the capabilities and high state of readiness required to accomplish their assigned missions.

Training is focused on preparing for worldwide deployment. Naval forces generally deploy in specially organized units called Strike Groups. A Strike Group may be organized around one or more aircraft carriers, together with several surface combatant ships and submarines, collectively known as a Carrier Strike Group (CSG). A naval force known as a Surface Strike Group (SSG) consists of three or more surface combatant ships. The Navy and Marine Corps deploy CSGs and SSGs on a continuous basis. The number and composition of Strike Groups deployed and the schedule for deployment are determined based on worldwide requirements and commitments.

1.2.2 The Strategic Importance of the Alaska Training Areas

The ATA has a unique combination of attributes that make it a strategically important training venue for the Navy. These attributes include:

Location. The large contingent of Air Force aircraft and Army assets based within a few hundred miles of the TMAA creates the possibility of rare joint training opportunities with Navy forces. The TMAA provides a maritime training venue that is located within flight range of Elmendorf Air Force Base (AFB), Eielson AFB, Fort Richardson, Fort Wainwright, Fort Greely, and their associated air and land training ranges (Figure 1-1). Furthermore, numerous shipping lanes in the GOA and the abundance of commercial vessels on those shipping lanes provide valuable training during exercise scenarios.

Oceanographic conditions. The complex bathymetric and oceanographic conditions, including a continental shelf, submarine canyons, numerous seamounts, and fresh water infusions from multiple sources, create a challenging environment in which to search for and detect submarines in ASW training activities. In the summer, the TMAA provides a safe cold-water training environment.

Area of Training Space. The ATA is one of the largest air, surface, subsurface, and land training areas in the Northern Pacific. Detailed descriptions of these areas are provided in Section 1.3.2. This vast training area provides ample space to support the necessary forces and allow for the full range of activities required of a robust joint training scenario.

1.3 OVERVIEW OF THE ALASKA TRAINING AREAS

1.3.1 Mission

The ATA is the principal training venue for the naval forces that participate in large-scale joint exercises in the Alaska area. Northern Edge[5] is a large-scale joint exercise that has been conducted annually, principally within the TMAA (see Figure 1-2 and Section 1.3.2 for description of the TMAA) for several years. The TMAA meets large-scale joint exercise training objectives to support naval and joint operational readiness by providing a "geographically realistic" training area for U.S. Pacific Command (PACOM), Joint Task Force Commander[6] scenario-based training, and supports the mission requirement of Alaskan Command (ALCOM)[7] to conduct joint training for Alaska-based forces. The strategic vision of the Commander, U.S. Pacific Fleet (CPF) and the Commander, United States Fleet Forces (USFF) for this training area is that it support naval operational readiness by providing a realistic, live-training environment for forces assigned to the Pacific Fleet and other users with the capability and capacity to support current, emerging, and future training requirements.

1.3.2 Primary Components

The ATA consists of three primary components: the TMAA, the Air Force SUA, and the Army training lands (to include associated airspace). The components of the ATA encompass 42,146 square nautical miles (nm^2) (145,482 square kilometers [km^2]) of sea space, 88,731 nm^2 (305,267 km^2) of SUA (not including the portion of Warning Area 612 [W-612] that falls outside the MAA), and over 2,624 square miles (mi^2) (6,796 km^2) of land area (Army ranges). Each of the primary components of the ATA can be divided into numerous subcomponent training areas, which are described in detail in Chapter 2.

TMAA. The TMAA (see Figure 1-2) is composed of the 42,146 nm^2 (145,482 km^2) of surface and subsurface operating area and overlying airspace that includes the majority of W-612 located over Blying Sound. W-612 is 2,256 nm^2 (8,766 km^2) of SUA. The TMAA is roughly rectangular shaped and oriented from northwest to southeast, approximately 300 nautical miles (nm) (555.6 kilometers [km]) long by 150 nm (277.8 km) wide, situated south of Prince William Sound and east of Kodiak Island. The TMAA is bounded by the following coordinates: 57° 30‘N, 141° 30’W to 59° 36’N, 148° 10’W to 58° 57’N, 150° 04’W to 58° 20’N, 151° 00’W to 57° 16’N, 151° 00’W to 55° 30’N, 142° 00’W. The majority of Navy training activities occur in the TMAA. The specific geographical area of the TMAA supports operational and logistical (time, speed, and distance) challenges associated with real world scenarios that support joint operations within PACOM's unique area of responsibility. For example, CSG and land based joint operations, both overland and overwater, require air route access to land ranges, proximity to bases where a landing could be made in an emergency, and supportable fuel costs, which includes air-to-air refueling where appropriate. The TMAA provides these requirements.

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[5] Northern Edge is training exercise that exercises joint interoperability of service component forces by testing and evaluating contingency plans, policies, procedures, command structure, communications, logistics, and operations in a joint environment. The exercise also provides a venue for the development and implementation of joint experimentation in Alaska. Depending on the specific exercise objectives, Northern Edge may also incorporate joint task force training modules and transformation initiatives for air and space operations center employment, defensive counter air, counter surface/maritime interdiction, and personnel recovery.

[6] A Joint Task Force Commander and supporting staff is capable of planning and executing any contingency from relatively small-scale operations, such as noncombatant evacuations or maritime interdiction, to major theater conflict.

[7] The mission requirement of ALCOM is to: 1) integrate military activities within Alaska to maximize the readiness of theater forces, 2) expedite deployment of forces from and through Alaska in support of worldwide contingencies, and 3) serve as the JTF headquarters for protection of critical infrastructure and coordination of Military Assistance to Civil Authorities.

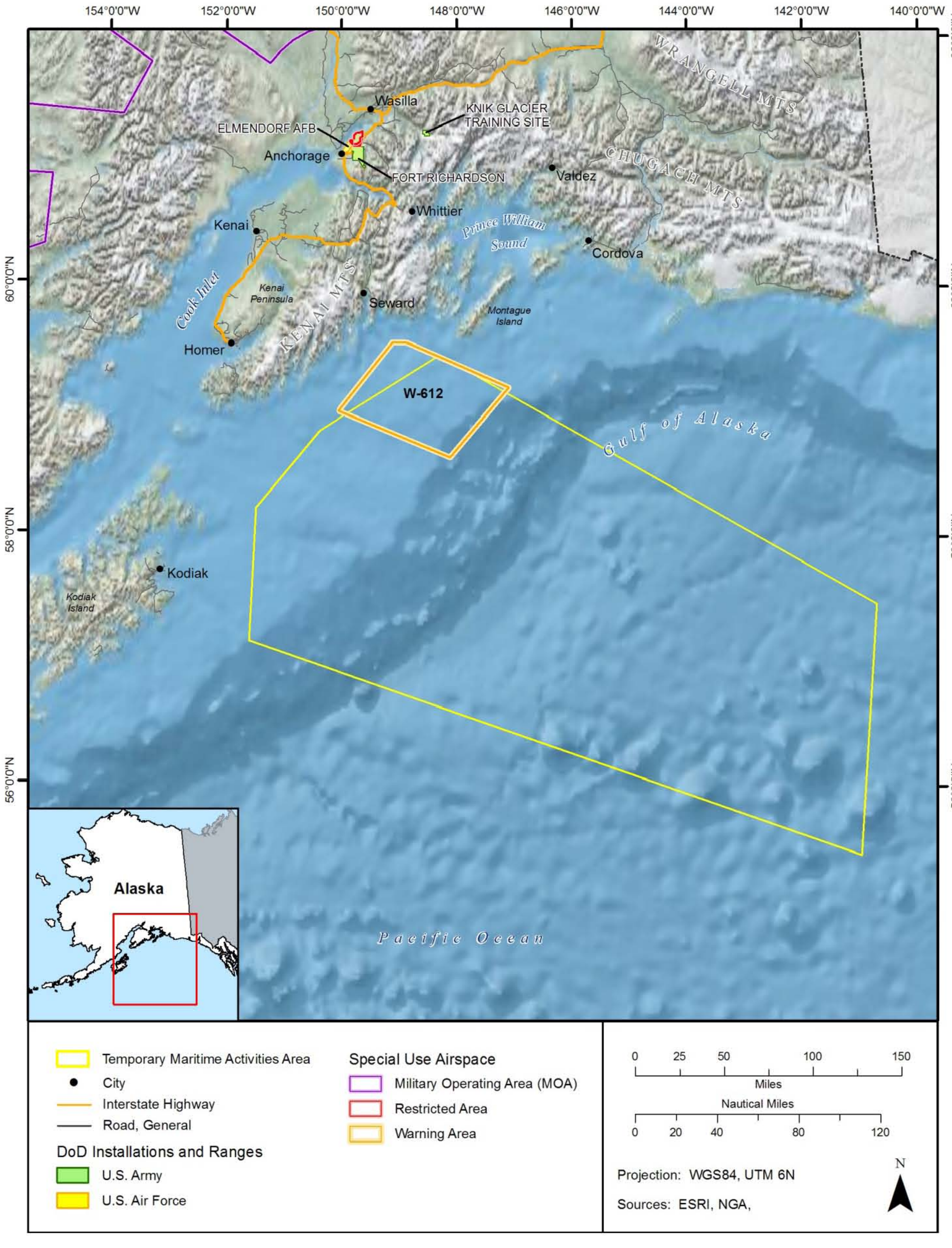


Figure 1-2: Gulf of Alaska Temporary Maritime Activities Area

Air Force Inland Special Use Airspace Training Areas. The ATA includes numerous Air Force airspace areas designated as Restricted Areas (RAs), Military Operations Areas (MOAs) or Visual Flight Rules (VFR) corridors. Other airspace for special use in Alaska consists of Military Training Routes (MTRs), Air Traffic Control Assigned Airspace (ATCAA), Air Refueling Anchors/Tracks, Low-Altitude Tactical Navigation (LATN) areas, Controlled Firing Areas, and Slow Speed Low-Altitude Training Routes. In total, these training areas comprise 46,585 nm^2 (159,782 km^2/61,692 mi^2) of SUA, 43,963 nm^2 (150,789 km^2/58,220 mi^2) of which is instrumented (ability to track, score and replay events), that overlays portions of the State of Alaska, generally to the west and north of Anchorage and to the east of Fairbanks. The Air Force's SUA in Alaska is among the largest components of SUA in the Air Force's range inventory, facilitating realistic training involving high speed military aircraft with the capability to traverse extensive airspace very quickly. A significant portion of naval air activity occurs in the Air Force's SUA.

Army Training Land. The ATA includes numerous Army land training areas that are located both on and off Army installations. In total, these training areas comprise 2,624 mi^2 (1,981 nm^2/6,796 km^2) of land that is located generally to the south and east of Fairbanks, below the Air Force's SUA. The Army's land training areas in Alaska are among the largest of all training areas in the Army's inventory. These ground training areas provide an extensive suite of capabilities for tactical training, including live-fire training areas for small arms, maneuver areas, and other dedicated areas for the conduct of training. These training areas have extensive instrumentation, and provide opposing force simulation and targets for use in land and air live-fire training. Additionally, these training areas contain airfields, drop zones, landing zones, and other infrastructure for training and logistical support. Combined with the Air Force's SUA, these ground training areas provide Navy and Air Force aircraft the capability to drop live and inert munitions into existing impact areas near instrumented ranges during large, complex flying evolutions.

1.4 PURPOSE AND NEED OF THE PROPOSED ACTION

Given the vital importance of the ATA to the readiness of naval forces and the unique training environment provided by the ATA, the Navy proposes to take actions for the purposes of:

- Supporting PACOM training requirements;
- Supporting Joint Task Force Commander training requirements;
- Achieving and maintaining Fleet readiness using the ATA to support and conduct current, emerging, and future training activities; and
- Expanding warfare missions supported by the ATA, consistent with requirements.

The Proposed Action is needed to continue providing a training environment with the capacity and capabilities to fully support required training tasks for operational units participating in joint exercises, such as the annual Northern Edge exercise. The Navy has developed alternatives criteria based on this statement of the purpose and need for the Proposed Action (see Section 2.3.1).

In this regard, the ATA furthers the Navy's execution of its roles and responsibilities under Title 10. To comply with its Title 10 mandate, the Navy needs to:

- Maintain current levels of military readiness by training in the ATA;
- Accommodate future increases in training activity tempo in the ATA;
- Support the acquisition and implementation into the Fleet of advanced military technology using the ATA to conduct training activities for new platforms and associated weapons systems

(EA-18G Growler aircraft, Guided Missile Submarines [SSGN], P-8 Poseidon Multimission Maritime Aircraft [MMA], Guided Missile Destroyer [DDG] 1000 {Zumwalt Class destroyer}, and several types of Unmanned Aerial Systems [UASs]);

- Identify shortfalls in training, particularly training instrumentation and address through enhancements;
- Maintain the long-term viability of the ATA as a premiere Navy training area while protecting human health and the environment, and enhancing the quality, capabilities, and safety of the training area; and
- Be able to bring Army, Navy, Air Force, and Coast Guard assets together into one geographic area for joint training.

1.5 THE ENVIRONMENTAL REVIEW PROCESS

1.5.1 The National Environmental Policy Act

The National Environmental Policy Act of 1969 requires Federal agencies to examine the environmental effects of their Proposed Actions. An EIS is a detailed public document that provides an assessment of the potential effects that a Federal action might have on the human, natural, or cultural environment. The Navy is the lead agency for the EIS/OEIS as set forth in 40 CFR § 1501.5; NMFS is a cooperating agency as set forth in 40 CFR § 1501.6.

The Navy is preparing a Draft EIS/OEIS for the ATA to assess the effects of ongoing and proposed future activities on the environment. The Draft EIS/OEIS also gives the Navy an opportunity to review its procedures and ensure the benefits of recent scientific and technological advances are applied toward minimizing environmental effects.

The first step in the NEPA process is the preparation of a Notice of Intent (NOI) to develop an EIS/OEIS. The NOI provides an overview of the Proposed Action and the scope of the EIS/OEIS. The NOI for this project was published in the *Federal Register* on March 17, 2008, and in four local newspapers, (*Anchorage Daily News*, *Kodiak Daily Mirror*, *Cordova Times*, *Peninsula Clarion* [see Appendix G for information on the scoping meetings]). The NOI and newspaper notices included information about comment procedures, a list of information repositories (public libraries), the project website address (http://www.GulfofAlaskaNavyEIS.com), and the dates and locations of the scoping meetings.

Scoping is an early and open process for developing the "scope" of issues to be addressed in the EIS/OEIS, and for identifying significant issues related to a Proposed Action. The scoping meetings for this EIS/OEIS were advertised in local newspapers; the advertisements invited public attendance to help define and prioritize environmental issues, and convey these issues to the Navy (see Appendix G for information on the scoping meetings). Comments from the public, as well as from agencies and special interest groups, including the development of alternatives were considered in the preparation of this EIS/OEIS.

Some of the comments received from the public during the scoping process are categorized and summarized in Table 1-1. This table is not intended to provide a complete listing, but to show the extent of the scope of comments.

Table 1-1: Public Scoping Comment Summary

Category	Comment Summary
Marine Mammals	Concerns about physical and physiological effects to marine mammals from Navy activities. In particular, injuries from ship strikes and sonar, to include being disoriented, strandings, and hearing loss.
Sonar, Sound in the Water	Desires that the EIS/OEIS consider alternative technologies to mid-frequency active (MFA) sonar. General feeling that MFA and other forms of sonar are not required for training and should not be conducted within the GOA.
Fish and Marine Habitat	Concerns about the effects to fish and marine mammal habitats from Navy activities to include migratory routes, feeding grounds, and breeding as well as impacts from hazardous materials and waste.
Mitigation	Concern about the Navy's training program for spotting animals - The belief that spotting marine mammals is extremely difficult, even for expert observers, and doubts that shipboard lookouts will be able to detect animals in the adverse sea conditions - especially at night. Questions about mitigating the possible adverse impacts to marine mammals from sonar. Belief that, in general, the Navy needs to aggressively consider ways to expand, improve, and employ better protective measures in future and to better identify clear monitoring goals and objectives with specific parameters for measuring success, and provide a feedback mechanism for the public to view information on mitigation effectiveness and monitoring results.
Policy/NEPA Compliance and Public Participation	Concern that information available during scoping was inadequate to inform comments or that the "poster" session was not the best format. Others desired a more open forum-type format, where all questions voiced could be heard by all. Request that meeting locations be expanded.
Threatened & Endangered Species	Concerns about the number of endangered species, particularly whales (seven in total), within the GOA, and designation of critical habitats.
Commercial Fishing	Concerns about the effects of Navy activities upon fish, their embryos, migration patterns, and the overall impact on the commercial fishing industry and thus the livelihoods of Alaskans in general.

Subsequent to the scoping process, this Draft EIS/OEIS was prepared to assess the potential effects of the Proposed Action and alternatives on the environment. A Notice of Availability (NOA) was published in the *Federal Register,* and notices were placed in the aforementioned newspapers announcing the availability of the Draft EIS/OEIS. The Draft EIS/OEIS is now available for general review, and is being circulated for review and comment. Although exact venues have not been identified, public meetings will be advertised and held in the same cities as the scoping meetings, as well as two additional cities, Homer and Juneau, to receive public comments on the Draft EIS/OEIS.

A Final EIS/OEIS will be prepared that responds to all public comments received on the EIS/OEIS. Responses to public comments may take various forms as necessary, including correction of data, clarifications of and modifications to analytical approaches, and inclusion of additional data or analyses. The Final EIS will then be made available for public review.

Finally, after the Final EIS/OEIS is made available to the public and a 30 day wait period has elapsed, a Record of Decision (ROD) will be issued. The ROD will summarize the Navy's decision, identify the selected alternative, describe the public involvement and agency decision-making processes, and present commitments to specific mitigation measures.

Navy training activities that occur within the Air Force inland SUA and the Army training lands are analyzed under separate previous NEPA documentation (the *Alaska Military Operations Area EIS* [USAF

1995], *Improvements to Military Training Routes in Alaska Environmental Assessment* [USAF 2007], the *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* [Army 1999], and the *Transformation of U.S. Army Alaska FEIS* [Army 2004]). These documents are incorporated by reference which, in NEPA terms, means that the environmental effects of these activities are addressed in these documents. For additional information, see Section 1.6.

1.5.2 Jurisdictional Considerations (Executive Order 12114)

In 1969, Congress enacted NEPA, which provides for the consideration of environmental issues in Federal agency planning and decision-making. Regulations for federal agency implementation of the act were established by the President's CEQ. NEPA requires that federal agencies prepare an EIS if an Environmental Assessment (EA) determines a proposed action might significantly affect the quality of the human environment. The EIS must disclose significant environmental impacts and inform decision makers and the public of the reasonable alternatives to the Proposed Action. Presidential Proclamation 5928, issued December 27, 1988 (54 Fed. Reg. 777, titled 'Territorial Sea of the United States'), extended the exercise of United States sovereignty and jurisdiction under international law to 12 nm; however, the Proclamation expressly provides that it does not extend or otherwise alter existing federal law or any associated jurisdiction, rights, legal interests, or obligations. As a result, the Navy analyzes environmental effects and actions within 12 nm under NEPA and those effects occurring beyond 12 nm under the provisions of EO 12114. Table 1-2 presents a list of training activities (by warfare area) and the geographical area in which they occur (Inland, 0-12 nm, and beyond 12 nm). As shown in Table 1-2, the majority of training activities occur outside of territorial waters (not within 12 nm of shore)

For the majority of resource sections addressed in this Draft EIS/OEIS, projected impacts outside of U.S. territorial waters would be similar to those within territorial waters. Beyond 12 nm (22 km) is simply a jurisdictional boundary and is not delineated for purposes of scheduling or management of military training activities. In addition, the baseline environment and associated impacts to the various resource areas analyzed in this Draft EIS/OEIS are not substantially different within or outside the 12 nm (22 km) jurisdictional boundary. Therefore, for these resource sections, the impact analyses contained in the main body of the Draft EIS/OEIS are comprehensive and follow both NEPA and EO 12114 guidelines. The description of the affected environment addresses areas both within and beyond U.S. territorial sea.

Table 1-2 lists training activities by warfare area, and indicates whether a given activity is addressed pursuant to NEPA (because it occurs within U.S. territory, including the territorial seas) or pursuant to EO 12114 (because it occurs outside the territorial seas).

Table 1-2: Training Activities Analyzed under NEPA and EO 12114

Warfare Area	Training Activity	NEPA		EO 12114
		Inland[2]	0-12 NM[3]	Beyond 12 NM
Anti-Air Warfare (AAW)	Aircraft Combat Maneuvers	X	X	X
	Air Defense Exercise		X	X
	Surface-to-Air Missile Exercise (MISSILEX)			X
	Surface-to-Air Gunnery Exercise (GUNEX)		X	X
	Air-to-Air MISSILEX		X	X
Anti-Submarine Warfare (ASW)[1]	Helicopter ASW Tracking Exercise (TRACKEX)			X
	MPA ASW TRACKEX		X	X
	Extended Echo Ranging (EER) ASW Exercises			X
	Surface Ship ASW TRACKEX			X
	Submarine ASW TRACKEX			X

Table 1-2: Training Activities Analyzed under NEPA and EO 12114 (continued)

Warfare Area	Training Activity	NEPA		EO 12114
		Inland[2]	0-12 NM[3]	Beyond 12 NM
Anti-Surface Warfare (ASUW)	Visit Board Search and Seizure			X
	Air-to-Surface MISSILEX			X
	Air-to-Surface Bombing Exercise (BOMBEX)			X
	Air-to-Surface GUNEX			X
	Surface-to-Surface GUNEX			X
	Maritime Interdiction		X	X
	Sea Surface Control			X
	Sinking Exercise		X	X
Electronic Combat (EC)	EC Exercise	X	X	X
	Chaff Exercise	X	X	X
	Counter Targeting Exercise			X
Naval Special Warfare (NSW)	Insertion/Extraction	X		
Strike Warfare (STW)	Air-to-Ground BOMBEX	X	X	
	Personnel Recovery	X		X
Other Activities				
N/A	Deck Landing Qualification (DLQs)			X

1 – ASW activities are not currently conducted in the TMAA. N/A – Not applicable.
2 - Navy inland activities are a part of the Proposed Action; however, those inland activities are analyzed under existing USAF/Army NEPA documents, including potential increases in training activities.
3 – The only activities that occur within 0-12 nm are aircraft overflights above 15,000 feet.

1.5.3 Government-to-Government Consultations

As part of the EIS/OEIS process, the Navy contacted the following federally recognized tribes in Alaska for Government-to-Government consultations on this document: Afognak, Chenega, Eyak, Kaguyak, Lesnoi Village, Old Harbor, Ouzinke, Port Graham, Port Lions, Shoonaq, Tatitlek, and Yakutat. To date, all tribes have informally (telephonically/verbally) responded that they will not be requesting Government-to-Government consultations.

1.5.4 Regulatory Agency Briefings

The Navy held a series of regulatory agency briefings in November of 2008, with the following regulators: U.S. Fish and Wildlife Service (USFWS) Alaska Region, the Environmental Protection Agency (EPA) Region X, and the Alaska Department of Natural Resources (ADNR) Coastal Zone Management Act (CZMA) staff.

1.5.5 Coastal Zone Management Act

The *Coastal Zone Management Act* (CZMA) of 1972 (16 U.S.C. § 1451) encourages coastal states to be proactive in managing coastal uses and coastal resources in the coastal zone. The CZMA established a voluntary coastal planning program; participating states submit a Coastal Management Plan (CMP) to the National Oceanographic and Atmospheric Administration (NOAA) Office of Ocean and Coastal Resource Management (OCRM) for approval. Under CZMA, federal actions are required to be consistent, to the maximum extent practicable, with the enforceable policies of approved CMPs.

CZMA defines the coastal zone (16 U.S.C. § 1453) as extending, "to the outer limit of State title and ownership under the Submerged Lands Act." The coastal zone extends inland only to the extent necessary to control the shoreline. Excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of, or which is held in trust by, the federal government (16 U.S.C. § 1453). Accordingly, federal military lands are not within the coastal zone. In the State of Alaska, CZMA coastal boundaries are determined by each individual Coastal Resource District pursuant to 11 Alaska Administrative Code (AAC) 114.220.

The State of Alaska has an approved CMP, the Alaska Coastal Management Program (ACMP), which is found at Alaska Statutes Annotated (AS) Title 45 Chapter 40. The ACMP received federal approval from the NOAA in 1979. The ACMP provides stewardship for Alaska's rich and diverse coastal resources to ensure a healthy and vibrant Alaskan coast that efficiently sustains long-term economic and environmental productivity. The Alaska Department of Natural Resources (ADNR) is the state's designated coastal management agency and is responsible for reviewing projects for consistency with the CMP and issuing coastal management decisions under the provisions of 11 AAC Code Chapters 110 and 112. Specific statewide standards for review under the ACMP are found at 11 AAC Chapter 112.

The CZMA federal consistency determination process includes a review of the Proposed Action to determine whether it has potential direct or indirect effects on coastal zone resources or uses under the provisions of the CMP. An in-depth examination of any such effects, and a determination on whether those effects are consistent to the maximum extent practicable with the state's enforceable policies, is then conducted by the action proponent. Specific standards under the ACMP that appear applicable to proposed training activities occurring in the TMAA are 11 AAC Chapter 112 Sections 280 ("Transportation Routes and Facilities"), 300 ("Habitats"), 310 ("Air, Land, and Water Quality), and 320 ("Historic, Prehistoric, and Archeological Resources").

For the activities covered in this Draft EIS/OEIS, the Navy will ensure compliance with the CZMA through coordination with the ADNR.

1.5.6 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972 established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction. The act further regulates "takes" of marine mammals in the global commons (that is, the high seas) by vessels or persons under U.S. jurisdiction. The term "take," as defined in Section 3 (16 USC 1362) of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of harassment, Level A (potential injury) and Level B (potential disturbance).

The National Defense Authorization Act of Fiscal Year 2004 (Public Law 108-136) amended the definition of harassment as applied to military readiness activities or scientific research activities conducted by or on behalf of the federal government, consistent with Section 104(c)(3) [16 U.S.C. 1374 (c)(3)]. The Fiscal Year 2004 National Defense Authorization Act adopted the definition of "military readiness activity" as set forth in the Fiscal Year 2003 National Defense Authorization Act (Public Law 107-314). Military training activities within the TMAA constitute military readiness activities as that term is defined in Public Law 107-314 because training activities constitute "training and operations of the Armed Forces that relate to combat" and constitute "adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat use."

For military readiness activities, the relevant definition of harassment is any act that:

- Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment").
- Disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered ("Level B harassment") [16 U.S.C. 1362 (18)(B)(i)(ii)].

16 U.S.C. § 1371(a)(5) directs the Secretary of the Department of Commerce to allow, upon request, the incidental (but not intentional) taking of marine mammals by U.S. citizens who engage in a specified activity (exclusive of commercial fishing), if certain findings are made and regulations are issued. Permission will be granted by the Secretary for the incidental take of marine mammals if the taking will have a negligible impact on the species or stock and will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses.

In support of the Proposed Action, the Navy is requesting a Letter of Authorization (LOA) pursuant to Section 101(a)(5)(A) of the MMPA. After the application is reviewed by NMFS, a Notice of Receipt of Application will be published in the *Federal Register*. Publication of the Notice of Receipt of Application will initiate the 30-day public comment period, during which time anyone can obtain a copy of the application by contacting NMFS. In addition, the MMPA requires NMFS to develop regulations governing the issuance of a LOA and to publish these regulations in the *Federal Register*. Subsequently, NMFS will publish its Proposed Rule in the *Federal Register*. After receiving public comments on this Proposed Rule, NMFS will publish its Final Rule. Several species of marine mammals occur in the TMAA. Accordingly, the Navy has initiated the MMPA compliance process with NMFS, by submission of a request for a LOA. The Navy will receive a LOA from NMFS to permit takes as appropriate.

1.5.7 Endangered Species Act

The Endangered Species Act (ESA) of 1973 established protection over and conservation of threatened and endangered species and the ecosystems upon which they depend. An "endangered" species is a species that is in danger of extinction throughout all or a significant portion of its range, while a "threatened" species is one that is likely to become endangered within the foreseeable future throughout all or in a significant portion of its range. The USFWS and NMFS jointly administer the ESA and are also responsible for the listing of species (designating a species as either threatened or endangered). The USFWS has primary management responsibility for management of terrestrial and freshwater species, while the NMFS has primary responsibility for marine species and anadromous fish species (species that migrate from saltwater to freshwater to spawn). The ESA allows the designation of geographic areas as critical habitat for threatened or endangered species.

The ESA provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The law requires federal agencies, in consultation with the USFWS and/or NMFS, to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of any threatened or endangered species or result in the destruction or adverse modification of designated critical habitat of such species. Under Section 7 of the ESA, "jeopardize" means to engage in any action that would be expected to reduce appreciably the likelihood of the survival and recovery of a listed species by reducing its reproduction, numbers, or distribution.

Regulations implementing the ESA expand the consultation requirement to include those actions that "may affect" a listed species or adversely modify critical habitat. If an agency's proposed action would take a listed species, the agency must obtain an incidental take statement from the responsible wildlife agency. Consultation is complete once NMFS prepares a final Biological Opinion (BO) and issues an incidental take statement.

Seven marine mammal species that are listed as endangered under the ESA could potentially occur in the TMAA. Critical habitat for Northern Pacific right whales and Steller sea lions has been designated under the ESA; however, these areas are outside the action area of the TMAA. Accordingly, the Navy has initiated the ESA Section 7 consultation process with NMFS.

1.5.8 Other Environmental Requirements Considered

The Navy must comply with a variety of other federal environmental laws, regulations, and EOs. These include (among other applicable laws and regulations):

- Migratory Bird Treaty Act (MBTA) (16 U.S.C. §§ 703-711);
- Rivers and Harbors Act (RHA) (33 U.S.C. §§ 401-426);
- Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (16 U.S.C. §§ 1801-1891);
- Clean Air Act (CAA) (42 U.S.C. §§ 7401-7671);
- Federal Water Pollution Control Act (Clean Water Act, CWA) (33 U.S.C. §§ 1251-1387);
- National Historic Preservation Act (NHPA) (16 U.S.C. § 470);
- EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (EO 12898, 59 Federal Register [FR] 7269 [Feb 16, 1994]);
- EO 13045, Environmental Health and Safety Risks to Children (EO 13045, 62 FR 19885 [Apr 23, 1997]);
- Alaska Native Claims Settlement Act of 1971 (ANCSA) (43 U.S.C. §§ 1601-1629); and
- Alaska National Interest Lands Conservation Act (ANILCA) (16 U.S.C. §§ 3101-3233).

In addition, laws and regulations of the State of Alaska appropriate to Navy actions are identified and addressed in this EIS/OEIS. This EIS/OEIS will facilitate compliance with applicable, appropriate state laws and regulations.

1.6 RELATED ENVIRONMENTAL DOCUMENTS INCORPORATED BY REFERENCE

According to CEQ regulations for implementing NEPA, material relevant to an EIS may be incorporated by reference with the intent of reducing the size of the document (40 C.F.R. § 1502.21). Some of the programs and projects in the GOA that have undergone environmental review and documentation to ensure NEPA compliance are identified below and incorporated herein by reference.

- U.S. Department of the Air Force, 1995. Alaska Military Operations Areas Environmental Impact Statement. August 1995.

  - This EIS analyzed periodic major Joint Task Force (JTF[8]) (Army, Air Force, Marine Corps, and Navy) exercises such as COPE THUNDER and NORTHERN EDGE which utilize the three withdrawn military areas and which stage assets and/or personnel at the Army installations as well as at Eielson and Elmendorf Air Force Bases. The EIS evaluated the occurrence of up to six JTF exercises or Major Flying Exercises (MFE) each year, one sometime between February and April, four between May and August, and one between October and November. Each JTF or MFE usually covers 10 to 15 flying days, not exceeding 60 flying days each year. Additionally, each MFE could have up to 100 aircraft and 200 sorties per MFE-day.

  - The military uses examined in the *Military Operations Areas Environmental Impact Statement* correspond to the military activities of aircraft combat maneuvers, electronic combat operations, insertion/extraction, air-to-ground bombing exercises, and personnel recovery included in the Proposed Action addressed in the GOA EIS.

- U.S. Department of the Air Force, 2007. Improvements to Military Training Routes (MTRs) in Alaska Environmental Assessment (EA), Elmendorf AFB, Alaska: 11 AF.

  - The *Improvements to MTRs in Alaska EA* analyzed the environmental effects of modifying the Alaska network of MTRs to address the inefficiencies of existing routes and improve training efficiency. These modifications included modifying eight routes, removing two routes, adding two new routes, and extending two routes to the coast. The EA analyzed the effects of the Proposed Action on climate and topography, vegetation and wildlife, subsistence uses, parks and recreation, airspace, air quality, and noise. No significant impacts were identified by the EA.

  - The numbers and timing of sorties and the aircraft altitudes and speeds examined in the *Improvements to MTRs in Alaska EA* encompass those that would be associated with the military activities of aircraft combat maneuvers, electronic combat operations, insertion/extraction, air-to-ground bombing exercises, and personnel recovery included in the Proposed Action addressed in the GOA EIS.

- U.S Department of the Army, 1999. Alaska Army Lands Withdrawal Renewal Final Legislative Environmental Impact Statement.

  - The *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999) examined the effects of continued withdrawal from public use under the Military Lands Withdrawal Act and the continued military use of the Fort Wainwright Yukon Training Area (formerly the Fort Wainwright Maneuver Area), the Fort Greely West Training Area (formerly the Fort Greely Maneuver Area) and the Fort Greely East Training Area (formerly the Fort Greely Air Drop Zone). These areas together cover approximately 871,500 acres (352,684 hectares) in interior Alaska.

  - The EIS examined military aircraft air-to-ground training in restricted airspaces R2202 and R2205 over Fort Greely West Training Area and Fort Wainwright Yukon Training Area, respectively. It also analyzed periodic major JTF (Army, Air Force, Marine Corps,

[8] These JTF exercises are not "certification for deployment" exercises as conducted by Naval Forces in other Range Complexes

and Navy) exercises such as COPE THUNDER and NORTHERN EDGE which utilize the three withdrawn military areas and which stage assets and/or personnel at the Army installations as well as at Eielson and Elmendorf Air Force Bases. The EIS evaluated the occurrence of up to six JTF exercises or Major Flying Exercises (MFE) each year, one sometime between February and April, four between May and August, and one between October and November. Each JTF or MFE usually covered 10 to 15 flying days, but not exceeding 60 flying days each year.

- The EIS also assessed Air Force and joint forces uses of Fort Wainwright and Fort Greely areas for military aircraft air-to-ground training in the restricted airspaces R2202 and R2205. The use of mock enemy airfields, targets, manned radar emitters, anti-aircraft threat simulators, and electronic scoring sensors in the areas was examined. Both low altitude and high altitude bombing by most aircraft in the military inventory at the time of the EIS were analyzed. Weaponry training included aircraft machine guns, rockets, bombs, and air-to-ground missiles.
- The military uses examined in the *Alaska Army Lands Withdrawal Final Legislative EIS* correspond to the military activities of aircraft combat maneuvers, electronic combat operations, insertion/extraction, air-to-ground bombing exercises, and personnel recovery included in the Proposed Action addressed in the GOA EIS.

- U.S. Department of the Army, 2004. Transformation of U.S. Army Alaska Final Environmental Impact Statement.
    - The *Transformation of U.S. Army Alaska Final EIS* examined the effects of transforming the Army's Current Force to a Future Force during the next 30 years. This transformation would affect most aspects of the Army's doctrine, training, leader development, organizations, installations, materiel, and Soldiers. As part of this action, the Army transformed the 172nd Infantry Brigade (Separate) at FWA and FRA into a Stryker Brigade Combat Team (SBCT). Transformation to a SBCT included stationing additional Soldiers; acquiring the Stryker vehicle, UASs and other weapon systems; changing training requirements; and constructing facilities.
    - The military uses examined in the *Transformation of U.S. Army Alaska Final EIS* are consistent with the land training elements of the Proposed Action addressed in the GOA EIS, including insertion/extraction and personnel recovery.

2 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

The Navy proposes to implement actions within the Alaska Training Areas (ATA) to:

- Increase training activities from current levels as necessary to support Fleet exercise requirements to include the use of active sonar; and
- Accommodate new training requirements associated with force structure changes and introduction of new weapons and systems to the Fleet.

The No Action Alternative is required by regulations of the Council on Environmental Quality (CEQ) as a baseline against which the impacts of the Proposed Action are compared. In this Draft Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) (hereafter referred to as "EIS/OEIS"), the No Action Alternative is represented by baseline training activities at current levels (one joint force exercise occurring over a maximum time period of 14 days during summer months [April through October]).

The Proposed Action would result in selectively focused but critical increases in training to address training shortfalls, as necessary to ensure the ATA supports Navy training and readiness objectives.

Actions to support current, emerging, and future training activities in the ATA will be evaluated in this EIS/OEIS. These actions include:

- Increasing the number of training activities from current levels as necessary to support Fleet exercise requirements (that could last up to 21 days between April and October);
- Conducting training in the Primary Mission Areas (PMARs) including Anti-Air Warfare (AAW), Anti-Surface Warfare (ASUW), Anti-Submarine Warfare (ASW), Naval Special Warfare (NSW), Strike Warfare (STW), and Electronic Combat (EC). Conduct of training may include that necessary for newer systems, instrumentation, and platforms, including the EA-18G Growler aircraft, Guided Missile Submarines (SSGN), P-8 Poseidon Multimission Maritime Aircraft (MMA), Guided Missile Destroyer (DDG) 1000 (Zumwalt Class) destroyer, and several types of Unmanned Aerial Systems (UASs);
- Accommodating training enhancement instrumentation, to include the use of a Portable Undersea Tracking Range (PUTR);
- Conducting an additional Carrier Strike Group (CSG) exercise during the months of April through October which could also last up to 21 days (first CSG exercise being part of the baseline No Action Alternative); and
- Conducting a Sinking Exercise (SINKEX) during each summertime exercise (a maximum of 2) in the TMAA.

This chapter includes the following major topical subsections: Section 2.1 describes the components of the ATA, and Sections 2.2 through 2.6 describe the major elements of the Proposed Action and alternatives to the Proposed Action, including the No Action Alternative.

2.1 DESCRIPTION OF THE ALASKA TRAINING AREAS

Military activities in the ATA occur:

- In the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA) to include: the ocean surface; under the ocean surface; and in the air.

- In the inland Special Use Airspace (SUA) areas of the United States (U.S.) Air Force (Air Force) to include: Restricted Airspace; Military Operations Areas (MOAs); and Visual Flight Rules (VFR) Corridors.
- On the training lands of the U.S. Army (Army) to include: Restricted Areas[1]; Fort Richardson; Fort Wainwright; and the Donnelly Training Area.

Figure 2-1 depicts the components of the ATA.

2.1.1 Gulf of Alaska Temporary Maritime Activities Area

The TMAA is a temporary area that is established in conjunction with the Federal Aviation Administration (FAA) for up to 14 days per year to support the Northern Edge exercise. The TMAA is a surface, undersea space and airspace maneuver area within the GOA for ships, submarines, and aircraft to conduct required training activities. As depicted in Figure 2-2, the TMAA is a polygon that roughly resembles a rectangle oriented from northwest to southeast, approximately 300 nautical miles (nm) (555.6 kilometers [km]) in length by 150 nm (277.8 km) in width, located south of Prince William Sound and east of Kodiak Island. With the exception of Cape Cleare on Montague Island located over 12 nm (22 km) from the northern point of the TMAA, the nearest shoreline (Kenai Peninsula) is located approximately 24 nm (44 km) north of the TMAA's northern boundary. The approximate middle of the TMAA is located 140 nm (259 km) offshore.

2.1.1.1 Airspace of the Temporary Maritime Activities Area

The SUA of the TMAA overlies the surface and subsurface training area. This overwater airspace supports the majority of aircraft training activities conducted by Navy and Joint aircraft throughout the Northern Edge exercise. This SUA extends from the ocean surface to 60,000 feet (ft) (18,288 meters [m]) above mean sea level (MSL), and encompasses 42,146 square nautical miles (nm^2) (145,482 square kilometers [km^2]) of airspace. Additionally, the TMAA overlays a majority of Warning Area (W-612), located over Blying Sound, towards the northwestern quadrant of the TMAA. A Warning Area is airspace of defined dimensions, extending from 3 nm outward from the coast of the United States, which contains activity that may be hazardous to nonparticipating aircraft. The purpose of such Warning Areas is to warn nonparticipating pilots of the potential danger. A Warning Area may be located over domestic or international waters, or both. When not included as part of the TMAA, W-612, which provides 2,256 nm^2 (8,766 km^2) of SUA, is used by the Air Force to conduct training in Anti-Air Warfare (AAW) and by the United States Coast Guard (USCG) to fulfill some of its training requirements. Air Force and USCG activities conducted as part of joint training within the TMAA are included in this EIS/OEIS analysis.

2.1.1.2 Sea Space of the Temporary Maritime Activities Area

The TMAA surface area is depicted in Figure 2-2. Total surface area of the TMAA is 42,146 nm^2 (145,482 km^2). While the sea space is ample for training, no permanent infrastructure is in place to support training (i.e., no dedicated training frequencies for communications, instrumentation for tracking and replaying of training activities, Meteorological and Oceanographic Operations [METOC] systems, or target systems). In this region of the Pacific Ocean, storms and high sea states can create challenges for surface ship training between November and March. In part as a result of these conditions, annual joint training activities are typically conducted during the summer months (April to October).

[1] Restricted Areas: An area or volume of airspace in which the local controlling authorities have determined that air traffic must be restricted (if not continually prohibited) for safety or security concerns. Restricted areas denote the existence of unusual, often invisible, hazards to aircraft such as artillery firing, aerial gunnery, or guided missiles.

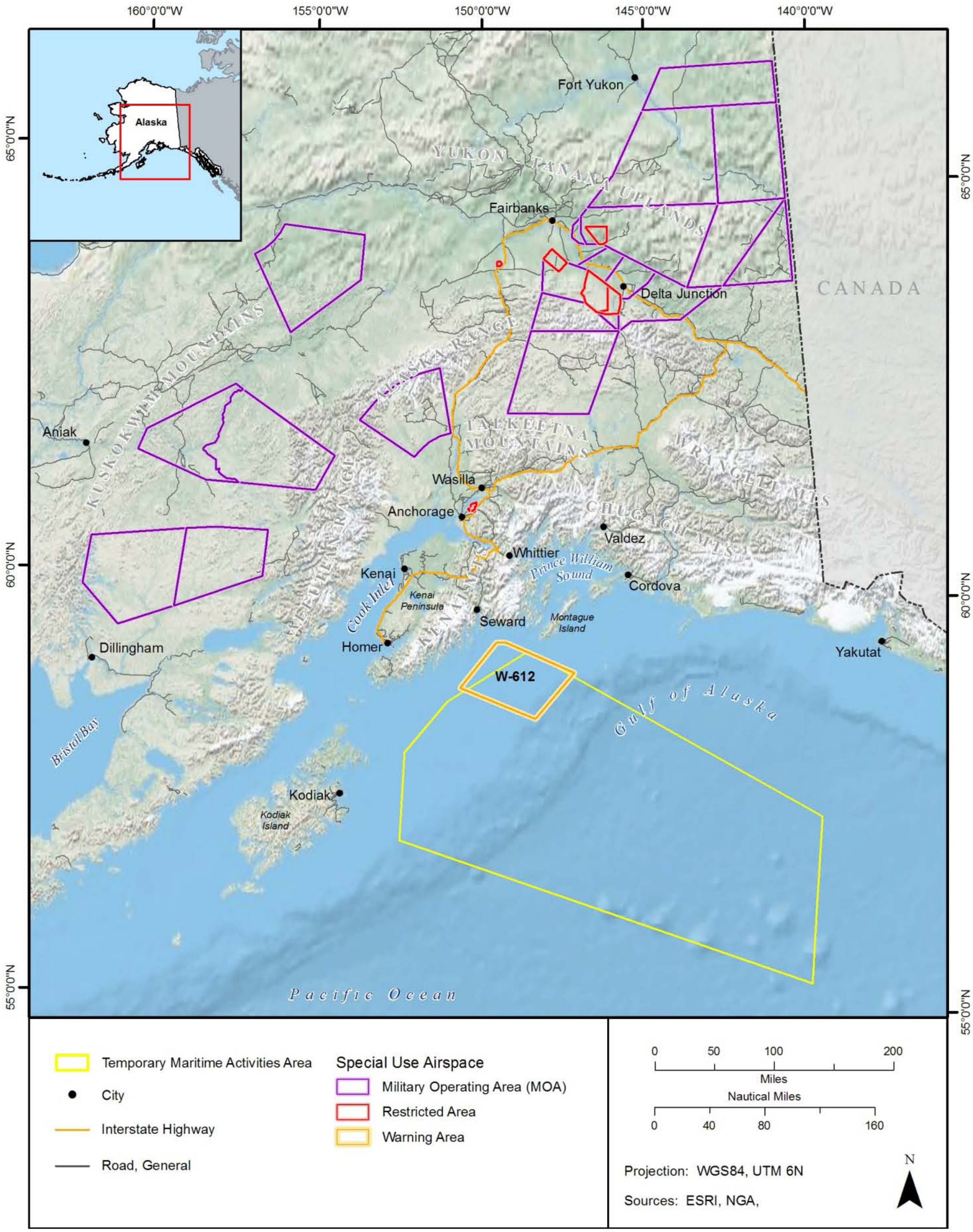


Figure 2-1: Alaska Training Areas

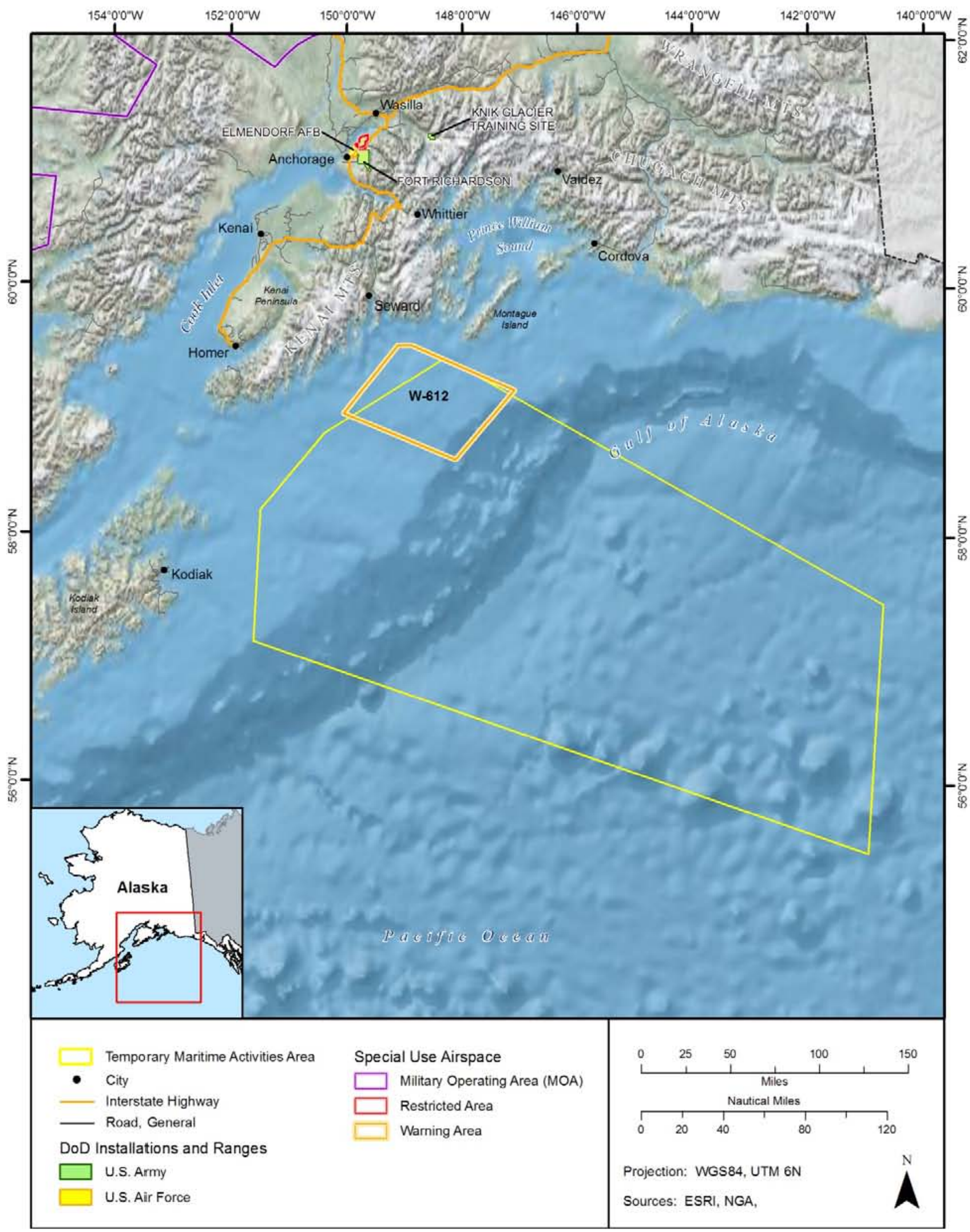


Figure 2-2: Gulf of Alaska Temporary Maritime Activities Area

2.1.1.3 Undersea Space of Temporary Maritime Activities Area

The TMAA undersea area lies beneath the surface area, as described above and depicted in Figure 2-2. Commander Submarine Force, U.S. Pacific Fleet[2] (COMSUBPAC) manages this underwater space as transit lanes and operational areas for U.S. submarines. The undersea area extends to the seafloor. Although ASW activities are not currently conducted, the TMAA undersea operating area is mentioned here because ASW activities, to include the use of active sonar, are part of the Proposed Action.

Table 2-1 summarizes the air, sea, and undersea space of the TMAA and Figure 2-2 depicts the TMAA.

2.1.2 The Inland Special Use Airspace Training Areas of the United States Air Force

The Air Force has a vast network of SUA to conduct flight operations (Figures 2-3 and 2-4). During joint training activities, these inland SUAs are used by the Navy and joint aircraft to conduct AAW and Air-to-Ground integrated Strike Warfare (STW) training activities. In total, the Air Force has over 46,585 nm^2 (159,782 km^2/61,692 square miles [mi^2]) of SUA, of which 43,963 nm^2 (150,789 km^2/58,220 mi^2) are instrumented. The Air Force's SUAs include Restricted Areas (RAs), Military Operations Areas (MOAs), and Visual Flight Rules (VFR) corridors.

RAs are SUAs within which the flight of aircraft, while not wholly prohibited, is subject to restrictions. Activities within these areas must be confined because of their nature or limitations imposed upon aircraft operations that are not a part of those activities or both. Restricted areas denote the existence of unusual, often invisible, hazards to aircraft such as artillery firing, aerial gunnery, or guided missiles. The Army RAs include:

- Oklahoma (R-2202A/B/C) air-to-ground weapons range
- Stuart Creek (R-2205) air-to-ground weapons range
- Blair Lake (R-2211) air-to-ground weapons range
- Fort Richardson (R-2203A/B/C)

Table 2-1: Air, Sea, and Undersea Areas of the Temporary Maritime Activities Area

Area Name	Airspace (nm^2)	Sea Space (nm^2)	Undersea Space (nm^2)
TMAA	42,146	42,146	42,146
W-612	2,256	2,256	2,256

[2] The Commander Submarine Force, U.S. Pacific Fleet is the principal advisor to the Commander, U.S. Pacific Fleet for submarine matters. The force provides anti-submarine warfare, anti-surface ship warfare, precision land strike, mine warfare, intelligence, surveillance, and early warning and special warfare capabilities to the U.S. Pacific Fleet and strategic deterrence capabilities to the U.S. Strategic Command.

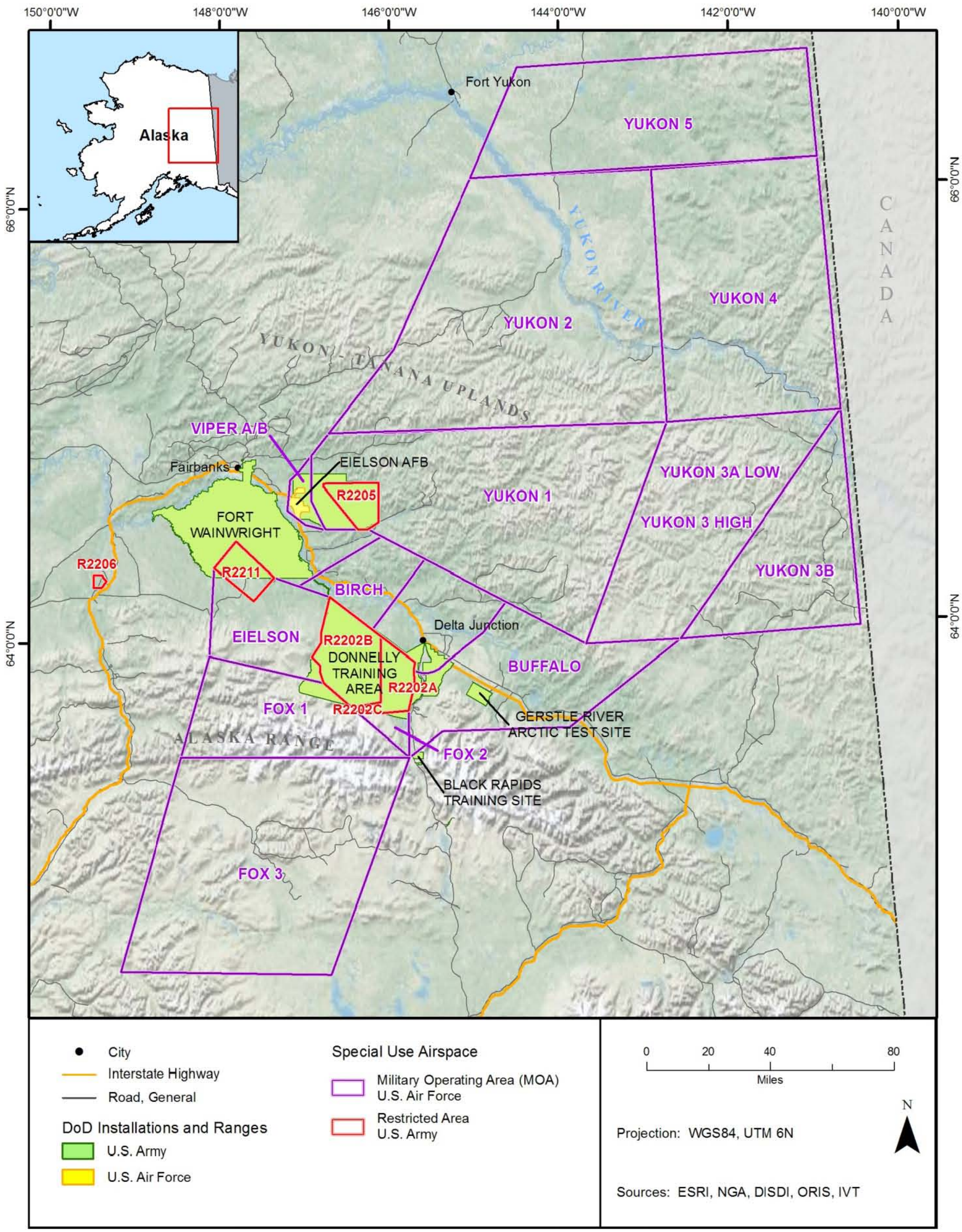


Figure 2-3: Inland Air Ranges and Training Lands of the United States Air Force and Army

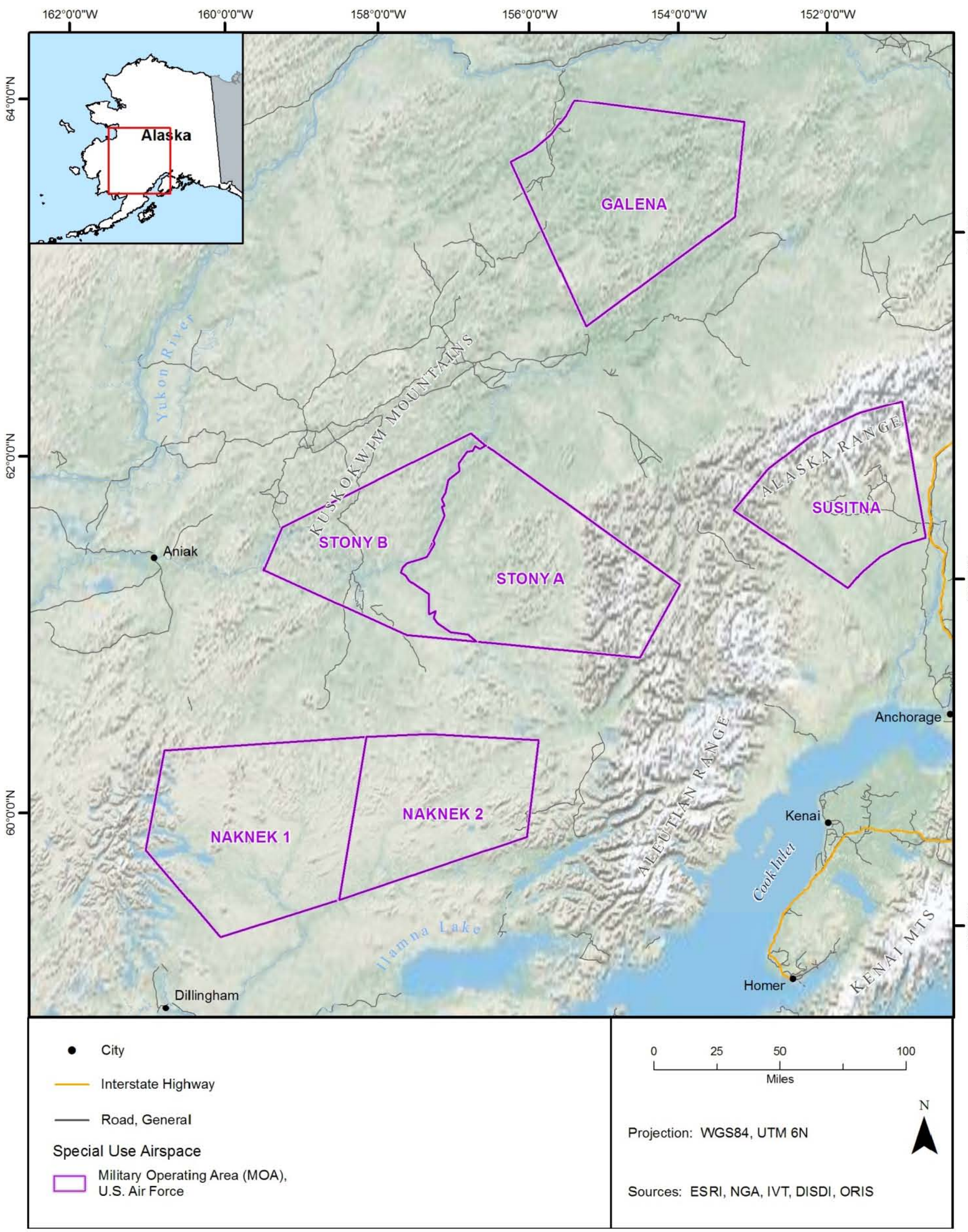


Figure 2-4: Inland Air Ranges of the United States Air Force

MOAs are SUA of defined vertical and lateral dimensions established outside of Class A airspace to separate certain nonhazardous military activities from Instrument Flight Rules (IFR) traffic in controlled airspace and to identify for VFR traffic where these activities are conducted. The Air Force MOAs include:

- Eielson
- Fox 1, 2, 3
- Falcon
- Birch
- Buffalo
- Viper A & B
- Yukon: 1, 2, 3 High, 3A Low, 3B Low, 4, 5, and 6
- Stony A and B, Galena, Susitna, Naknek 1 and 2

VFR corridors are airspace of defined vertical and lateral dimensions that permit general aviation aircraft operating on VFR flight plans to pass through a controlled airspace that would normally require an aircraft to be on an IFR flight plan. These corridors are designed to allow sightseeing of structures of interest that lie within MOA airspace, or allow general aviation aircraft to travel from airport to airport, below or through the MOA, with provided separation from military aircraft. They are typically very specific in regards to altitudes, headings, and speeds to be flown and communications to be made. The Air Force VFR corridors include:

- Richardson Highway
- Alaska Highway
- Birch

The specifics of each SUA are detailed in the Alaska MOAs EIS (USAF 1995). Although Navy AAW and STW activities occurring in Air Force SUAs are discussed in this GOA Draft EIS/OEIS, these activities were analyzed under separate National Environmental Policy Act (NEPA) analysis by the Air Force (Alaska MOAs EIS [USAF, 1995]) for which a Record of Decision (ROD) was issued by the Air Force (U.S. Department of the Air Force 1997). These documents are incorporated by reference, which, in NEPA terms means that the environmental effects of these activities are addressed in these documents. Therefore, further effects analysis of Navy training activities in Air Force airspace in this document is not required. Figures 2-3 and 2-4 depict the Inland Air Ranges of the Air Force.

2.1.3 The Training Lands of the United States Army

The Army training lands used in conjunction with the Proposed Action (Figures 2-3 and 2-5) are robust (roughly 1.3 times the size of the state of Delaware), and provide Navy and Air Force aircraft with the capability to drop live and inert weapons on instrumented ranges in large, complex flying evolutions. In addition to STW activities, the Navy can conduct other ground activities, such as Naval Special Warfare (NSW) and Personnel Recovery (PR) on Army training lands. In total, the Army has over 2,624 mi^2 (6,796 km^2) of training area, of which 1,106 mi^2 (2,866 km^2) are designated as restricted for air-to-ground ordnance. The Army's training lands include:

- Restricted Areas:
    - Donnelly Training Area (R-2202)

  - Yukon Training Area (R-2205)
  - Blair Lake Training Range (R-2211)
- Fort Richardson
- Fort Wainwright

The specifics of each land range are detailed in the Army's *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (1999) and the *Transformation of U.S. Army Alaska FEIS* (Army 2004). Although Navy STW, NSW, and PR activities occurring on Army training lands are discussed in this GOA EIS/OEIS, these activities were analyzed under separate environmental NEPA analysis by the *Army Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (1999) and the *Transformation of U.S. Army Alaska FEIS* (Army 2004). Congress passed the National Defense Authorization Act (P.L. 106-65 2000) for the *Army Lands Withdrawal EIS* in 2000, which approved the Army's withdrawal of lands. Similar to the Air Force documents, these documents are incorporated by reference. Therefore, further environmental effects analysis of Navy activities on Army training lands in this document is not required. Figures 2-3 and 2-5 depict the training lands of the Army.

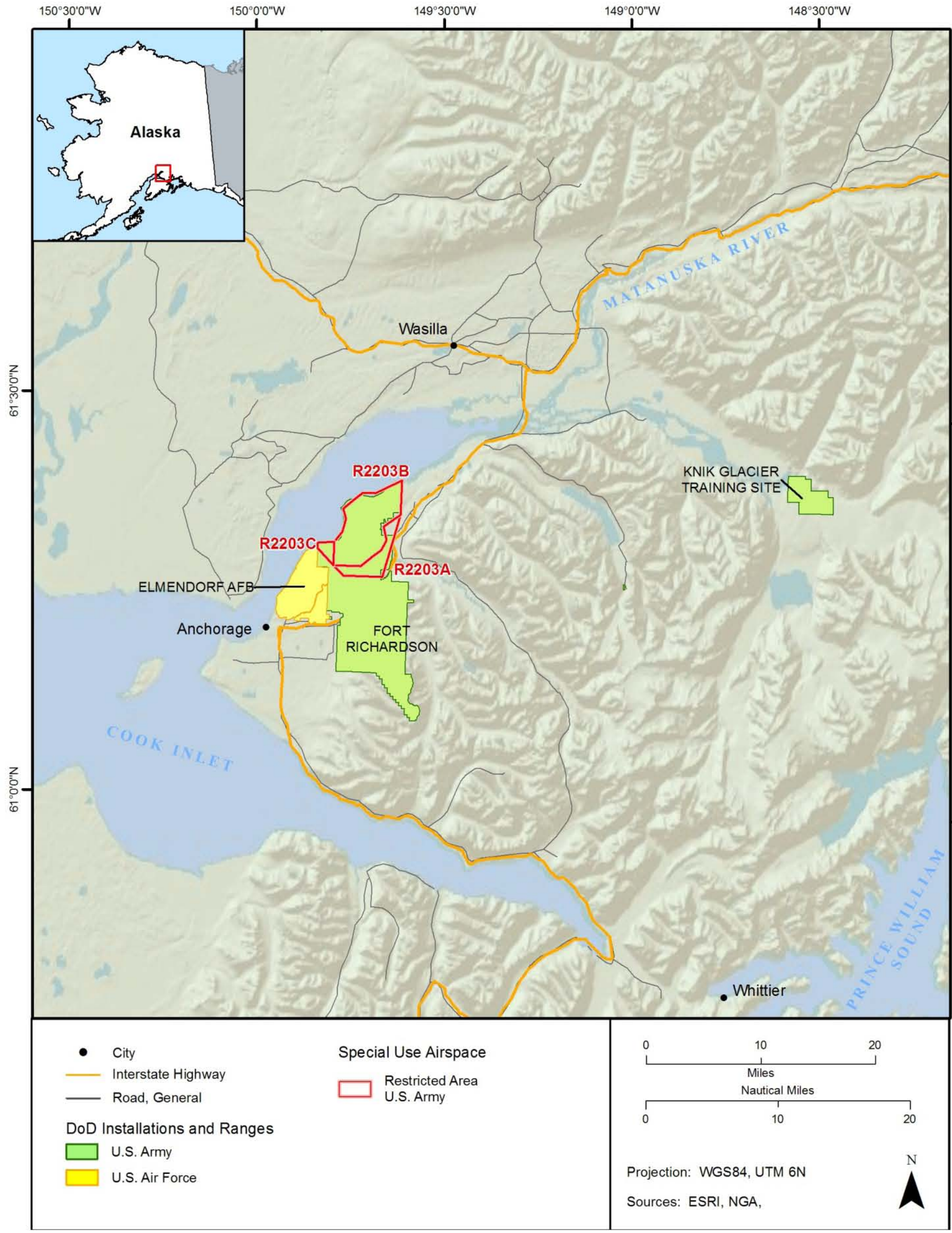


Figure 2-5: Training Lands of the United States Army

2.2 NAVY SONAR SYSTEMS

Navy sonar training is a significant component of overall Navy training. Recently, sonar and its potential impacts to the marine environment have become a controversial issue. This section is designed to better inform the reader about a) What is sonar; b) Why the Navy trains with Sonar; and c) What sonar is used in the TMAA? The analysis of impacts of sonar to the marine environment is conducted in Chapter 3 of this EIS/OEIS.

2.2.1 What is Sonar?

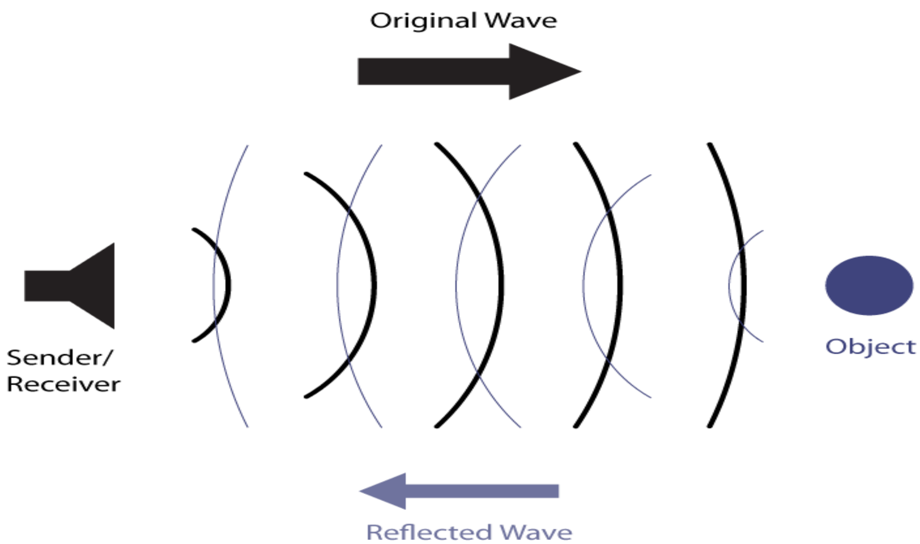
Sonar, which stands for "**SO**und **N**avigation **A**nd **R**anging," is a tool that uses underwater acoustics to navigate, communicate, or detect other underwater objects. There are two basic types of sonar: active and passive.

- **Active sonar** emits pulses of sound waves that travel through the water, reflect off objects, and return to the receiver on the ship or other sonar sources. By knowing the speed of sound in water and the time for the sound wave to travel to the target and back, a sonar operator can quickly calculate distance between the ship and the underwater object. For example, active sonar systems can be used to track targets and realign internal navigation systems by identifying known ocean floor features. Whales, dolphins, and bats use the same technique, echolocation, for identifying their surroundings and locating prey.
- **Passive sonar** is a listening device that uses hydrophones (underwater microphones) that receive, amplify, and process underwater sounds. Passive sonar is used primarily to detect the presence of submarines. The advantage of passive sonar is that it places no sound in the water, and thus does not reveal the location of the listening vessel. Passive sonar can indicate the presence, character, and direction of submarines.

Underwater sounds in general, and sonar specifically, can be categorized by their frequency. For the analysis in this EIS/OEIS, sonar falls into one of three frequency ranges: low-frequency, mid-frequency, and high-frequency.

- **Low-frequency** sonar is sonar that emits sounds in the lower frequency range, less than 1 kilohertz (kHz). Low-frequency sonar is useful for detecting objects at great distances, as low-frequency sound does not dissipate as rapidly as higher frequency sounds. However, lower frequency sonar provides less accuracy than other sonars. There are only two ships in use by the U.S. Navy that are equipped with low-frequency sonar: both are ocean surveillance vessels operated by Military Sealift Command. While SURTASS low-frequency active sonar was analyzed in a separate EIS/OEIS, the proposed action does not include the integration of LFA into the alternatives considered in this Draft EIS/OEIS.
- **Mid-frequency** sonar uses sound in the frequency spectrum between 1 kHz and 10 kHz. With a typical range of up to 10 nm, mid-frequency sonar is the Navy's primary tool for detecting and identifying submarines. Sonar in this frequency range provides a valuable combination of range and target resolution (accuracy).
- **High-frequency** sonar uses frequencies greater than 10 kHz. Although high-frequency sonar dissipates rapidly, giving it a shorter effective range, it provides higher resolution and is useful at detecting and identifying smaller objects such as sea mines.

Modern sonar technology includes a multitude of sonar sensor and processing systems. In concept, the simplest active sonar emits sound waves, or "pings," sent out in multiple directions (i.e., is omnidirectional). Sound waves reflect off the target object and move in multiple directions (Figure 2-6). The time it takes for some of these sound waves to return to the sonar source is calculated to provide a variety of information, including the distance to the target object. More sophisticated active sonars emit an omnidirectional ping and then rapidly scan a steered receiving beam to provide directional as well as range information. Even more advanced sonars use multiple pre-formed beams to listen to echoes from several directions simultaneously and provide efficient detection of both direction and range. For more information about sonar or sound in the sea, go to www.dosits.org.



Source: ManTech-SRS, 2008

Figure 2-6: Principle of an Active Sonar

2.2.2 Why the Navy Trains with Sonar

Sea control is the foundation for the United States' global power projection. If the United States cannot command the seas and airspace above them, it cannot project power to command or influence events ashore and it cannot shape the security environment. For the last century, submarines have been the weapon of choice for countries intending on contesting another nation's control of the seas. Today, the proliferation of advanced, stealthy, nuclear and non-nuclear submarines, equipped with anti-ship weapons of increasing range and lethality, challenge the Navy's ability to guarantee the access and safety of joint forces. Effective ASW remains a remarkably and increasingly complex, high-risk warfare area that will require continued investment in research and development to counter the capabilities of current and future adversaries. The key to maintaining the Navy's ability to defend against adversary submarines is a comprehensive "at-sea" training regime to prepare our Sailors for this contingency. This training requires the use of active sonar. The skills developed during this training are perishable and require periodic refreshing, which can't be regenerated easily. If training is not as realistic as possible, the Navy will quickly lose its edge in this critical dimension of the battlefield.

Submarines have been and are likely to remain the weapon system with the highest leverage in the maritime domain. The ability to locate and track a submarine is a mission skill that must be possessed by every ASW-capable ship, submarine, and aircraft.

There are three fundamental truths about ASW. First, it is critically important to U.S. Navy strategies of sea control, power projection, and direct support to land campaigns.

Second, ASW requires a highly competent team of air, surface, and subsurface platforms to be effective in a complex and a highly variable three-dimensional environment. Each asset has unique strengths that contribute to the full spectrum of undersea, surface, airborne, and space-based ASW systems. The undersea environment – ranging from the shallows of the littoral to the vast depths of the great ocean basins and polar regions under ice – demand a multidisciplinary approach: reliable intelligence; oceanography; and surveillance and cueing of multiple sensors, platforms, and undersea weapons. Most importantly, it takes highly skilled and motivated people.

Finally, as modern submarines have become significantly quieter, passive sonar is not effective enough in tracking and prosecuting all enemy submarines. Active sonar systems, particularly medium frequency active (MFA) sonar, are key enablers of our ability to conduct effective ASW. MFA sonar is the Navy's most effective tool for locating and tracking submarines at distances that preclude effective attack on our ships. The Navy must conduct extensive integrated training, to include the use of active sonar, which mirrors the intricate operating environment present in hostile waters, particularly the littorals. This is of the highest importance to our national security and the safety of our Sailors and Marines

2.3 PROPOSED ACTION AND ALTERNATIVES

2.3.1 Alternatives Development

NEPA implementing regulations provide guidance on the consideration of alternatives in an EIS. These regulations require the decision maker to consider the environmental effects of the Proposed Action and a range of alternatives to the Proposed Action (40 Code of Federal Regulations [C.F.R.] § 1502.14). The range of alternatives includes reasonable alternatives, which must be rigorously and objectively explored, as well as other alternatives that are eliminated from further consideration and from further detailed study. To be "reasonable," an alternative must meet the stated purpose of and need for the Proposed Action.

In addition to being required by 40 C.F.R § 1502.14(d), the No Action Alternative in environmental impact analyses is included to ensure that agencies compare the potential impacts of the proposed federal action to the known impacts of maintaining the status quo.

The No Action Alternative currently exists in the EIS/OEIS as a baseline, where the action presented represents a regular and historic level of activity in the ATA to support this type of training and exercises. In other words, the EIS/OEIS's baseline, or No Action Alternative, represents no change from current levels of training usage. The potential impacts of the current level of training activities in the ATA (defined by the No Action Alternative) are compared to the potential impacts of activities proposed under Alternative 1 and Alternative 2.

The Navy solicited input on the alternatives during public scoping meetings, and discussions with regulators and Alaska Native Tribes. Subsequently, alternatives considered in this EIS/OEIS were developed by the Navy after careful assessment by subject-matter experts, including units and commands that use the ATA, range management professionals, and Navy environmental managers and scientists.

The Navy has developed a set of criteria to use in assessing whether a possible alternative meets the purpose of and need for the Proposed Action. Each of these criteria assumes implementation of mitigation measures for the protection of natural resources, as appropriate. Any alternative considered for future analysis should support or employ the following:

1. Appropriate physical environment, including unique and complex bathymetric and oceanographic conditions. These attributes combine to provide a challenging environment for Navy forces to conduct ASW training.
    - Existence of a continental shelf, submarine canyons, and seamounts in the area;
    - Fresh water inputs into the GOA from multiple sources; and

- Unique areas of upwelling and currents.

2. Proximity of Alaska land and sea training areas to each other to accommodate the joint training mission. The location of the TMAA is directly related to the location of permanent land and air training ranges in Alaska, and supports the mission requirement of Alaskan Command (ALCOM) to conduct joint training for Alaska-based forces and the following elements:
    - Ability to support ALCOM simulated combat conditions, and activities;
    - Infrastructure that supports a robust opposition force, which allows realistic training;
    - Land based infrastructure to support safety of naval aviation including air fields for aircraft emergency diverted landings; and
    - Facilitation of Joint Task Force training in support of PACOM.
3. Availability of sufficiently sized airspace and ranges that support tactically realistic joint training activities. This criterion allows for:
    - Fewer restrictions on supersonic flights;
    - Ability to conduct numerous types of training activities at the same time in relative proximity without compromising safety and training objectives;
    - Continuous, nonsegmented training, from launch to recovery; and
    - Support of the full spectrum of joint, allied, and coalition training.
4. Appropriate weather conditions for a cold-water environment (water temperature between 50 and 60 degrees Fahrenheit [10-15.5 degrees Celsius]) (OPNAVINST 3710.7T, 2004) suitable for maritime activities at sea, including a sea state of three or less on the Beaufort scale (defined as a moderate sea; average wave height is 2-4 ft [0.6-1.2 m]).
5. Minimal encroachments on joint training requirements that could include, but are not limited to:
    - Low interference in the electronic spectrum to allow for unrestricted use of electronic sensors and systems; and
    - Large areas with sparse populations or low to no permanent human populations.
6. Training sustainment in support of the DoD Title 10 mandate.
7. Proximity to shipping lanes for realistic training on avoiding conflicts with air and marine traffic.

NEPA regulations require that the federal action proponent study means to mitigate adverse environmental impacts of the Proposed Action or an alternative (40 C.F.R. § 1502.16). Additionally, an EIS is to include study of appropriate mitigation measures not already included in the Proposed Action or alternatives (40 C.F.R. § 1502.14(f)). Each of the alternatives considered in this EIS/OEIS includes mitigation measures intended to reduce the environmental effects of Navy activities. Mitigation measures, such as Standard Operating Procedures (SOPs), are discussed throughout this EIS/OEIS in connection with affected resources, and are also addressed in Chapter 5.

2.3.2 Alternatives Eliminated from Further Consideration

Having identified criteria for generating alternatives for consideration in this EIS/OEIS (see Section 2.3.1), the Navy eliminated several alternatives from further consideration pursuant to 40 C.F.R. § 1502.14(a). Specifically, the alternatives described in Sections 2.3.2.1 through 2.3.2.4 were not considered further because, after careful consideration of each in light of the identified criteria and the purpose and need, the Navy determined that none of the eliminated alternatives meet the Navy's purpose of and need for the Proposed Action and satisfy all of the above listed selection criteria.

2.3.2.1 Alternative Locations

An alternate location for Navy training in the ATA that meets the purpose of and need for the Proposed Action does not exist. The proposed locale in the ATA is based on the mission of ALCOM to support the needs of military forces within Alaska and forces deploying through Alaska. ALCOM integrates military activities within Alaska to maximize the readiness of theater forces from and through Alaska in support of worldwide contingencies. The proposed locale encompasses existing training areas with unique sizes and capabilities, and training areas that have the continuity and capability to support Joint training purposes.

The ATA provides a venue in which a large Air Force contingent of aircraft can train jointly with and around a complete Navy Carrier Strike Group (CSG), comprised of an aircraft carrier and several other combatant surface ships. When the Navy conducts Joint training with Air Force assets, the training is often limited to Navy and Air Force aircraft conducting air training on Navy or Air Force ranges. In some cases, Air Force aircraft train with CSGs in other Pacific ranges; however, the size and mix of Air Force forces are significantly limited by the availability of local Air Force assets or by the cost of transporting and sustaining the aircraft and crews for the duration of an exercise. More importantly, very few airfields could meet the parking requirements of the large number of Air Force aircraft that would be involved in a robust Joint training exercise.

However, the Navy's CSG is mobile and capable of carrying out sustained operations over a long period of time. Having Navy forces transit to the TMAA for training not only adds realism, but is economically prudent. When operating in the TMAA, CSG aircraft can reach established Air Force and Army instrumented ranges in which they can conduct air-to-ground and air-to-air training. Likewise, Alaska-based Air Force aircraft can reach the TMAA without refueling to conduct training with the CSG.

Navy training in the ATA is not limited to air-to-air and air-to-ground training. The unique and complex bathymetric and oceanographic environment in the TMAA presents a challenging ASW training opportunity. The complexity of the sea bottom, the input of freshwater into the sea, and the areas of upwelling and ocean currents combine in the TMAA like in no other training area in the Pacific Ocean. Numerous air, surface, and subsurface assets within a CSG would gain valuable experience conducting ASW training in this environment. For these reasons, alternative sites do not meet the purpose of and need for the Proposed Action and, therefore, were eliminated from further study and analysis.

2.3.2.2 Reduced Training

The Navy's requirements for training have been developed through many years of iteration to ensure Sailors and Marines achieve levels of readiness to ensure they are prepared to properly respond to the many contingencies that may occur during an actual mission. These training requirements are designed to provide the experience and proficiency needed to ensure Sailors are properly prepared for operational success. The Navy has identified training requirements to acquire war fighting proficiency. There is no "extra" training built into the Navy training program. Any reduction of training would not allow the Navy to achieve the levels of certification, proficiency and readiness required to accomplish assigned missions. For this reason, alternatives that would reduce training would not meet the purpose and need of the proposal, and therefore were eliminated from further study and analysis.

2.3.2.3 Alternate Time Frame

An alternate period in which to hold Navy training in the ATA, such as in the winter months, would not be feasible because of extreme cold weather and sea state conditions in the TMAA during that time of year. Additionally, the extreme weather conditions during the winter months would needlessly jeopardize the health and safety of the exercise participants. Therefore, an alternate time frame would not meet the evaluation factor/screening criterion #4 for maritime activities at sea.

2.3.2.4 Simulated Training

Navy and Marine Corps training already uses of computer-simulated training and conducts command and control exercises without operational forces (constructive training) whenever possible. These training methods have substantial value in achieving limited training objectives. Computer technologies provide excellent tools for implementing a successful, integrated training program while reducing the risk and expense typically associated with live military training. However, virtual and constructive training are an adjunct to, not a substitute for, live training, including live-fire training. Unlike live training, these methods do not provide the requisite level of realism necessary to attain combat readiness, and cannot replicate the high-stress environment encountered during an actual contingency situation.

The Navy and Marine Corps continue to research new ways to provide realistic training through simulation, but there are limits to realism that simulation can presently provide, most notably in dynamic environments involving numerous forces, and where the training environment is too complex to accurately model, such as sound behavior in the ocean. Specifically, one such area that would be particularly adversely affected by simulation is ASW training.

Current simulation technology does not permit ASW training with the degree of fidelity required to maintain proficiency. Basic training of sonar technicians does take place using simulators, but beyond basic levels, simulation is of limited utility. A simulator cannot match the dynamic nature of the environment, either in bathymetry, sound propagation properties, or oceanography. Specifically, coordinated unit level and Strike Group Training activities require multiple crews to interact in a variety of acoustic environments that cannot be simulated. Moreover, it is a training imperative that crews actually use the equipment they will be called upon to operate.

Sonar operators and crews must train regularly and frequently to develop the skills necessary to master the process of identifying underwater threats in the complex subsurface environment. They cannot reliably simulate this training through current computer technology because the actual marine environment is too complex. Sole reliance on simulation would deny Navy Strike Groups the ability to develop battle-ready proficiency in the employment of active sonar in the following specific areas:

- Bottom bounce and other environmental conditions;
- Mutual sonar interference;
- Interplay between ship and submarine target; and
- Interplay between ASW teams in the strike group.

Currently, these factors cannot be adequately simulated to provide the fidelity and level of training necessary to safely and effectively use active sonar. Further, like any perishable skill, employment of active sonar is a skill that must be exercised – in a realistic and integrated manner – in order to maintain proficiency. Eliminating the use of active sonar during the training cycle would cause ASW skills to atrophy, and thus would put U.S. Navy forces at risk during operations.

This alternative—substitution of simulation for live training—fails to meet the purpose of and need for the Proposed Action, and was therefore eliminated from detailed study.

2.3.3 Proposed Action and Alternatives Considered

Three alternatives are analyzed in this EIS/OEIS: 1) The No Action Alternative – current activities (no active sonar); 2) Alternative 1 – increase training activities to include the use of active sonar, and accommodate force structure changes to include new platforms, weapon systems, and training enhancement instrumentation; 3) Alternative 2 – increase training activities to include the use of active sonar, accommodate force structure changes to include new platforms, weapon systems, and training enhancement instrumentation, and conduct one additional summertime CSG exercise annually.

As noted in Section 1.4, the purpose of the Proposed Action is to achieve and maintain Fleet readiness using the ATA to support current and future training activities. The Navy proposes to:

- Increase training activities from current levels as necessary to support the Fleet exercise requirements to include the use of active sonar;
- Accommodate new training requirements associated with force structure changes and introduction of new platforms, weapon systems, and training enhancement instrumentation to the Fleet.

The following sections contain the detailed discussion of alternatives carried forward for analysis in the EIS/OEIS.

2.4 No Action Alternative – Current Training Activities within the Alaska Training Areas

The Navy routinely trains in the ATA for national defense purposes. Under the No Action Alternative, training activities (no active sonar) as part of large-scale joint exercises would continue at baseline levels required to execute the joint training exercise requirements (one joint force exercise occurring over an maximum time period of 14 consecutive days during summer months [April through October]). The Navy would not increase training activities above historical levels, but would continue exercises in the ATA, and specifically the TMAA, with one CSG or equivalent forces. Evaluation of the No Action Alternative in this EIS/OEIS provides a baseline for assessing environmental impacts of Alternative 1 and Alternative 2 (Preferred Alternative), as described in the following subsections.

Training activities and exercises currently conducted in the ATA are briefly described below. Each military training activity described in this EIS/OEIS meets a requirement that can be traced ultimately to requirements from the National Command Authority.[3] Training activities in the ATA stem from large-scale joint exercises, such as Northern Edge, which may involve thousands of participants and span several days. These exercises include basic individual or unit level training events of relatively short duration involving few participants that occur simultaneously with the large-scale joint exercises.

Over the years, the tempo and types of activities have fluctuated within the ATA due to changing requirements, the introduction of new technologies, the dynamic nature of international events, advances in warfighting doctrine and procedures, and force structure changes. Such developments have influenced the frequency, duration, intensity, and location of required training. The factors influencing tempo and types of activities are fluid in nature and will continue to cause fluctuations in training activities within

[3] National Command Authority (NCA) is a term used by the United States military and government to refer to the ultimate lawful source of military orders. The term refers collectively to the President of the United States (as commander-in-chief) and the United States Secretary of Defense.

the ATA. Accordingly, training activity data used throughout this EIS/OEIS are a representative baseline for evaluating impacts that may result from the proposed training activities.

2.4.1 Description of Current Training Activities within the Alaska Training Areas

For purposes of analysis, training activity data used in this EIS/OEIS are organized by Navy Primary Mission Areas (PMARs). The Navy currently trains in five PMARs in the TMAA; AAW, ASUW, EC, NSW, and STW. The Navy also conducts STW, EC, and NSW training in the Air Force SUA and Army training lands of the ATA. Although discussed in this document, these inland activities and their impacts are covered under other NEPA documentation by the Air Force and Army (USAF 1995, USAF 2007, Army 1999, and Army [2004] [refer to Sections 2.1.2 and 2.1.3]). In the future, Navy requirements will mandate ASW training activities take place in the TMAA using active sonar. Summary descriptions of current training activities conducted in the TMAA and other components of the ATA are provided in the following subsections. As stated earlier, the No Action Alternative is the baseline of current training area usage, thus allowing a comparative analysis between the current tempo and proposed new uses and accelerated tempo of use.

2.4.1.1 Anti-Air Warfare (AAW) Training

In general, AAW is the PMAR that addresses combat activities by air and surface forces against hostile aircraft. Navy ships contain an array of modern anti-aircraft weapon systems, including naval guns linked to radar-directed fire-control systems, surface-to-air missile systems, and radar-controlled cannon for close-in point defense. Strike/fighter aircraft carry anti-aircraft weapons, including air-to-air missiles and aircraft cannons. AAW training encompasses events and exercises to train ship and aircraft crews in employment of these weapon systems against mock threat aircraft or targets. AAW training includes surface-to-air gunnery, surface-to-air and air-to-air missile exercises and aircraft force-on-force combat maneuvers.

Air Combat Maneuvers (ACM): ACM includes Basic Flight Maneuvers (BFM) where aircraft engage in offensive and defensive maneuvering against each other. During an ACM engagement, no ordnance is fired. These maneuvers typically involve two aircraft; however, based upon the training requirement, ACM exercises may involve over a dozen aircraft. For the purposes of this document, aircraft activities will be described by the term “sortie.” A sortie is defined as a single activity by one aircraft (i.e., one complete flight from takeoff to landing).

ACM activities within the ATA are conducted in the TMAA and the inland SUA of the Air Force. These activities are primarily conducted by F/A-18 aircraft. However, for purposes of this study, ACM includes other aircraft activities conducted routinely in preparation for more advanced training flights such as ACM. These other activities include in-flight refueling, basic familiarization training, and formation flying. Additionally, Air Force F-15s, F-16s, and F/A-22s also conduct ACM in the TMAA. No ordnance is released during these exercises. When conducted in the inland SUA of the Air Force, these activities and their impacts are covered under other NEPA analyses (refer to Sections 2.1.2 and 2.1.3).

Air Defense Exercise (ADEX): ADEX is an exercise to train surface and air assets in coordination and tactics for defense of the strike group or other Naval Forces from airborne threats. The activities occur within the TMAA; however, no ordnance is fired.

Surface to Air Missile Exercise (SAMEX): During a SAMEX, surface ships engage threat missiles and aircraft with missiles with the goal of disabling or destroying the threat. One live or inert missile is expended against a target towed by a commercial air services Lear jet after two or three tracking runs. The exercise lasts about 2 hours. The BQM-74E target drone, sometimes augmented with a Target Drone Unit (TDU), is used as an alternate target for this exercise. The BQM target is a subscale, subsonic, remote controlled ground or air launched target. A parachute deploys at the end of target flight to enable recovery at sea. The Surface to Air Missile (SAM) launched can be a Rolling Airframe Missile if installed on an aircraft carrier; otherwise the SAM used is the NATO Sea Sparrow Missile or the Standard Missile. These activities occur within the TMAA.

Surface-to-Air Gunnery Exercise (GUNEX S-A): During a GUNEX S-A, a ship's gun crews engage threat aircraft or missile targets with their guns with the goal of disabling or destroying the threat. A typical scenario involving a DDG with 5-inch guns and/or a guided missile frigate (FFG) with 76 millimeter (mm) Main Battery Guns would have a threat aircraft or anti-ship missile being simulated by an aircraft towing a target (a cloth banner) toward the ship below 10,000 ft, at a speed between 250 and 500 knots (kts) (463 to 926 kilometers per hour [km/h]). Main battery guns are manned and 5-inch and/or 76mm rounds are fired at the threat with the goal of destroying the threat before it reaches the ship. This is a defensive exercise where about six rounds of 5-inch Variable Timed, Non-Fragmentation (VTNF) ammunition and/or 12 rounds of 76-mm per gun mount are fired at a target towed by a commercial air services Lear jet. The ship(s) will maneuver but will typically operate at 10 to 12 kts (18 to 22 km/h) or less during the exercise. The exercise lasts about 2 hours, which normally includes several nonfiring tracking runs followed by one or more firing runs. The target must maintain an altitude above 500 ft (152.4 m) for safety reasons, and is occasionally not destroyed during the exercise. These activities occur within the TMAA.

A typical scenario involving a DDG or FFG with 20mm Close-in-Weapon System (CIWS) is similar, except the ships involved engage the simulated threat aircraft or missile with the CIWS. CIWS-equipped ships can expend between 900 and 1,400 rounds per mount per firing run, for a total of up to five runs during the typical 2-hour exercise. The actual number of rounds expended during this exercise is dependent on the ship class, the CIWS model installed, and the available ammunition allowance.

There is also a Preventive Maintenance requirement to test fire CIWS prior to this exercise, called a Pre-action calibration firing (PACFIRE). A PACFIRE generally expends about 30 rounds per firing mount.

Air to Air Missile Exercise (AAMEX): During an AAMEX, aircraft attack a simulated threat target aircraft with air-to-air missiles with the goal of destroying the target. Air-to-air missiles (approximately half of the missiles have live warheads and about half have an inert telemetry package) are fired from aircraft against aerial targets to provide aircrews with experience using aircraft missile firing systems and training on air-to-air combat tactics. Participating air units include fighter and fighter/attack aircraft firing a variety of air-to-air missiles. The main aerial targets are flares for heat-seeking missiles and Tactical Air Launched Decoys (TALDs) for radar-guided missiles. The targets typically are launched by other Navy aircraft that are participating in the exercise. Neither the flares nor TALDs are recovered after use. These activities occur within the TMAA. Similar activities could occur in the Air Force SUAs of the ATA, but their impacts are covered under other NEPA analyses (refer to Sections 2.1.2 and 2.1.3).

A typical scenario would involve a flight of two aircraft operating between 15,000 and 25,000 ft (4,572 and 7,620 m) and at a speed of about 450 kts (834 km/h) that approach a target from several miles away and, when within missile range, launch their missiles against the target. The missiles fired, to include the AIM-7 Sparrow, AIM-9 Sidewinder and AIM-120 AMRAAM, are not recovered. The target is either a TALD or a LUU-2B/B illumination paraflare (an illumination flare that hangs from a parachute). Both the TALDs and the paraflares are expended. These exercises last about one hour, and are conducted in the TMAA outside of 12 nm (22 km) and well above 3,000 ft (914 m).

2.4.1.2 Anti-Surface Warfare (ASUW) Training

In general, ASUW is the PMAR that addresses combat (or interdiction) activities in which aircraft, surface ships, and submarines employ weapons and sensors directed against enemy surface ships or boats.

Air-to-surface ASUW is conducted by aircraft assets employing long-range attack maneuvers using precision guided munitions or aircraft cannons. ASUW also is conducted by warships employing naval guns and surface-to-surface missiles. Submarines attack surface ships using submarine-launched, anti-ship cruise missiles. Training in ASUW includes surface-to-surface gunnery and missile exercises, air-to-surface gunnery and missile exercises, and submarine missile launch events. Training generally involves expenditure of ordnance against a towed target. ASUW also encompasses maritime interdiction, that is, the interception of a suspect surface ship by a Navy ship for the purpose of boarding-party inspection or the seizure of the suspect ship.

Visit Board Search and Seizure/Vessels of Interest (VBSS/VOI): VBSS/VOI missions are the principal type of Maritime Interdiction Operations (MIO) used by naval forces. Highly trained teams of armed personnel, wearing body armor, flotation devices, and communications gear are deployed from ships at sea into small Zodiac boats or helicopters to board and inspect ships and vessels suspected of carrying contraband. Once aboard, the team takes control of the bridge, crew, and engineering plant, and inspects the ship's papers and its cargo. VBSS missions are assumed to be nonhostile, but team members are trained and prepared to deal with noncooperation at all levels. When a helicopter is involved, either to provide cover or embark the inspection party, it is considered a Helicopter Visit Board Search and Seizure. These activities occur within the TMAA.

Air-to-Surface Missile Exercise (A-S MISSILEX): A-S MISSILEX involves fixed-winged aircraft and helicopter crews launching missiles at surface maritime targets, day and night, with the goal of training to destroy or disable enemy ships or boats. These activities occur within the TMAA; however all missile launches are be simulated.

For helicopter A-S MISSILEX, one or two MH-60R/S helicopters approach and acquire an at-sea surface target, which is then designated with a laser to guide an AGM-114 Hellfire missile to the target. The laser designator may be onboard the helicopter firing the hellfire, another helicopter, or another source. The helicopter simulates launching a missile from an altitude of about 300 ft against a specially prepared target with an expendable target area on a nonexpendable platform. The platform fitted with the expendable target could be a stationary barge, a remote-controlled speed boat, or a jet ski towing a trimaran whose infrared signature has been augmented with a heat source (charcoal or propane) to better represent a typical threat vessel. All missile firings would be simulated.

For A-S MISSILEX fired from fixed-wing aircraft, the simulated missile used is typically an AGM-84 Standoff Land Attack Missile-Expanded Response (SLAM-ER), an AGM-84 Harpoon, or an AGM-65 Maverick. A flight of one or two aircraft approach an at-sea surface target from an altitude between 40,000 ft (12,192 m) and 25,000 ft (7,620 m) for SLAM-ER or Harpoon, and between 25,000 ft (7,620 m) and 5,000 ft (1,524 m) for Maverick, complete the internal targeting process, and simulate launching the weapon at the target from beyond 150 nm (278 km) for SLAM-ER and from beyond 12 nm (22 km) for Maverick. The majority of unit level exercises involve the use of captive carry (inert, no release) training missiles; the aircraft perform all detection, tracking, and targeting requirements without actually releasing a missile. These activities occur within the TMAA and all missile launches would be simulated.

Air-to-Surface Bombing Exercise (A-S BOMBEX): During an A-S BOMBEX, maritime patrol aircraft (MPA) or F/A-18 deliver free-fall bombs against surface maritime targets, with the goal of destroying or disabling enemy ships or boats.

A flight of one or two aircraft will approach the target from an altitude of between 15,000 ft (4,570 m) to less than 3,000 ft (914 m) while adhering to designated ingress and egress routes. Typical bomb release altitude is below 3,000 ft (914 m) and within a range of 1,000 yards (yd) (914 m) for unguided munitions, and above 15,000 ft (4,572 m) and in excess of 10 nm (18 km) for precision-guided munitions. Exercises at night will normally be done with captive carry (no drop) weapons because of safety considerations. Laser designators from own aircraft or a support aircraft are used to illuminate certified targets for use with lasers when using laser guided weapons. Bombs used could include BDU-45 (inert) or MK-82/83/84 (live and inert). These activities occur within the TMAA. In the near future, the Navy will be transitioning all carrier based MK-80 series bombs to BLU 110, 111, and 117 live and inert bombs. The difference is that the BLU-series bombs contain insensitive (less likely to accidently explode) high explosives, which make them safer for carrier-based operations. All other attributes would remain the same.

Air-to-Surface Gunnery Exercise (A-S GUNEX): Strike fighter aircraft and helicopter crews, including embarked NSW personnel use guns to attack surface maritime targets, day or night, with the goal of destroying or disabling enemy ships, boats, or floating or near-surface mines.

For fixed-wing A-S GUNEX, a flight of two F/A-18 aircraft will begin a descent to the target from an altitude of about 3,000 ft (914 m) while still several miles away. Within a distance of 4,000 ft (1,219 m) from the target, each aircraft will fire a burst of about 30 rounds before reaching an altitude of 1,000 ft (305 m), then break off and reposition for another strafing run until each aircraft expends its exercise ordnance allowance of about 250 rounds from its 20mm cannon.

For rotary-wing A-S GUNEX, a single helicopter will carry several air crewmen needing gunnery training and fly at an altitude between 50 and 100 ft (15 to 30m) in a 300-ft (91-m) racetrack pattern around an at-sea target. Each gunner will expend about 200 rounds of 0.50 caliber (cal) and 800 rounds of 7.62mm ordnance in each exercise. The target is normally a noninstrumented floating object such as an expendable smoke float, steel drum, or cardboard box, but may be a remote-controlled speed boat or jet ski type target. The exercise lasts about 1 hour and occurs within the TMAA.

Surface-to-Surface Gunnery Exercise (S-S GUNEX): These exercises train surface ship crews in high-speed surface engagement procedures against mobile (towed or self-propelled) seaborne targets. Both live and inert training rounds are used against the targets. The training consists of the pre-attack phase, including locating, identifying, and tracking the threat vessel, and the attack phase in which the missile is launched and flies to the target. In a live-fire event, aircraft conduct a surveillance flight to ensure that the range is clear of nonparticipating ships.

For S-S GUNEX from a Navy ship, gun crews engage surface targets at sea with their main battery 5-inch and 76mm guns as well as smaller surface targets with 25mm, 0.50-caliber (cal), or 7.62mm machine guns, with the goal of disabling or destroying the threat target.

For S-S GUNEX from a Navy small boat, the weapon used is typically a 0.50-cal, 7.62mm or 40mm machine gun.

The number of rounds fired depends on the weapon used for S-S GUNEX. For 0.50-cal, 7.62mm, or 40mm ordnance, the number of rounds is approximately 200, 800, and 10 rounds respectively. For the ship main battery guns, the gun crews typically fire approximately 60 rounds of 5-inch or 76mm ordnance during one exercise. These activities occur within the TMAA.

Maritime Interdiction (MI): MI is a coordinated defensive preplanned attack against multiple sea-borne and air targets using airborne and surface assets with the objective of delivering a decisive blow to enemy forces. These exercises typically involve all the assets of the CSG and Joint forces in an attempt to neutralize the threat. Weapons firing is simulated, and the exercise occurs exclusively within the TMAA each day.

Sea Surface Control (SSC): SSC exercises involve aircraft, typically FA-18 hornets, performing reconnaissance of the surrounding battlespace. Under the direction of the Sea Combat Commander[4], the airborne assets investigate surface contacts of interest and attempt to identify, via onboard sensors or cameras, the type, course, speed, name, and other pertinent data about the ship of interest. Due to the curvature of the earth, surface assets are limited in their ability to see over the horizon. The airborne assets, due to their speed and altitude, can cover great distances in relatively short periods, and see far beyond the capabilities of the surface ship. This enables them to report contacts that cannot be seen by ships. By using airborne assets, the Sea Combat Commander, in effect, is able to see beyond the horizon and develop a clearer tactical picture well in advance. These activities occur within the TMAA.

2.4.1.3 Electronic Combat (EC) Training

In general, EC is the PMAR that aims to control the use of the electromagnetic spectrum and to deny its use by an adversary. Typical EC activities include threat avoidance training, signals analysis for intelligence purposes, and use of airborne and surface electronic jamming devices to defeat tracking systems.

Electronic Combat (EC): EC exercises are conducted to prevent or reduce the effective use of enemy electronic equipment and ensure the continued use of friendly electronic equipment, including command and control capabilities. During EC training, appropriately configured aircraft fly threat profiles against ships so that the ship's crews are trained to detect electronic signatures of various threat aircraft and counter the jamming of the ship's own electronic equipment by the simulated threat.

Electronic Support (ES) provides the capability to intercept, identify, and locate enemy emitters while Electronic Attack (EA) employs tactics, such as electronic jamming, to prevent or reduce effective use of enemy electronic equipment and command and control capability. EA and ES are subsets of EC. Typical EC activities include threat-avoidance training, signals analysis, and use of airborne and surface electronic jamming devices to defeat tracking radar systems. During these exercises, aircraft, surface ships, and submarines attempt to control critical portions of the electromagnetic spectrum used by threat radars, communications equipment, and electronic detection equipment to degrade or deny the enemy's ability to defend its forces from attack and/or recognize an emerging threat early enough to take the necessary defensive actions. These activities occur within the TMAA. Additionally, this activity can occur in and on the Air Force SUA and Army land ranges of ATA. When conducted in the Air Force SUA and Army land ranges, these activities and their impacts are covered under other NEPA analyses (refer to Sections 2.1.2 and 2.1.3).

Chaff Exercise (CHAFFEX): Ships, fixed-winged aircraft, and helicopters deploy chaff to disrupt threat targeting and missile guidance radars and to defend against an attack. The chaff exercise trains aircraft in the use and value of chaff to counter an enemy threat. Radio frequency chaff is an electronic countermeasure designed to reflect radar waves and obscure aircraft, ships, and other equipment from radar tracking sources. Chaff is released or dispensed from military vehicles in cartridges or projectiles that contain millions of chaff fibers. Chaff is composed of an aluminum alloy coating on glass fibers of silicon dioxide. These aluminum-coated glass fibers (about 60 percent silica and 40 percent aluminum by weight) range in lengths of 0.8 to 7.5-cm with a diameter of about 40 micrometers. When deployed, a diffuse cloud of fibers undetectable to the human eye is formed. Chaff is a very light material that can remain suspended in air anywhere from 10 minutes to 10 hours. Chaff is employed for a number of

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[4] The Sea Combat Commander is the individual who has the overall responsibility for defending the CSG against surface threats.

different tactical reasons, but the end goal is to create a target from the chaff that will lure enemy radar and weapons system away from the actual friendly platform.

Chaff may be employed offensively, such as before a major strike to "hide" inbound striking aircraft or ships, or defensively in reaction to being detected by an enemy targeting radar. Defensive chaff training is the most common exercise used for training both ships and aircraft. In most cases, the chaff exercise is training for the ship or aircraft that actually deploys the chaff, but it is also a very important event to "see" the effect of the chaff from the "enemy" perspective so that radar system operators may practice corrective procedures to "see through" the chaff jamming, so exercises are often designed to take advantage of both perspectives. These activities occur within the TMAA. Additionally, this activity can occur in and on the Air Force SUA and Army land ranges of ATA. When conducted in the Air Force SUA and Army land ranges, these activities and their impacts are covered under other NEPA analyses (refer to Sections 2.1.2 and 2.1.3).

Counter Targeting: A Counter Targeting exercise is a coordinated, defensive activity utilizing surface and air assets, that attempts to use jamming and chaff to show a false force presentation to inbound surface-to-surface platforms. During these exercises, EA-6B jamming aircraft will position itself between the CSG assets and the threat and jam the radar systems of potential hostile surface units. CSG ships will launch chaff to create false targets that saturate the threat radars return, thus masking their true position. These activities occur within the TMAA.

2.4.1.4 Naval Special Warfare (NSW) Training

In general, NSW forces (Sea, Air, Land [SEALs] and Special Boat Units [SBUs]) train to conduct military activities in five Special Operations mission areas: unconventional warfare, direct action, special reconnaissance, foreign internal defense, and counterterrorism. NSW training involves specialized tactics, techniques, and procedures, employed in training events that could include insertion/extraction activities using parachutes, rubber boats, or helicopters and other equipment.

Insertion/Extraction: Personnel approach or depart an objective area using various transportation methods and covert or overt tactics depending on the tactical situation. These exercises train forces to insert and extract personnel and equipment day or night. There are a number of different insertion or extraction techniques that are used depending on the mission and tactical situation. NSW personnel conduct insertion/extraction exercises using helicopters and other equipment. These activities take place in existing Air Force SUA and Army training lands. When conducted in the Air Force SUA and Army land ranges, these activities and their impacts are covered under other NEPA analyses (refer to Sections 2.1.2 and 2.1.3).

2.4.1.5 Strike Warfare (STW) Training

In general, Strike Warfare is the PMAR that addresses combat (or interdiction) activities by air and surface forces against hostile land based forces and assets. STW activities include training of fixed-wing fighter/attack aircraft in delivery of precision guided munitions, nonguided munitions, rockets, and other ordnance against land targets in all weather and light conditions. Training events typically involve a strike mission with a flight of four or more aircraft. The strike mission practices attacks on "long-range targets" (i.e., those geographically distant from friendly ground forces), or close air support of targets within close range of friendly ground forces. Laser designators from aircraft or ground personnel may be employed for delivery of precision-guided munitions. Some strike missions involve no-drop events in which prosecution of targets is practiced, but video footage is often obtained by onboard sensors. Strike exercises occur on the land and air training ranges as identified in the Air Force Alaska MOAs EIS, (USAF 1995) and their impacts are covered under its environmental analysis.

Air-to-Ground Bombing Exercise (BOMBEX): Air-to-ground bombing exercises consist of fixed-winged strike fighter aircraft that deliver bombs and rockets against land targets, day or night, with the goal of destroying or disabling enemy vehicles, infrastructure, and personnel. Typically, a flight of two to four aircraft will depart the aircraft carrier and fly inland at high altitude (greater than 30,000 ft [9,144 m]). The flight will approach the inland target from an altitude of between 15,000 ft (4,572 m) to less than 3,000 ft (914 m) and, will usually establish a racetrack pattern around the target. The pattern is established in a predetermined horizontal and vertical position relative to the target to ensure that all participating aircraft follow the same flight path during their target ingress, ordnance delivery, target egress, and "downwind" profiles. This type of pattern is designed to ensure that only one aircraft will be releasing ordnance at any given time. The typical bomb release altitude is below 3,000 ft (914 m) and within a range of 1,000 yards (yd) (914 m) for unguided munitions or above 15,000 ft (4,572 m) and may be in excess of 10 nm (18 km) for precision-guided munitions. Exercises at night will normally be done with captive carry (no drop) weapons because of safety considerations. Laser designators from the aircraft dropping the bomb, a support aircraft, or ground support personnel are used to illuminate certified targets for use with lasers when using laser-guided weapons. The average time for this exercise is about 1 hour. These activities take place in the inland SUA of the Air Force and on the Army land ranges of the ATA, where their impacts are covered under other NEPA analyses (refer to Sections 2.1.2 and 2.1.3).

Personnel Recovery (PR): PR is a strike warfare activity with the purpose of training aircrews to locate, protect, and evacuate downed aviation crew members. In a hostile environment, this exercise becomes a Combat Search and Rescue (CSAR) mission. The activity can include reconnaissance aircraft to find the downed aircrew, helicopters to conduct the rescue, and fighter aircraft to perform close air support to protect both the downed aircrews and the rescue helicopters. These activities can take place throughout the ATA.

2.4.1.6 Other Training

Deck Landing Qualifications (DLQs): This mission provides training for helicopter crews to land on ships underway at sea. Perhaps the most demanding mission of any aviator is landing an aircraft aboard a ship. The mission is made even more difficult when these activities are required at night or in rough sea states. Further compounding the situation during Northern Edge exercises is the fact that aircrew from the Air Force, Army, and U.S. Coast Guard, who do not normally perform DLQs, use this venue to practice helicopter DLQs onboard naval vessels. For safety, the Navy has strict guidelines and rules on frequency and duration between landings. As this is not a normal activity for Air Force, Army, and USCG helicopter crews, the number and duration of particular DLQs that occur during a joint training exercise can vary dramatically.

DLQ activities take place on an underway Navy or USCG ship. The activities take place in both day and night, and could involve more than one helicopter over a period of several hours. The crew that is receiving the training typically departs from a shore facility and flies out to sea to make an approach and landing aboard the ship. After the required number of landings is completed, the helicopter either remains aboard ship or departs for shore. These activities take place in the TMAA.

2.4.2 Naval Force Structure

The Navy has established policy governing the composition and required mission capabilities of deployable naval units, focused on maintaining flexibility in the organization and training of forces. Central to this policy is the ability of naval forces of any size to operate independently or to merge into a larger naval formation to confront a diverse array of challenges. Thus, individual units may combine to form a Strike Group, and Strike Groups may combine to form a Strike Force. Composition of the Strike Groups and Strike Forces is discussed in Section 2.4.2.1.

2.4.2.1 "Baseline" Naval Force Composition

Navy policy defines the "baseline" composition of deployable naval forces. The baseline is intended as an adaptable structure to be tailored to meet specific requirements. Thus, while the baseline composition of a CSG calls for a specified number of ships, aviation assets, and other forces, a given CSG may include more or fewer units, depending on their mission. The baseline naval force structures established by Navy policy for a CSG are: One Aircraft Carrier; One Carrier Air Wing consisting of four Strike Fighter squadrons, one Electronic Combat squadron, two Combat Helicopter squadrons, and two logistics aircraft; Five Surface Combatant Ships where "Surface Combatant" refers to guided missile cruisers, destroyers, and frigates, and future DDG 1000 and Littoral Combat Ship platforms; one attack submarine; and one logistic support ship.

2.4.2.2 Opposition Force Composition

To support a realistic training scenario, the Navy routinely contracts civilian vessels, such as fishing and recreational vessels, to simulate enemy targets and make up an opposition force. To support exercises in the TMAA, there are approximately nineteen contracted vessels hired to support a typical joint training exercise.

2.5 Alternative 1 – Increase Training Activities to Include Anti-Submarine Warfare Activities and Accommodate Force Structure Changes

Under Alternative 1, in addition to training activities currently conducted, the ATA would support an increase in training activities designed to meet Navy and DoD current and near-term operational requirements. This increase would encompass conducting one large-scale joint force exercise, including ASW activities and the use of active sonar, occurring over a maximum time period of up to 21 consecutive days during the summer months (April through October). Alternative 1 would include basic individual or unit level training events of relatively short duration occurring simultaneously with the large-scale joint force exercise. Alternative 1 would also accommodate increases in training activities due to force structure changes associated with the introduction of new weapon systems, vessels, aircraft, and training instrumentation into the Fleet. Training activities associated with force structure changes would be implemented for the EA-18G Growler, SSGN, P-8 MMA, DDG 1000 (Zumwalt Class), and UASs. Force structure changes associated with new weapons systems would include new types of sonobuoys. Force structure changes associated with new training instrumentation include the use of a Portable Undersea Tracking Range (PUTR) (refer to Section 2.5.3.3).

2.5.1 Description of Training Activities and Levels

Table 2-5 identifies the baseline and proposed increases in activities in the ATA if Alternative 1 were to be implemented.

2.5.2 Anti-Submarine Warfare (ASW) Training

ASW Tracking Exercise (TRACKEX) trains aircraft, ship, and submarine crews in tactics, techniques, and procedures for search, detection, localization, and tracking of submarines with the goal of determining a firing solution that could be used to launch a torpedo and destroy the submarine. A typical unit-level exercise involves one (1) ASW unit (aircraft, ship, or submarine) versus one (1) target, usually a MK-39 Expendable Mobile ASW Training Target (EMATT) (Appendix H) or a live submarine. The target may be nonevading while operating on a specified track or fully evasive. Participating units use active and passive sensors, including hull-mounted sonar, towed arrays, dipping sonar, variable depth sonar and sonobuoys for tracking. ASW activities will include the use of active sonar.

Helicopter ASW TRACKEX: A helicopter ASW TRACKEX typically involves one or two MH-60R helicopters using both passive and active sonar for tracking submarine targets. For passive tracking, the MH-60R will deploy patterns of passive sonobuoys that will receive underwater acoustic signals, providing the helicopter crew with locating information on the target. Active sonobuoys may also be used. An active sonobuoy, as in any active sonar system, emits an acoustic pulse that travels through the water, returning echoes if any objects, such as a submarine, are within the range of acoustic detection. For active sonar tracking, the MH-60R crew will rely primarily on its AQS-22 Dipping Sonar. The sonar is lowered into the ocean while the helicopter hovers within 50 ft (15m) of the surface. Similar to the active sonobuoy, the dipping sonar emits acoustic energy and receives any returning echoes, indicating the presence of an underwater object.

The target for this exercise is either an EMATT or live submarine which may be either nonevading and assigned to a specified track or fully evasive depending on the state of training of the helicopter crew. A Helicopter TRACKEX usually takes 2 to 4 hours. No torpedoes are fired during this exercise.

Maritime Patrol Aircraft (MPA)[5] *ASW TRACKEX*: During these exercises, a typical scenario involves a single MPA dropping sonobuoys, from an altitude below 3,000 ft (914 m), into specific patterns designed for both the anticipated threat submarine and the specific water conditions. These patterns vary in size and coverage area based on anticipated threat and water conditions. Typically, passive sonobuoys will be used first, so the threat submarine is not alerted. Active sonobuoys will be used as required either to locate extremely quiet submarines or to further localize and track submarines previously detected by passive buoys (see Section 2.2.1 for a discussion of passive and active sonar). The MPA will typically operate below 3,000 ft (914 m) to drop sonobuoys, will sometimes be as low as 400 ft (122 m), then it may climb to several thousand feet after the buoy pattern is deployed. The higher altitude allows monitoring the buoys over a much larger search pattern area.

The target for this exercise is either an EMATT or live submarine which may be either nonevading and assigned to a specified track or fully evasive depending on the state of training of the MPA. A TRACKEX-MPA usually takes 2 to 4 hours. No torpedoes are fired during this exercise.

Extended Echo Ranging (EER) ASW Exercises: This exercise is an at-sea flying event designed to train MPA crews in the deployment and use of the EER sonobuoy systems. This system uses the SSQ-110A as the signal source and the SSQ-77 as the receiver buoy. This activity differs from the MPA ASW TRACKEX in that the SSQ-110A sonobuoy uses two explosive charges per buoy for the acoustic source. Other active sonobuoys use an electrically generated "ping."

A typical EER exercise lasts approximately 6 hours. The aircrew will first deploy 16 to 20 SSQ-110A sonobuoys and 16 to 20 passive sonobuoys in 1 hour. For the next 5 hours, the sonobuoy charges will be detonated, while the EER system analyzes the returns for evidence of a submarine. This exercise may or may not include a practice target. In the near future, the Navy will be replacing the EER sonobuoys with the Multi-static Active Coherent (MAC) sonobuoys, which are described in detail in Section 2.5.3.2.

ASW TRACKEX (Surface Ship): Surface ships operating in the TMAA would use hull-mounted active sonar to conduct ASW Tracking exercises. Typically, this exercise would involve the coordinated use of other ASW assets, to include MPA, helicopters, and other ships.

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[5] MPA currently refers to the P-3C Orion aircraft. The P-8 Multi-Mission Maritime Aircraft is scheduled to replace the P-3C as the Navy's Maritime Patrol Aircraft.

ASW TRACKEX (Submarine): During these exercises submarines use passive sonar sensors to search, detect, classify, localize, and track the threat submarine with the goal of developing a firing solution that could be used to launch a torpedo and destroy the threat submarine. However, no torpedoes are fired during this exercise.

2.5.2.1 Sonars Used in the TMAA

For the purposes of this EIS/OEIS, the term sonar refers to a system, either passive or active, used to locate underwater objects. In addition to those systems commonly referred to as sonar, there are other acoustic sources used or proposed for use by the Navy in the TMAA. For example, the MK-84 tracking pinger and the PUTR uplink transmitter are both sources of underwater sound. Although not technically sonars, they do create sound and are considered in this analysis as acoustic systems. Tables 2-2 and 2-3 list typical U.S. Navy acoustic systems and identify those that may be used during training activities conducted in the TMAA. All sources that may be used in the TMAA were analyzed for potential impacts to the marine environment.

Certain systems, because of their frequent use or high power output, were quantitatively modeled for their acoustic impacts. The acoustic systems presented in Table 2-2 have been quantitatively modeled. Table 2-3 lists the systems that have been analyzed, but not quantitatively modeled. The systems that were not modeled include systems that are typically operated at frequencies greater than 200 kHz. Because it is not used in the TMAA, low-frequency sonar was not analyzed in this EIS/OEIS.

It is important to note that, as a group, marine mammals have functional hearing ranging from 10 hertz (Hz) to 180 kHz (Southhall et al. 2007). Their best hearing sensitivities are concentrated near the middle of that range. Since active sonar sources operating at 180 kHz or higher dissipate rapidly and are at or outside the upper frequency limit of marine mammals, further consideration and modeling of these higher frequency acoustic sources are not warranted. As such, high-frequency active sonar systems in excess of 180 kHz are not analyzed in this EIS/OEIS.

Table 2-2: Acoustic Systems Quantitatively Modeled

System*	Frequency	Associated Platform	System Use/Description	Currently Used in TMAA	Proposed Use in TMAA
AN/SQS-53C	MF	Surface ship sonar (DDG/CG)	Utilized 70% in search mode and 30% in track mode.	No	Yes
AN/SQS-56C	MF	Surface ship sonar (FFG)	Utilized 70% in search mode and 30% in track mode.	No	Yes
AN/SSQ-62 DICASS Sonobuoy	MF	Helicopter and MPA deployed	12 pings, 30 seconds between pings.	No	Yes
AN/AQS-13 or AN/AQS-22	MF	Helicopter dipping sonar	AN/AQS-22: 10 pings/dip, 30 seconds between pings)- also used to represent AN/AQS-13.	No	Yes
AN/SSQ-110A Explosive source Sonobuoy	Impulsive	MPA deployed	Contains two 4.1 lb charges.	No	Yes

Table 2-2: Acoustic Systems Quantitatively Modeled (continued)

System*	Frequency	Associated Platform	System Use/Description	Currently Used in TMAA	Proposed Use in TMAA
MK-48 Torpedo	HF	Submarine	Active for 15 minutes per torpedo run – To be used during SINKEX.	No	Yes
MK-84 Pinger	HF	Submarines, Surface ships and Targets	PUTR target tracking.	No	Yes
PUTR Uplink Transmitter	MF/HF	PUTR	PUTR tracking uplink signal.	No	Yes
MK-39 EMATT	MF	Ship and aircraft deployed	Simulates a target submarine for tracking exercises	No	Yes
AN/BQQ-10	MF	Submarine Sonar	Submarine hull-mounted sonar (2 pings per hour)	No	Yes
AN/BQS-15	HF	Submarine Sonar	Submarine mine detection sonar.	No	Yes
SUS, MK-84	Selectable 3.3 or 3.5 kHz	Limited duration, system is used for communications between surface ship and submarines	Expendable buoy deployed from aircraft and ships used as a signaling device to communicate with submarines. Operating life of 70 seconds.	No	Yes

*System Descriptions are discussed within Appendix H

DDG – Guided Missile Destroyer; CG – Guided Missile Cruiser; DICASS – Directional Command-Activated Sonobuoy System; FFG – Fast Frigate; MF – Mid-Frequency; MPA – Maritime Patrol Aircraft

Table 2-3: Acoustic Systems Not Quantitatively Modeled

System	Frequency	Reason Not Modeled	System Use/Description	Currently used in TMAA	Proposed use in TMAA
AN/SQQ-32	HF	Not used in TMAA	MCM over the side system.	No	No
MK-46, MK-54 Torpedo	HF	Not used in TMAA	Surface ship and aircraft fired exercise torpedo.	No	No
AN/SLQ-25 (NIXIE)	MF	Not used in TMAA	DDG, CG, and FFG towed array.	No	No
AN/SQS-53 and AN/SQS-56 (Kingfisher)	MF	Not used in TMAA	DDG, CG, and FFG hull-mounted sonar (small object detection).	No	No
ADC MK-3 and MK-2	MF	Not used in TMAA	Submarine-fired countermeasure.	No	No

Table 2-3: Acoustic Systems Not Quantitatively Modeled (continued)

System	Frequency	Reason Not Modeled	System Use/Description	Currently used in TMAA	Proposed use in TMAA
Surface Ship and Submarine Fathometer	12 kHz	System is not unique to military and operates identically to commercially available bottom sounder	Depth finder on surface ships and submarines.	Yes	Yes
SQR-19	Passive	System is a passive towed array emitting no active sonar	A listening device towed behind a surface ship.	Yes	Yes
TB-16/23/29/33	Passive	System is a passive towed array emitting no active sonar	A listening device towed behind a submarine.	Yes	Yes
AN/SSQ-53 DIFAR Sonobuoy, AN/SSQ-101 (ADAR), AN/SQS-77 (VLAD)	Passive	Sonobuoy is passive & emits no active sonar	Passive listening buoys deployed from helicopter or MPA.	No	Yes
AN/SQQ-125 (MAC) Sonobuoy	MF	MPA deployed	Replacement for AN/SSQ-110A, uses electronic, not explosive, sound source	No	Yes
AN/AQS-14/20/24	>200 kHz	System frequency outside the upper limit for marine mammals and not used in TMAA	Helicopter towed array used in MIW for the detection of mines.	No	No
Acoustic Detection Countermeasures (MK-1, MK-2, MK-3, MK-4)	MF	Not used in TMAA	Countermeasure package deployed during some ASW events to counter torpedoes.	No	No
Unmanned Underwater Vehicles	MF/HF	Not used in TMAA	Data collection telemetry and mapping sonars may be active sources.	No	No

Table 2-3: Acoustic Systems Not Quantitatively Modeled (continued)

System	Frequency	Reason Not Modeled	System Use/Description	Currently used in TMAA	Proposed use in TMAA
AN/WSQ-9; ACOMMS	MF/HF	Limited duration, system is used for communications between surface ship and submarines	Surface ship and submarine buoys – operational use of passive hydrophones and arrays and active transducers as system components used to transmit voice and data underwater for safety, data sharing, and communications.	No	Yes

ADC – Acoustic Device Countermeasure; DDG – Guided Missile Destroyer; DIFAR – Directional Frequency Analysis and Recording; FFG – Fast Frigate; HF – High-Frequency; kHz – Kilohertz; MCM – Mine Countermeasures; MF – Mid-Frequency; MIW – Mine Warfare; MPA – Maritime Patrol Aircraft

2.5.3 Force Structure Changes

The Navy will train with new ships, aircraft, and systems as they become operational in the Fleet. Several future platforms and weapon systems have been identified that are in development, and are likely to be incorporated into Navy training requirements within the 10-year planning horizon. Several of these new technologies are in early stages of development, and thus specific concepts of operations, operating parameters, or training requirements are not yet available. However, when made available, information will be incorporated into the development of the EIS/OEIS.

Specific force structure changes and their impact on training within the GOA are based on the Navy's knowledge of future requirements for the use of new platforms and weapons systems and based on the level of information available to evaluate potential environmental impacts. Therefore, this EIS/OEIS, to the extent feasible, will evaluate potential environmental impacts associated with the introduction of the following platforms and weapon systems. Should additional requirements for the use of platforms and weapon systems be needed, separate NEPA and environmental documentation would be required to analyze potential impacts.

2.5.3.1 New Platforms/Vehicles

EA-18G Growler

The EA-18G Growler is an electronic combat version of the FA-18 E/F that will replace the EA-6B Prowler. Analysis within this EIS/OEIS of any EA-6B activity also considers the potential impacts of future activities with the EA-18G. The Growler will have an integrated suite of advanced communications and EC systems that will initially be centered on the Improved Capability (ICAP) III system, but will also include tactical jamming pods, a radar receivers wingtip pods, an advanced crew station, the Airborne Electronically Scanned Array (AESA) multimode radar, and a communications receiver and jammer. The EA-18G will have a limited self-protection capability requiring aircrews to train for offensive air-to-air missile engagements and conduct missile exercises. The advanced capabilities of the Growler will require greater standoff ranges and broader frequency spectrum access than current systems.

Guided Missile Submarine (SSGN)

Four *Ohio*-class *Trident* submarines that were previously scheduled for inactivation during Fiscal Years 2003 and 2004 were converted to SSGNs over a 5-year period ending in 2008. The primary missions of the SSGN are land attack (STW) and Special Operations Forces (SOF) insertion and support. Secondary missions are the traditional attack submarine missions of Intelligence, Surveillance, and Reconnaissance (ISR), battle space preparation, and sea control.

These ships are armed with up to 154 Tomahawk or Tactical Tomahawk land attack missiles. They have the ability to carry and support a team of 66 SOF personnel for up to 90 days as compared to 15 days for a SOF outfitted Fast Attack Submarine (SSN). Clandestine insertion and retrieval of these SOF is enhanced by the ability to host dual dry deck shelters or Advanced Seal Delivery System. Each SSGN is able to conduct a variety of peace-time, conventional deterrent and combat activities all within the same deployment. The first SSGNs became operational in Fiscal Year (FY) 2007. Their use in Alaska waters will not include the strike mission, but may involve clandestine special operations.

Although potential use of the SSGN in the TMAA is not clear, any impacts would be identical to those of the SSN; therefore no further differentiation of the SSGN in this analysis is necessary.

P-8 Poseidon Multimission Maritime Aircraft (MMA)

The P-8A Poseidon MMA is the Navy's replacement for the aging P-3 Orion aircraft. It is a modified Boeing 737-800ERX that brings together a highly reliable airframe and high-bypass turbo fan jet engine with a fully connected, state-of-the-art open architecture mission system. This combination, coupled with next-generation sensors, will dramatically improve ASW and ASUW capabilities. The MMA will ensure the Navy's future capability in long-range maritime patrol. It will be equipped with modern ASW, ASUW, and ISR sensors. In short, MMA is a long-range ASW, ASUW, ISR aircraft that is capable of broad-area, maritime, and littoral activities. Initial Operational Capability (IOC) is expected in FY 2013.

Analysis within this EIS/OEIS of any P-3 activity also considers the potential impacts of future activities with the P-8A.

The DDG-1000 Zumwalt Class Destroyer

The DDG-1000 Destroyer is the lead ship in a class of next-generation, multimission surface combatants tailored for land attack and littoral dominance, with capabilities designed to defeat current and projected threats as well as improve Strike Group defense. This class of ship is undergoing design and development, and is not expected to be introduced to the Fleet before 2012. Training activities involving this class of ship are addressed in this EIS/OEIS.

Analysis within this EIS/OEIS of surface ship activities also considers the potential impacts of future activities with the DDG-1000.

Unmanned Aerial Systems (UAS)

Fire Scout UAS: The Fire Scout UAS is a Vertical Takeoff and Landing UAS (VTUAS) designed to operate from air-capable ships, carry modular mission payloads (ordnance), and operate using the Tactical Control System and Tactical Common Data Link. It provides day/night real-time ISR and targeting as communication-relay and battlefield management capabilities to support Littoral Combat Ship (LCS) mission areas of ASW, MIW, and ASUW. Operation of these systems could produce new requirements for the GOA in terms of airspace and frequency management. Fire Scout will be fielded in early LCS versions.

Broad Area Maritime Surveillance (BAMS) UAS: The BAMS UAS is being designed to support persistent, worldwide access through multisensor, maritime ISR providing unmatched awareness of the battlespace. It will support a spectrum of Fleet missions serving as a distributed ISR node in the overall naval environment. These missions include maritime surveillance, Battle-Damage Assessment (BDA), port surveillance and homeland security support, MIW, MI, Surface Warfare (SUW), counter drug activities, and battlespace management. The BAMS will operate at altitudes above 40,000 ft (12.2 km), above the weather, and above most air traffic to conduct continuous open-ocean and littoral surveillance of targets as small as exposed submarine periscopes. Operation of these systems could produce new requirements for range complexes in terms of airspace and frequency management. IOC is anticipated for FY09.

Navy Unmanned Combat Air System (N-UCAS): The N-UCAS (Grumman X-47B) program is a Navy effort to demonstrate the technical feasibility, military utility, and operational value of an aircraft carrier based, networked system of high performance, weaponized UASs to effectively and affordably execute 21st century combat missions, including Suppression of Enemy Air Defenses (SEAD), surveillance, and precision strike within the emerging global command, and control architecture. Operation of these systems could produce new requirements for range complexes in terms of airspace, frequency management, and target sets. IOC of these systems has not yet been established.

2.5.3.2 New Weapons Systems

Under the Proposed Action, the only weapons systems being introduced at this time that warrant evaluation in this EIS/OEIS are the sonobuoys.

Multi-Static Active Coherent (MAC) System

The proposed MAC system, previously referred to as the Advanced Extended Echo Ranging (AEER) system, is used in the same manner and for the same purpose as the EER/Improved EER (IEER) system. The MAC will use the same Air Deployed Active Receiver (ADAR) sonobuoys as the acoustic receiver and will be used for a large area ASW search capability in both shallow and deep water. However, instead of using an explosive AN/SQS-110A as an impulsive source for the active acoustic wave, the MAC system will use a battery-powered (electronic) source for the AN/SSQ 125 sonobuoy. The output and operational parameters for the AN/SSQ-125 sonobuoy (source levels, frequency, wave forms, etc.) are classified; however, this MAC sonobuoy is intended to replace the EER/IEER’s use of explosives and is scheduled to be deployed in 2011.

2.5.3.3 New Training Instrumentation Technology

The Navy has identified a specific training instrumentation enhancement to optimize and adequately support required training for all missions and roles assigned to the TMAA. The proposed enhancement for the TMAA is discussed below and will be analyzed in this EIS/OEIS.

Portable Undersea Tracking Range (PUTR)

The PUTR is a self-contained, portable, undersea tracking capability that employs modern technologies to support coordinated undersea warfare training for Forward Deployed Naval Forces (FDNF). PUTR will be available in two variants to support both shallow and deep water remote activities in keeping with Navy requirements to exercise and evaluate weapons systems and crews in the environments that replicate the potential combat area. The system will be capable of tracking submarines, surface ships, weapons, targets, and Unmanned Underwater Vehicles (UUVs) and distribute the data to a data processing and display system, either aboard ship, or at a shore site.

The PUTR would be developed to support ASW training in areas where the ocean depth is between 300 and 12,000 ft (91 and 3,657 m) and at least 3 nm (5.5 km) from land. However, for exercises occurring within the GOA, the PUTR would be deployed solely within the TMAA. This proposed project would temporarily (for the duration of the exercise) instrument an area on the seafloor from 25-100 nm^2 or smaller, and would provide high fidelity crew feedback and scoring of crew performance during ASW training activities. When training is complete, the PUTR equipment would be recovered.

No onshore construction would take place. Seven electronics packages, each approximately 3 ft (0.9 m) long by 2 ft (0.6 m) in diameter, would be temporarily installed on the seafloor by a range boat, in water depths greater than 600 ft (182 m). The anchors used to keep the electronics packages on the seafloor would be either concrete or sand bags, which would be approximately 1.5 by 1.5 ft (0.45 by 0.45 m) and would weigh approximately 300 pounds. Operation of this range requires that underwater participants transmit their locations via pingers (see "Range Tracking Pingers" below). Each package consists of a hydrophone that receives pinger signals, and a transducer that sends an acoustic "uplink" of locating data to the range boat. The uplink signal is transmitted at 8.8 kHz, 17 kHz, or 40 kHz, at a source level of 190 decibels (dB). The PUTR system also incorporates an underwater voice capability that transmits at 8-11 kHz and a source level of 190 dB. Each of these packages is powered by a D cell alkaline battery. After the end of the exercise the electronic packages would be recovered and the anchors would remain on the seafloor. No additional ASW activity is proposed as a result of PUTR use.

Range tracking pingers would be installed on ships, submarines, and ASW targets when ASW TRACKEX training is conducted on the PUTR. A typical range pinger generates a 12.93-kHz sine wave in pulses with a maximum duty cycle of 30 milliseconds (3 percent duty cycle) and has a design power of 194 dB re 1 micro-Pascal at 1 meter. Although the specific exercise, and number and type of participants will determine the number of pingers in use at any time, a maximum of three pingers and a minimum of one pinger would be used for each ASW training activity. On average, two pingers would be in use for 3 hours each during PUTR operational days.

2.6 Alternative 2 – (Preferred Alternative) Increase Training Activities, Accommodate Force Structure Changes, Conduct One Additional Annual Exercise, and Conduct One SINKEX During Each Summertime Exercise

Implementation of Alternative 2 would include all elements of Alternative 1 (accommodating training activities currently conducted, increasing specific training activities to include the use of active sonar, and accommodating force structure changes). In addition, under Alternative 2 the following activities would occur:

- Conduct one additional separate large-scale joint force exercise, occurring over a maximum time period of up to 21 consecutive days during the summer months (April through October).
- Conduct a SINKEX during each summertime exercise (a maximum of 2) in the TMAA

Alternative 2 is the Preferred Alternative because it would allow the greatest flexibility for Navy exercise planners to benefit from the unique joint training environment in the ATA.

2.6.1 Proposed New Activity

Alternative 2 proposes the conduct of one type of training activity that is not presently conducted in the TMAA. Under Alternative 2, this type of training would be conducted as discussed below.

2.6.1.1 Sinking Exercise (SINKEX)

A SINKEX is typically conducted by aircraft, surface ships, and submarines in order to take advantage of a full size ship target and an opportunity to fire live weapons.

The target is typically a decommissioned combatant or merchant ship that has been made environmentally safe for sinking according to standards set by the U.S. Environmental Protection Agency (USEPA). It is placed in a specific location that is greater than 50 nm (93 km) out to sea and in water depths greater than 6,000 ft (1,830 m) (40 C.F.R. § 229.2) so that when it sinks it will not be a navigation hazard to marine traffic.

Ship, aircraft, and submarine crews typically are scheduled to attack the target with coordinated tactics and deliver live ordnance to sink the target. Inert ordnance is often used during the first stages of the event so that the target may be available for a longer time. The duration of a SINKEX is unpredictable because it ends when the target sinks, but the goal is to give all forces involved in the exercise an opportunity to deliver their live ordnance. Sometimes the target will begin to sink immediately after the first weapon impact and sometimes only after multiple impacts by a variety of weapons. Typically, the exercise lasts for 4 to 8 hours and possibly over 1 to 2 days, especially if inert ordnance, such as 5-inch gun projectiles or MK-82 dummy bombs, is used during the first hours.

A SINKEX is conducted under the auspices of a permit from the USEPA.

The participants and assets could include, but are not limited to:

- One full-size target ship hulk
- One to five CG, DDG, or FFG firing ships
- One to 10 F/A-18, or MPA firing aircraft and One E-2 aircraft for Command and Control
- One or two HH-60H, MH-60R/S, or SH-60B Helicopters
- One firing submarine
- One to three range clearance aircraft.

Some or all of the following weapons could be employed (see Table 2-7):

- Two HARM air-to-surface missiles
- Five Harpoon surface-to-surface or air-to-surface missiles
- One Hellfire air-to-surface missiles
- Three air-to-surface Maverick missiles
- One Penguin air-to-surface missiles
- One surface-to-air Standard Missile 1 and One surface-to-air Standard Missile 2
- 10 MK-82 General Purpose Bombs (seven live, three inert)
- Four MK-83 General Purpose Bombs
- 400 rounds 5-inch gun
- One MK-48 heavyweight submarine-launched torpedo

Figure 2-7 identifies the area with the TMAA that, based upon USEPA requirements, could support a SINKEX.

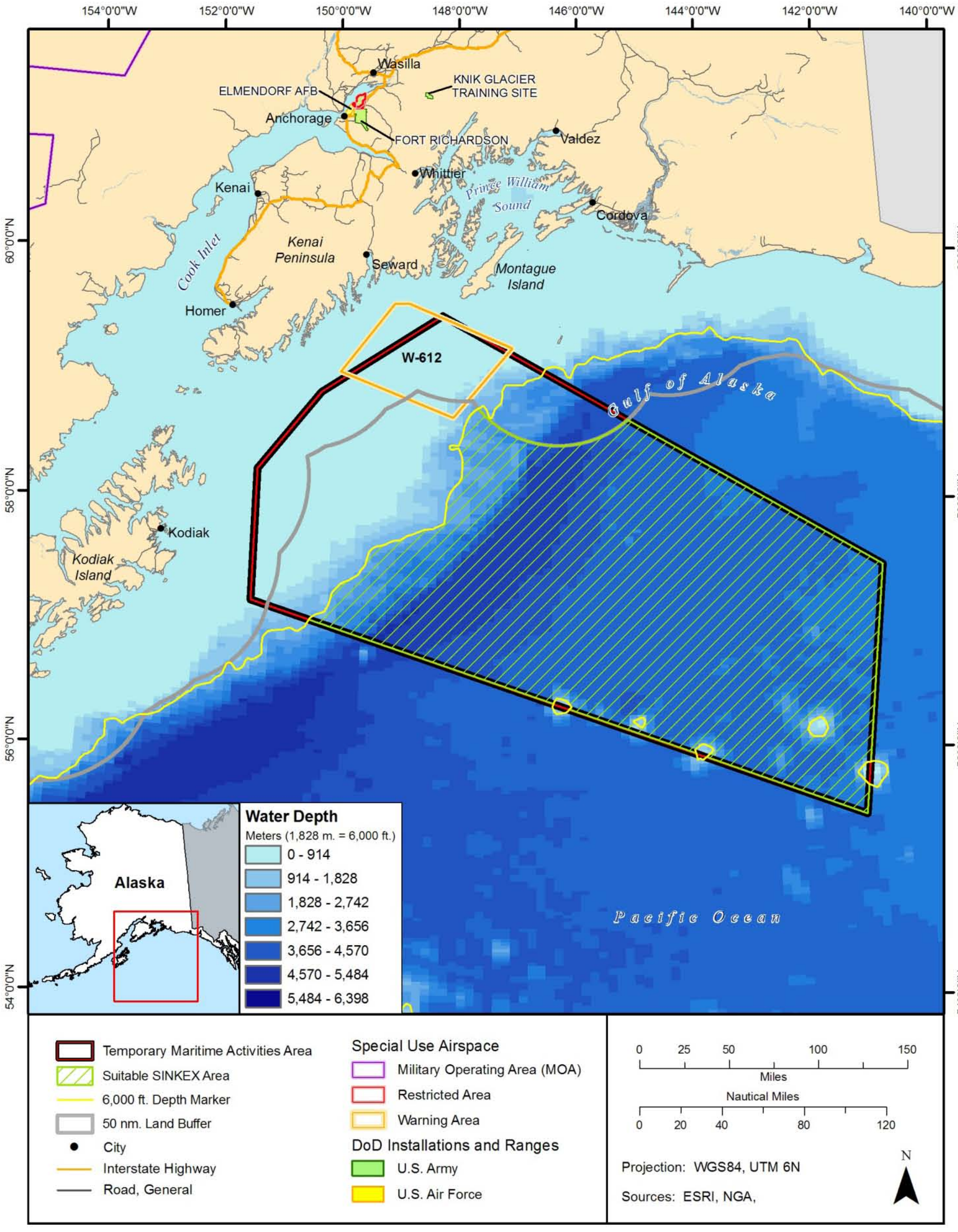

Figure 2-7: Possible Locations of a SINKEX within the TMAA

2.6.2 Revised Level of Activities

Table 2-5 identifies the baseline and proposed increases in activities in the ATA under Alternative 2. In general, most activities would increase under Alternative 2.

2.6.3 Activity Summary Tables

Tables 2-4 through 2-7 summarize the activities in the ATA. Table 2-4 lists the active sources proposed for use in the TMAA under Alternatives 1 and 2. Table 2-5 provides detailed information on each of the No Action Alternative (Baseline), Alternative 1, and Alternative 2 activities. Table 2-6 lists the annual expenditure of ordnance and other related training materials in the TMAA. Table 2-7 lists that annual expenditure of ordnance used during SINKEX activities under Alternative 2.

Table 2-4: Active Systems and Platforms Proposed for Use in the TMAA

System	Hours Modeled (Annual)		Associated Platform/Use
	Alt 1	Alt 2	
AN/SQS-53	289	578	DDG and CG hull-mounted sonar
AN/SQS-56	26	52	FFG hull-mounted sonar
AN/BQQ-10	24	48	Submarine hull-mounted sonar
AN/AQS-13 or AN/AQS-22	96	192	Helicopter dipping sonar
BQS-15	12	24	SSN navigation
PUTR Transponders	40	80	Portable Undersea Tracking Range
MK-84 Range Tracking Pingers	40	80	Ships, submarines, ASW targets
DICASS Sonobuoy (AN/SSQ-62)	133	266	MPA deployed sonobuoys
IEER Sonobuoy (AN/SSQ-110A)	20	40	MPA deployed sonobuoys
MAC Sonobuoy (AN/SSQ-125)	20	40	MPA deployed sonobuoys
SUS, MK-84	12	24	Surface Ships and Aircraft
EMATT	6	12	Surface ships and Aircraft

CG – Guided Missile Cruiser; DDG – Guided Missile Destroyer; FFG – Fast Frigate; DICASS – Directional Command-Activated Sonobuoy System; HF – High-Frequency; MF – Mid-Frequency.

Table 2-5: Current and Proposed Annual Level of Activities in the Alaska Training Areas

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
ANTI-AIR WARFARE (AAW)						
Aircraft Combat Maneuvers	EA-6B, EA-18G, FA-18, F-16, F-15, F-22	None	300 sorties	300 sorties	600 sorties	TMAA, Air Force SUA[1]
Air Defense Exercise	FA-18, F-16, F-15, F-22, EA-6B, EA-18G, P-3C, P-8 MMA, CVN, CG, DDG, FFG	None	3 events	4 events	8 events	TMAA
S-A Missile Exercise	CVN, CG, DDG, FFG	Sea Sparrow Missile, Standard Missile 1, or RAM Target: BQM-74E	2 events	3 events	6 events	TMAA
Surface-to-Air (S-A) Gunnery Exercise	CG, DDG, FFG, AOE	5"/54 BLP, 20mm CIWS, 7.62mm Target: Towed TDU-34	2 events	3 events	6 events	TMAA
Air-to-Air (A-A)Missile Exercise	FA-18, F-16, F-15, F-22 E-2C, EA-6B, EA-18G	AIM-7, AIM-9, AIM-120 AMRAAM Targets: TALD or LUU-2B/B	2 events	3 events	6 events	TMAA, Air Force SUA[1]
ANTI-SURFACE WARFARE (ASUW)						
Visit Board Search and Seizure	MH-60S, RHIB, NSW Personnel	None	12 events	12 events	24 events	TMAA
Air-to-Surface (A-S) Missile Exercise	MH-60R/S, FA-18, F-16, F-15, F-22, EA-6B, EA-18G	CATM-114 Hellfire, CATM-84 (SLAM-ER), an CATM-84 Harpoon, or an CATM-65 Maverick (all captive carry/not released)	1 events	2 events	4 events	TMAA

Table 2-5: Current and Proposed Annual Level of Activities in the Alaska Training Areas (continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Air-to-Surface (A-S) Bombing Exercise	FA-18, F-16, F-15, F-22	MK-82 (live),MK-83 (live), MK-84 (live) BDU-45 (inert), MK-58 marine marker	12 events	18 events	36 events	TMAA
Air-to-Surface (A-S) Gunnery Exercise	MH-60R/S	GAU-16 (0.50-cal) or M-60 (7.62mm) machine gun Targets: HSMST, Trimaran, SPAR, Surface Target Balloon	5 events	7 events	14 events	TMAA
Surface-to-Surface (S-S) Gunnery Exercise	CVN, CG, DDG, FFG, AOE	5”/54 BLP, 20mm CIWS, 25 mm, 7.62mm, 57mm, .50 cal Targets: HSMST, Trimaran, SPAR, Surface Target Balloon	5 events	6 events	12 events	TMAA
Maritime Interdiction	All	None	14 events	14 events	28 events	TMAA
Sea Surface Control	FA-18, EA-6B, EA-18G, P-3C, P-8 MMA, CG, DDG, FFG	None	6 events	6 events	12 events	TMAA
Sink Exercise	FA-18, F-16, F-15, F-22, EA-6B, EA-18G, P-3C, P-8 MMA, MH-60R/S, CVN, CG, DDG, FFG	MK-82 (Inert), MK-82 (live), MK-83, AGM-88 HARM, AGM-84 Harpoon, AGM-65 Maverick, AGM-114 Hellfire, AGM-119 Penguin, Standard Missile 1, Standard Missile 2, 5”/54 BLP	N/A	N/A	2 events	TMAA

Table 2-5: Current and Proposed Annual Level of Activities in the Alaska Training Areas (continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
ANTI-SUBMARINE WARFARE (ASW)						
Anti-Submarine Warfare (ASW) Tracking Exercise - Helicopter	MH-60R	Targets: SSN, MK-39 EMATT Sonobuoys: AN/AQS-22, SSQ-36 BT, SSQ-53 DIFAR (passive), SSQ-62 DICASS (active), SSQ-77 VLAD Other: MK-58 marine marker	N/A	22 events	44 events	TMAA
Anti-Submarine Warfare (ASW) Tracking Exercise - MPA	P-3C, P-8 MMA	Targets: SSN, MK-39 EMATT Sonobuoys: SSQ-36 BT, SSQ-53 DIFAR (passive), SSQ-62 DICASS (active), SSQ-77 VLAD Other: MK-58 marine marker	N/A	13 events	26 events	TMAA
ASW Tracking Exercise - Extended Echo Ranging (EER) (includes IEER and MAC)	P-3C, P-8 MMA	SSQ-110A EER/IEER, SSQ-125 MAC, SSQ-77 VLAD	N/A	2 events	4 events	TMAA
ASW Tracking Exercise - Surface Ship	DDG, FFG	SQS-53C, SQS-56 MFA sonar Targets: SSN, MK-39 EMATT	N/A	2 events	3 events	TMAA
ASW Tracking Exercise - Submarine	SSBN, SSGN	Targets: MK-39 EMATT	N/A	2 events	3 events	TMAA
ELECTRONIC COMBAT (EC)						
Electronic Combat (EC) Exercises	EA-6B, EA-18G, P-3, EP-3, CVN, CG, DDG, FFG	None	4	5 events	10 events	TMAA, Air Force SUA[1]

Table 2-5: Current and Proposed Annual Level of Activities in the Alaska Training Areas (continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Chaff Exercises	EA-6B, EA-18G, P-3, EP-3, FA-18, CVN, CG, DDG, FFG, AOE	Chaff	2 events	2 events	4 events	TMAA, Air Force SUA[1]
Counter Targeting Exercises	EA-6B, EA-18G, P-3, EP-3, FA-18, CVN, CG, DDG, FFG, AOE	None	4 events	4 events	8 events	TMAA
NAVAL SPECIAL WARFARE (NSW)						
Special Warfare Operations	C-130, MH-60S, SDV, RHIB, NSW Personnel.	None	10 events	10 events	20 events	TMAA, Air Force SUA[1], Army Training Lands[1]
STRIKE WARFARE (STW)						
Air-to-Ground Bombing Exercise	FA-18, F-16, F-15, F-22, EA-6B, EA-18G	MK-82/83/84 (live/Inert), BDU-45 (inert), CATM-88C (not released)	150 sorties	150 sorties	300 sorties	Air Force SUA[1], Army Training Lands[1]
Personnel Recovery	CVN, CG, DDG, FFG, AOE, MH-60S, RHIB, NSW Personnel.	None	3 events	4 events	8 events	Air Force SUA[1], Army Training Lands[1]
SUPPORT OPERATIONS						
Deck Landing Qualifications	Helicopters (Air Force, Army, Coast Guard – various)	None	4 events	6 events	12 events	TMAA

1: Activities within and upon these areas are covered under separate NEPA analysis.

Table 2-6: Annual Ordnance and Expendables Use in the TMAA

Training Area and Ordnance/Expendable Type	Number of Rounds/Expendables per Year				
	No Action	Alternative 1	% Increase over No Action	Alternative 2	% Increase over No Action
Gulf of Alaska Temporary Military Activities Area (TMAA)					
BOMBS					
BDU-45 (Inert)	72	108	50.0%	216	200.0%
MK-82 (HE)	42	64	52.4%	128	204.8%
MK-83 (HE)	4	6	50.0%	12	200.0%
MK-84 (HE)	2	2	0.0%	4	100.0%
MISSILES					
AIM-7 Sparrow	6	9	50.0%	18	200.0%
AIM-9 Sidewinder	8	12	50.0%	24	200.0%
AIM-120 AMRAAM	6	9	50.0%	18	200.0%
Standard Missile	2	3	50.0%	6	200.0%
NAVAL GUNSHELLS					
20mm (Inert)	8,000	10,000	25.0%	20,000	150.0%
25mm (Inert)	2,500	3,000	20.0%	6,000	140.0%
57mm (Inert)	0	100	N/A	200	N/A
76mm (HE)	10	14	40.0%	28	180.0%
76mm (Inert)	6	8	33.3%	16	166.7%
5 inch (HE)	30	42	40.0%	84	180.0%
5 inch (Inert)	18	24	37.5%	48	166.7%
SMALL ARMS ROUNDS					
7.62mm Projectile	4,000	4,500	12.5%	9,000	125.0%
.50 cal machine gun	1,000	1,200	20.0%	2,400	140.0%
PYROTECHNICS					
LUU-2B/B Flare	12	18	50.0%	36	200.0%
MK-58 Marine Marker (Day/Night smoke/flare)	20	60	200.0%	120	500.0%
TARGETS					
MK-39 Expendable Mobile ASW Training Target (EMATT)	N/A	6	N/A	12	N/A
Tactical Air Launched Decoy (TALD)	8	12	50.0%	24	200.0%
TDU-34 Towed Target (Retained, not expended)	2	3	50.0%	6	200.0%
BQM-74E	2	2	0.0%	4	100.0%
SPAR (Recovered)	10	12	20.0%	24	140.0%
Killer Tomato (Recovered)	10	12	20.0%	24	140.0%

Table 2-6: Annual Ordnance and Expendables Use in the TMAA (continued)

Training Area and Ordnance/Expendable Type	Number of Rounds/Expendables per Year				
	No Action	Alternative 1	% Increase over No Action	Alternative 2	% Increase over No Action
SONOBUOYS					
SSQ-36 BT	24	60	150%	120	400%
SSQ-53 DIFAR Passive	N/A	500	N/A	1,000	N/A
SSQ-62 DICASS Active	N/A	133	N/A	267	N/A
SSQ-77 VLAD	N/A	60	N/A	120	N/A
SSQ-110A/MAC	N/A	40	N/A	80	N/A
CHAFF					
ALE-43 Dispenser (Aluminized glass roll)	540 lbs	540 lbs	0.0%	1080 lbs	100.0%
SIGNALING DEVICE					
SUS MK-84	N/A	12	N/A	24	N/A

HE – High Explosive

Table 2-7: Representative Annual Ordnance Expended During a SINKEX in the TMAA

Ordnance Type	Number of Rounds per Year[2]
BOMBS[1]	
MK-82	14
MK-82 (Inert)	6
MK-83	8
MISSILES	
HARM	4
Harpoon	10
Maverick	6
Hellfire	2
Penguin Missile	2
Standard Missile 1	2
Standard Missile 2	2
TORPEDOES	
MK-48	2
NAVAL GUNSHELLS	
5 inch	800
TOTAL	**858**

1 MK-80 series bombs will be replaced with BLU series bombs
2 Total rounds are cumulative for 2 separate SINKEXs

3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter describes existing environmental conditions (affected environment) for resources potentially affected by the alternatives described in Chapter 2. Potential biological, physical, cultural, and social resource impacts (environmental consequences) are identified, described, and evaluated for the Proposed Action and its Alternatives. As discussed in Chapter 2 under the No Action Alternative, training activities would continue at current levels. Although the No Action Alternative would not meet the Navy's long-term training needs in the Alaska Training Areas (ATA), existing conditions serve as the baseline for analyzing the impacts of the Action Alternatives (Alternative 1 and Alternative 2, the Preferred Alternative).

The affected environment and environmental consequences are described and analyzed according to 14 categories of resources. The resource categories and their sections in this Draft Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS), from here on referred to as EIS/OEIS are:

- Air Quality (3.1)
- Expended Materials (3.2)
- Water Resources (3.3)
- Acoustic Environment (Airborne) (3.4)
- Marine Plants and Invertebrates (3.5)
- Fish (3.6)
- Sea Turtles (3.7)
- Marine Mammals (3.8)
- Birds (3.9)
- Cultural Resources (3.10)
- Transportation and Circulation (3.11)
- Socioeconomics (3.12)
- Environmental Justice and Protection of Children (3.13)
- Public Safety (3.14)

Land-based resource categories (Land Use, Geology and Soils, and Terrestrial Biological Resources), are not analyzed in this EIS/OEIS, as existing and proposed Navy activities and impacts to these resources have already been considered and analyzed in separate environmental documents by the United States (U.S.) Air Force (Air Force) and the U.S. Army (Army). Resource areas carried forward for analysis include reference to the appropriate Air Force/Army environmental analyses for addressing inland areas and their associated impacts from Navy training activities. Proposed Navy training activities that have the potential to affect land areas are evaluated in the aforementioned Air Force and Army environmental documents. Existing and planned activities were accounted for by Army and Air Force range planners. Proposed Navy training activities that do not have the potential to affect land areas are addressed and analyzed as appropriate in the resource sections listed above. Therefore, as noted in Chapter 2, separate environmental analyses of impacts from Navy training activities conducted in the inland training areas on Air Force/Army ranges is not required.

During the environmental impact analysis process, the resources analyzed are identified and the expected geographic scope of potential impacts for each resource is defined. Known as the resource's Region of Influence (ROI), this area is defined as the geographic area in which impacts to the subject resource have the potential to occur. For the majority of resource categories, the ROI coincides with the air, sea, and undersea training areas of the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA). For some resources, the ROI encompasses broader regions within the GOA.

In determining environmental consequences, this chapter incorporates current resource protection measures such as Standard Operating Procedures (SOPs), Best Management Practices (BMPs), and conservation measures that are integral to the activities covered by the Proposed Action and its Alternatives. Mitigation measures are discussed at the end of each resource section and summarized in Chapter 5.

The specific contributions of a particular project to global or regional climate change generally cannot be identified based on existing scientific knowledge, because they typically are extremely small. Also, climate processes are understood at only a general level. Cumulative regional contributions to climate change are addressed in Chapter 4.

3.0 General Approach To Analysis

The methods used in this EIS/OEIS to assess resource impacts associated with the proposed alternatives include the procedural steps outlined below:

- Describe existing resource conditions.
- Review existing federal and state regulations and standards relevant to resource-specific management and/or protection.
- Identify critical resource conditions or areas that require specific analytical attention, such as designated endangered species critical habitat.
- Analyze the warfare areas and activities to determine what stressors may affect the particular resource.
- Review and analyze data sources for information on stressor impacts to the resource, including modeling efforts and scientific research.
- Determine specific impacts to the resource associated with the stressors that result from Navy activities.
- Adjust initial impact determinations to account for use of SOPs, BMPs, and other mitigation measures.
- Determine overall impacts to the resource associated with the Proposed Action and Alternatives, given the applicable regulatory framework.
- Summarize impact findings with respect to resource effects and compliance with regulations and Navy policies for each alternative.

Additional steps may be added to some resource evaluations to address unique resource characteristics or specific regulatory and public-issue concerns.

3.0.1 Stressors

The EIS/OEIS interdisciplinary team and Navy subject matter experts used a screening process to analyze the warfare areas and training activities to identify specific activities in the alternatives that could act as stressors to resources. Other information that was evaluated to identify and analyze stressors included public and agency scoping comments, previous environmental analyses, agency consultations, resource-specific information, and applicable laws, regulations, and executive orders. This process was used to focus the information presented and analyzed in the affected environment and environmental consequences sections of this EIS/OEIS. Table 3-1 summarizes warfare areas, the number of yearly training activities of each type that would be associated with each alternative, and the stressors that potentially would occur within each warfare area because of those activities. The stressors and some of the mechanisms that would result in stress include:

- Vessel movements (disturbance and collisions);
- Low-altitude aircraft overflights (disturbance and strikes);
- Sonar (harassment);
- Weapons firing/nonexplosive practice ordnance (disturbance, strikes, and habitat alteration);
- High-explosive ordnance (harassment, strikes, and habitat alteration); and
- Expended materials (habitat alteration, entanglement, ingestion, and hazardous materials).

Table 3-1: Summary of Potential Stressors

		Number of Activities			Stressors					
Warfare Area and Activity	**Training Area(s)**	**No Action Alternative**	**Alternative 1**	**Alternative 2**	**Vessel Movements**	**Aircraft Overflights**	**SONAR**	**Weapons Firing/Non-Explosive Practice Ordnance**	**High-Explosive Ordnance**	**Expended Materials**
Anti-Air Warfare (AAW)										
Air Combat Maneuver (ACM)	TMAA, Air Force Special-Use Airspace (SUA)	300	300	600		✓				✓
Air Defense Exercise (ADEX)	TMAA	3	4	8	✓	✓				✓
Surface-to-Air Missile Exercise (S-A MISSILEX)	TMAA	2	3	6	✓	✓		✓	✓	✓
Surface-to-Air Gunnery Exercise (S-A GUNEX)	TMAA	2	3	6	✓	✓		✓	✓	✓
Air-to-Air (A-A) MISSILEX	TMAA, Air Force SUA	2	3	6		✓		✓	✓	✓
Anti-Surface Warfare (ASUW)										
Visit Board Search and Seizure (VBSS)	TMAA	12	12	24	✓	✓				
Air-to-Surface (A-S) MISSILEX	TMAA	1	2	4	✓	✓		✓	✓	✓
Air-to-Surface Bombing Exercise (A-S BOMBEX)	TMAA	12	18	36	✓	✓		✓	✓	✓
Air-to-Surface (A-S) GUNEX	TMAA	5	7	14	✓	✓		✓	✓	✓
Surface-to-Surface (S-S) GUNEX	TMAA	5	6	12	✓			✓	✓	✓
Maritime Interdiction Exercise (MI)	TMAA	14	14	28	✓	✓	✓			✓
Sea Surface Control (SSC)	TMAA	6	6	12	✓	✓				
Sinking Exercise (SINKEX)	TMAA	N/A	N/A	2	✓	✓		✓	✓	✓

Table 3-1: Summary of Potential Stressors (continued)

		Number of Activities			Stressors					
Warfare Area and Activity	**Training Area(s)**	**No Action Alternative**	**Alternative 1**	**Alternative 2**	**Vessel Movements**	**Aircraft Overflights**	**SONAR**	**Weapons Firing/Non-Explosive Practice Ordnance**	**High-Explosive Ordnance**	**Expended Materials**
Anti-Submarine Warfare (ASW)										
ASW Tracking Exercise – Helicopter (TRACKEX-Helo)	TMAA	N/A	22	44	✓	✓	✓		✓	✓
ASW Tracking Exercise – Maritime Patrol Aircraft (TRACKEX-MPA)	TMAA	N/A	13	26	✓	✓	✓		✓	✓
ASW Tracking Exercise - Extended Echo Ranging (EER) (Includes IEER and AEER)	TMAA	N/A	2	4		✓	✓		✓	✓
ASW Tracking Exercise - Surface Ship (TRACKEX-Surface)	TMAA	N/A	2	3	✓		✓			✓
ASW Tracking Exercise – Submarine (TRACKEX-Sub)	TMAA	N/A	2	3	✓	✓	✓			✓
Electronic Combat (EC)										
Electronic Combat (EC) Exercises	TMAA, Air Force SUA	4	5	10	✓	✓				✓
Chaff Exercise (CHAFFEX)	TMAA, Air Force SUA	2	2	4	✓	✓				✓
Counter Targeting Exercises	TMAA	4	4	8	✓	✓				
Naval Special Warfare (NSW)										
Special Warfare Operations	TMAA, Air Force SUA, Army Ranges	10	10	20	✓	✓		**N/A**		**N/A**

Table 3-1: Summary of Potential Stressors (continued)

		Number of Activities			Stressors					
Warfare Area and Activity	**Training Area(s)**	**No Action Alternative**	**Alternative 1**	**Alternative 2**	**Vessel Movements**	**Aircraft Overflights**	**SONAR**	**Weapons Firing/Non-Explosive Practice Ordnance**	**High-Explosive Ordnance**	**Expended Materials**
Strike Warfare										
Air-to-Ground Bombing Exercise (A-G BOMBEX)	Air Force SUA, Army Ranges	150	150	300		**N/A**		**N/A**	**N/A**	**N/A**
Personnel Recovery (PR)	TMAA, Air Force SUA, Army Ranges	3	4	8	✓	✓				
Support Operations										
Deck Landing Qualifications (DLQs)	ATA	4	6	12	✓	✓				

Note: N/A – Not Applicable because activity and stressors have been analyzed in previous environmental documents by the United States Air Force and/or the United States Army.

Table 3-2 shows the relationships between stressors and the physical and biological resources that are evaluated in this EIS/OEIS. These tables provide the organizational framework for the description of environmental impacts presented in the following sections.

Table 3-2: Physical and Biological Resources That Could Be Affected by Stressors Associated with the Alternatives

Potential Stressor	Water Resources	Marine Plants and Invertebrates	Marine Mammals	Sea Turtles	Fish and EFH	Birds
Vessel Movements						
Vessel Disturbance		✓	✓	✓	✓	✓
Vessel Collisions		✓	✓	✓	✓	✓
Aircraft Overflights						
Aircraft Disturbance			✓	✓	✓	✓
Aircraft Strikes						✓
SONAR						
Mid- and High-Frequency Sonar			✓	✓	✓	
Weapons Firing/Nonexplosive Practice Ordnance						
Weapons Firing Disturbance			✓	✓	✓	✓
Nonexplosive Ordnance Strikes		✓	✓	✓	✓	✓
Nonexplosive Ordnance Disturbance		✓	✓	✓	✓	✓
High Explosive Ordnance						
Underwater Detonations	✓	✓	✓	✓	✓	✓
Explosive Ordnance		✓	✓	✓	✓	✓
Expended Materials						
Ordnance-Related Materials	✓	✓	✓	✓	✓	
MK-58 Marine Markers			✓	✓	✓	✓
Target Related Materials		✓	✓	✓	✓	✓
Expendable Mobile ASW Training Targets		✓	✓	✓	✓	
Sonobuoys	✓	✓	✓	✓	✓	✓
Chaff	✓	✓	✓	✓	✓	✓
Flares	✓					

3.0.2 Data Sources

A systematic review of relevant literature, regulatory requirements, mitigation provisions, and data was conducted to complete the technical and compliance analysis for each resource category. Both published and unpublished documents were used, including journals, books, periodicals, bulletins, Department of Defense operations reports, theses, dissertations, endangered species recovery plans, species management plans, and other technical reports published by government agencies, private businesses, or consulting firms. The scientific literature was also consulted during the search for geographic location data (geographic coordinates) on the occurrence of marine resources within the GOA.

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3.1 AIR QUALITY

3.1.1 Affected Environment

For purposes of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the Region of Influence (ROI) for air quality includes the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA). Areas inland from the coastline, including United States (U.S.) Air Force (Air Force) air ranges and U.S. Army (Army) training lands, are addressed in the *Alaska Military Operations Areas EIS* (USAF 1995), *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999), and the *Transformation of U.S. Army Alaska Final EIS* (Army 2004).

3.1.1.1 Existing Conditions

Climate

The GOA has a typical maritime climate, being somewhat warmer than adjacent land areas in winter and somewhat cooler than these land areas in summer. The GOA is exposed to storms off the North Pacific Ocean. Consequently, it frequently experiences high winds and precipitation. Coastal southeastern Alaska adjoining the GOA is typically cool and cloudy, with frequent heavy precipitation. Even during the winter, most of the precipitation there falls as rain. The warmest weather is in June, July, and August.

Winds in the central GOA are primarily from the east or northeast, due to the interaction of the Pacific High with the GOA Low. Wind speeds often exceed 50 miles (mi) per hour (80 kilometers [km] per hour) except during the summer, when winds are relatively calm. Along the coast, this general circulation pattern may be altered locally by downslope surface winds following major river valleys that empty into the GOA, or by winds blowing through gaps in the ranges of mountains that border the GOA.

The continental climate in Alaska's interior, where Air Force air ranges and Army land ranges are located, is characterized by long, very cold winters and short, warm summers. The mean annual temperature in Fairbanks, for example, is 28 degrees Fahrenheit (°F) (-2 degrees Celsius [°C]). Daytime summer temperatures in the interior of Alaska are relatively high, in large part due to the long days, and rain showers are common. Most of southern Alaska, such as the Anchorage metropolitan area, has a climate intermediate between the continental climate of the interior and the maritime climate along the coast.

Regional Emissions

No stationary sources of air pollutant emissions exist within the GOA. Unknown quantities of air pollutants are emitted by commercial and recreational vessels operating in the GOA. Given the low population density of coastal areas in southeastern Alaska and prevailing wind directions, air pollutants generated in adjacent land areas likely have little or no effect on air quality in the GOA.

In mainland Alaska, the Anchorage, Fairbanks, and Juneau urban areas are large area sources of air pollutants, but these pollutants readily disperse during warm weather. In winter, when ground-based inversions are common, air pollutants from urban sources such as wood-burning stoves and automobiles become concentrated near the ground, where their concentrations may exceed health-based air quality standards. In rural areas, mining, oil extraction and refining, timber harvesting and processing, and other extractive industries are major point sources of air pollutants, as are large wildfires.

Existing Air Quality

The temporary boundaries of the TMAA form a rough rectangle oriented from northwest to southeast, approximately 300 nautical miles (nm) (556 km) long by 150 nm (278 km) wide, situated south of Prince

William Sound and east of Kodiak Island. The TMAA is 42,146 square nautical miles (nm^2) (144,556 square kilometers [km^2]) in area.

With the exception of Cape Cleare on Montague Island, located over 12 nm (22 km) from the northern edge of the TMAA, the nearest shoreline (Kenai Peninsula) is located approximately 24 nm (44 km) north of the TMAA's northern boundary. The approximate middle of the TMAA is located 140 nm (259 km) offshore. Therefore, air quality in the TMAA is not monitored. However, the GOA is well ventilated by air masses moving in from the North Pacific Ocean. There are no substantial sources of air pollutants in the GOA, and the frequent precipitation probably scavenges from the air any particulates or other pollutants that might be present. Therefore, the air quality in the GOA is expected to be very good.

Alaskan lands in the study area also should have generally good air quality because there are few industries or urban areas to generate criteria air pollutants. The State is divided into the Cook Inlet, North Alaska, South-Central Alaska, and Southeastern Alaska Intrastate Air Quality Control Regions (40 Code of Federal Regulations [C.F.R.], Part 81). The only portions of the State where air quality is regularly monitored, however, are the three major urban areas– Fairbanks, Anchorage, and Juneau. Monitoring data indicate that the two air pollutants of major concern in Alaska are carbon monoxide (CO) and particulate matter (PM).

In accordance with the federal Clean Air Act (CAA), the State of Alaska has adopted (and the U.S. Environmental Protection Agency [USEPA] has generally approved) a State Implementation Plan (SIP) with provisions to maintain the air quality in attainment areas and to improve the air quality in nonattainment areas. The SIP, however, does not extend to portions of the State designated as Indian Country under federal law (18 United States Code [U.S.C.] 1151); these areas are administered directly by USEPA.

Air quality regions that do not meet the National Ambient Air Quality Standards (NAAQS) for a specific criteria air pollutant are designated as nonattainment areas under the CAA. Anchorage and Fairbanks were designated as nonattainment areas for CO in 1990, but in 2004 were redesignated as CO maintenance areas (Alaska Department of Environmental Conservation [ADEC] 2007). Eagle River, near Anchorage, and Juneau are designated as nonattainment areas for particulates under 10 microns (μm) (PM_{10}), but are in the process of being redesignated as maintenance areas for PM_{10} (ADEC 2009). Concentrations of fine particulates continue to be a concern in developed areas of the State (see below). All other portions of the State are in attainment of the NAAQS, or unclassifiable due to an absence of monitoring data.

USEPA recently updated the NAAQS for PM. USEPA retained the current 24-hour PM_{10} standard of 150 micrograms (μg)/cubic meter (m^3) and eliminated the annual PM_{10} standard. USEPA increased the stringency of the standard for particulates under 2.5 μm ($PM_{2.5}$) by lowering the previous 24-hour standard of 65 μg/m^3 to 35 μg/m^3. USEPA left the annual $PM_{2.5}$ standard of 15 μg/m^3 in place. Until USEPA revised the standard, Alaska had been in compliance with the $PM_{2.5}$ standard. $PM_{2.5}$ monitoring shows Fairbanks North Star Borough (FNSB) exceeding the more stringent revised $PM_{2.5}$ standard; in the future, FNSB will be in "nonattainment" status.

In December 2007, the State proposed to reclassify portions of FNSB and Juneau Borough (Mendenhall Valley) as nonattainment for $PM_{2.5}$, with respect to the 24-hour averaging period. USEPA, in turn, proposed designation of a larger area. USEPA and ADEC have since been negotiating the boundaries of $PM_{2.5}$ nonattainment areas for these two regions of the State. While the final boundaries are yet to be agreed upon, the potential exists for portions of Fort Wainwright (cantonment area, Yukon Training Area, and Tanana Flats Training Area) and portions of Eielson Air Force Base (main base and Eielson, Birch, and Yukon Military Operations Area [MOAs]) to be encompassed by the new boundaries of the FNSB $PM_{2.5}$ nonattainment area.

Sensitive Receptors

Air quality is an environmental concern primarily because it affects human health. A secondary concern is its potential effects on vegetation and wildlife. In addition, some air pollutants can damage structures, reduce visibility, or contribute to climate change. On the ocean ranges in the study area, the air pollutants generated by the Proposed Action would mostly affect marine biological resources. Crews of vessels and recreational users of the GOA could also be affected by air pollutants, but such individuals are expected to be few in number and the durations of substantial exposures to these pollutants very limited.

Climate Change

Global warming is the increase in the average temperature of the Earth's near-surface air and oceans since the mid-20th century. Global surface temperatures have increased by an average of about 0.74 °C or by about 1.3 °F during the last century (Intergovernmental Panel on Climate Change [IPCC] 2007). Climate change has been attributed to many factors, including increasing atmospheric concentrations of carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and other greenhouse gases (GHG). Most of the observed temperature increase since the mid-20th century is correlated with increasing concentrations of GHGs emitted by human activities, such as combustion of fossil fuels and deforestation (IPCC 2007).

The GHG effect is the process by which absorption and emission of radiation by gases in the atmosphere warm a planet's lower atmosphere and surface. GHGs are transparent to long-wave radiation from the sun; this radiation passes through the atmosphere with little absorption or reflection, and warms the earth's surface. GHGs trap short-wave (infrared) radiation emitted by the earth's surface, however, preventing it from dissipating into space and re-radiating it down to the surface of the earth. The existence of the greenhouse effect is not disputed. The issues are how the strength of the greenhouse effect changes with increases in the concentrations of GHGs in the atmosphere, and the relationships among natural sources and sinks of GHGs, human sources of GHGs, and atmospheric concentrations of GHGs.

CO_2 is the major GHG emitted by human activities, primarily from the combustion of fossil fuels such as coal, oil, and natural gas. Atmospheric concentrations of CO_2 have increased by 36% since the mid-1700s (EPA 2008). This level is much higher than at any time during the last 650,000 years (Neftel et al. 1985). Less direct geological evidence indicates that CO_2 values this high were last seen about 20 million years ago (Pearson and Palmer 2000). The burning of fossil fuel has produced about 75 percent of the increase in CO_2 from human activity over the past 20 years.

GHG emissions for a proposed action can be inventoried, based on methods prescribed by state and federal agencies. However, the specific contributions of a particular project to global or regional climate change generally cannot be identified based on existing scientific knowledge, because individual projects typically have a negligible effect. Also, climate processes are understood at only a general level. Cumulative effects on climate change are addressed in Chapter 4.

3.1.1.2 Current Requirements and Practices

Equipment used by military organizations within the GOA, including ships and other marine vessels, aircraft, and other equipment, are properly maintained in accordance with applicable Navy and Marine Corps requirements. Operating equipment meets federal and state emission standards, where applicable.

3.1.2 Environmental Consequences

As noted in Section 3.1.1, the ROI for air quality includes the TMAA. Navy training activities that occur within the Air Force inland Special Use Airspace and the Army inland training lands were evaluated under previous National Environmental Policy Act (NEPA) documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents are incorporated by reference. Environmental effects in the open ocean beyond the U.S. territorial seas (outside of 12 nm [22 km]) are analyzed in this EIS/OEIS pursuant to Executive Order (EO) 12114.

3.1.2.1 Previous Analyses

Impacts related to air quality were previously evaluated in Sections 3.9, 4.9, and Appendix K of the *Alaska Military Operations Areas EIS* (USAF 1995); Sections 3.2.4 and 4.0 of the *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007); Sections 3.2, 3.15, 4.2, and 4.15 of the *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999); and Sections 3.2 and 4.2 of the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

3.1.2.2 Regulatory Framework

By regulation, air quality is defined primarily by the ambient air concentrations of seven major air pollutants determined by USEPA to substantially affect the health or welfare of the general public. These "criteria pollutants" are CO, sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), suspended particulate matter less than or equal to 10 μm in diameter (PM_{10}), fine particulate matter less than or equal to 2.5 μm in diameter ($PM_{2.5}$), and lead. USEPA calls these pollutants "criteria" air pollutants because it regulates them by developing human health or environmental criteria (science-based guidelines) for setting permissible levels.

Ambient air quality is defined by the atmospheric concentrations of criteria air pollutants and other selected chemical compounds at particular locations determined to be generally representative of local or regional conditions. Lower ambient concentrations of these air pollutants indicate higher air quality. Ambient air quality data are generally reported as a mass per unit volume (e.g., $\mu g/m^3$ of air) or as a volume fraction (e.g., parts per million [ppm] by volume). USEPA has established NAAQS for these pollutants (Table 3.1-1). Areas that exceed a NAAQS are designated as "nonattainment" for that pollutant, while areas that are in compliance with a NAAQS are in "attainment" for that pollutant.

USEPA typically delegates the regulation of air quality to local air quality management agencies. The CAA also allows states to establish air quality standards more stringent than the NAAQS. The GOA is located offshore of the State of Alaska in USEPA Region 10; some elements of the Proposed Action occur within the State. Statutory authority for air quality regulation in Alaska is delegated to the Air and Water Quality Division of ADEC. State of Alaska air quality standards generally correspond to federal primary standards. Additional Alaska standards include a 1-hour O_3 standard and an annual PM_{10} standard (Table 3.1-1).

Areas in which ambient air concentrations of a pollutant exceed a NAAQS are designated as "nonattainment" for that pollutant. Nonattainment areas for some criteria pollutants are further classified, depending upon the severity of their air quality problem, to facilitate their management:

- Ozone – marginal, moderate, serious, severe, and extreme;
- Carbon Monoxide – moderate and serious;
- Particulate Matter – moderate and serious.

Nonattainment areas are required to develop and execute plans, known as SIPs, that demonstrate how the area will meet the NAAQS. Areas that have achieved attainment may be designated as "maintenance areas," which are subject to maintenance plans showing how the area will continue to meet federal air quality standards.

The ambient air quality levels measured at a particular location are determined by the interactions of pollutant emissions, chemical properties and reactions that occur in the atmosphere, and meteorology. Emission considerations include the types, amounts, and locations of pollutants emitted into the atmosphere. Chemical reactions can transform pollutant emissions into criteria pollutants. Meteorological considerations include wind and precipitation patterns affecting the distribution, dispersion, and removal of pollutant emissions.

Air pollutants or pollutant precursors are released into the atmosphere (emitted) by air pollutant sources. Pollutant emissions contribute to the ambient air concentrations of criteria pollutants, either by directly affecting the pollutants in the ambient air or by reacting in the atmosphere to form criteria pollutants. Pollutants such as CO, SO_2, lead, and some particulates that are released directly into the atmosphere by emission sources are primary pollutants. Criteria pollutants such as O_3, NO_2, and some particulates are secondary pollutants formed through atmospheric chemical reactions that are influenced by meteorology, ultraviolet light, and other atmospheric processes. Air pollutants that lead to formation of secondary pollutants are termed precursor pollutants.

Table 3.1-1: National and State of Alaska Ambient Air Quality Standards

Pollutant	Averaging Period	NAAQS		Alaska State Standard
		Primary	Secondary	
Ozone (O_3)	1-Hour		Same as Primary Standard	235 μg/m^3
	8-Hour	0.075 ppm (157 μg/m^3)		
Carbon Monoxide (CO)	8-Hour	9.0 ppm (10 milligrams (mg)/m^3)	None	10 mg/m^3
	1-Hour	35 ppm (40 mg/m^3)		40 mg/m^3
Nitrogen Dioxide (NO_2)	Annual Average	0.053 ppm (100 μg/m^3)	Same as Primary Standard	100 μg/m^3
Sulfur Dioxide (SO_2)	Annual Average	80 μg/m^3 (0.03 ppm)	-	80 μg/m^3 (0.03 ppm)
	24-Hour	365 μg/m^3 (0.14 ppm)	-	365 μg/m^3 (0.14 ppm)
	3-Hour	-	1,300 μg/m^3 (0.5 ppm)	1,300 μg/m^3 (0.5 ppm)
Suspended Particulate Matter (PM_{10})	24-Hour	150 μg/m^3	Same as Primary Standard	150 μg/m^3
	Annual Arithmetic Mean	-		50 μg/m^3
Fine Particulate Matter ($PM_{2.5}$)	24-Hour	35 μg/m^3	Same as Primary Standard	35 μg/m^3
	Annual Arithmetic Mean	15 μg/m^3		15 μg/m^3
Lead (Pb)	Calendar Quarter	1.5 μg/m^3	Same as Primary Standard	1.5 μg/m^3

The following notes apply.

NAAQS (other than O_3, particulate matter, and those based on annual averages or annual arithmetic mean) are not to be exceeded more than once a year. The O_3 standard is attained when the fourth highest 8-hour concentration in a year, averaged over 3 years, is equal to or less than the standard. For PM_{10}, the 24-hour standard is attained when 99 percent of the daily concentrations, averaged over 3 years, are equal to or less than the standard. For $PM_{2.5}$, the 24-hour standard is attained when 98 percent of the daily concentrations, averaged over 3 years, are equal to or less than the standard. There are both primary and secondary NAAQS:

National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health.

National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

Source: 40 C.F.R. Part 50; 18 Alaska Administrative Code, Section 50.010, Ambient Air Quality Standards.

For example, reactive organic gases (ROG) and oxides of nitrogen (NO_x) are precursors of O_3. In general, emissions of precursors are monitored and regulated to control the ambient levels of their associated criteria pollutants. PM_{10} and $PM_{2.5}$ are primary pollutants emitted by various mechanical processes (e.g., abrasion, erosion, mixing, or atomization) or combustion processes. PM_{10} and $PM_{2.5}$ also can be formed as secondary pollutants by chemical reactions or by condensation of gaseous pollutants into fine aerosols.

Noncriteria air pollutants that can affect human health are categorized as hazardous air pollutants (HAPs) under Section 112 of the CAA. USEPA has identified 188 HAPs. Examples of HAPs include benzene, which is found in gasoline; perchloroethylene, which is emitted from some dry cleaning facilities; and methylene chloride, which is used as a solvent and paint stripper in some industries. HAPs are regulated under the CAA's National Emission Standards for Hazardous Air Pollutants, which apply to specific sources of HAPs, and under the Urban Air Toxics Strategy, which applies to area sources.

3.1.2.3 Approach to Analysis

The air quality impact evaluation requires two separate analyses. Effects of air pollutants emitted by Navy training in the GOA in U.S. territorial seas (i.e., within 12 nm [22 km] of the coast) are assessed under NEPA. Environmental effects of air pollutants emitted by Navy training activities outside of U.S. territorial seas in the GOA (namely those that occur in the TMAA) are evaluated under EO 12114. Waters within 3 nm (5.6 km) of the State are within the jurisdiction of the ADEC; portions of the GOA that lie more than 3 nm (5.6 km) from the coastline are not in any State air quality jurisdiction.

For assessing health-based air quality effects under NEPA, all training activities where aircraft, missiles, or targets operate at or below 3,000 feet (ft) (914 meters [m]) above ground level (AGL) or that involve vessels in U.S. territorial seas were included in the emissions estimates. For assessing health-based air quality effects under EO 12114, only those training activities where aircraft, missiles, or targets operate at or below 3,000 ft (914 m) AGL or that involve vessels outside of U.S. territorial seas were considered in the evaluation. Emissions that do or would occur above 3,000 ft (914 m) AGL are considered to be above the atmospheric inversion layer and, therefore, have no effect on air quality at the earth's surface (USEPA 1995, USEPA 1992). Because the only elements of Navy training in the GOA that occur within 12 nm (22 km) of the coast are aircraft overflights above 3,000 ft (914 m) AGL, a detailed air quality analysis was prepared only for EO 12114 compliance. For assessing effects on global climate change, however, all emissions of GHG from aircraft and vessel activities in the GOA were included because GHG emissions at altitudes above 3,000 ft AGL do have an effect.

The air quality analysis involves estimating the amounts of criteria air pollutants and HAPs emitted by the proposed activities and assessing their potential impacts on air quality. Trace amounts of HAPs would be emitted by combustion sources and ordnance. Potentially hazardous air pollutants, such as rocket motor exhaust and unspent missile fuel vapors, are emitted during missile and target operations. These pollutants would have no adverse effects because of their negligible emissions rates and their distance from potentially sensitive receptors. A quantitative evaluation of HAP emissions is thus not warranted.

The Proposed Action does not include training activities in nonattainment areas, so CAA General Conformity Analysis pursuant to the General Conformity Rule (40 C.F.R. Part 93, Subpart B) is not required. In addition, the General Conformity Rule does not apply to activities outside of U.S. territorial seas because the CAA does not apply to actions outside of the United States. The estimation of pollutants and assessment of potential effects on air quality outside of U.S. territorial seas is performed through the EO-compliant analysis.

Data for the air quality analysis are based, wherever possible, on information from the GOA participants and training requirements. These data were used to estimate the numbers and types of aircraft, surface ships and vessels, submarines, and ordnance that would be involved in training activities under each alternative. Each of these project elements is a potential source of air emissions. Emissions sources and the approach used to estimate emissions under the No Action Alternative (baseline), Alternative 1, and Alternative 2 are presented below.

Emissions Estimates

Aircraft Activities

To estimate aircraft emissions, the operating modes, number of hours of operation, and type of engine for each type of aircraft were evaluated. Aircraft flights are assumed to originate from aircraft carriers offshore. All aircraft are assumed to travel to and from training ranges at or above 3,000 ft (914 m) AGL and, therefore, their transits to and from the ranges do not affect surface air quality. Air Combat Maneuvers (ACM) and Air-to-Air Missile Exercise (A-A MISSILEX) are conducted at altitudes well in excess of 3,000 ft (914 m) AGL and, therefore, are not included in the estimated emissions of criteria air pollutants. All other training activities (Table 3.1-2) are included in the emissions estimates.

The types of aircraft used and the numbers of sorties flown under the No Action Alternative, which include both Navy and U.S. Air Force aircraft, are derived from historical data. For Alternatives 1 and 2, estimates of future aircraft sorties were based on evolutionary changes in the Navy’s force structure and mission assignments. Where there were no major changes in types of aircraft, future activity levels were estimated from the distribution of baseline activities.

Time on range (activity duration) under the No Action Alternative was calculated from average times derived from range records. To estimate time on range for each aircraft activity in Alternatives 1 and 2, an average duration was extrapolated from the baseline data. Estimated altitudes of activities for all aircraft were obtained from aircrew members in operational squadrons.

Air pollutant emissions were estimated based on the Navy’s Aircraft Environmental Support Office (AESO) Memorandum Reports for individual aircraft categories (Aircraft Emission Estimates: Mission Operations). For aircraft for which AESO emission factors were not available (such as the Learjet aircraft), emission factors were obtained from other published sources.

Surface Ship Activities

Marine vessel traffic in the TMAA includes military ship and boat traffic, including support vessels providing services for military training activities. A number of non-military commercial vessels and recreational vessels also are regularly present in the GOA. These vessels were not evaluated in the air quality analysis because they are not part of the Navy’s Proposed Action. The methods for estimating marine vessel emissions involve evaluating the type of activity, the number of hours of operation, the type of propulsion, and the type of onboard generator for each vessel type.

The types of surface ships and numbers of operations for the No Action Alternative are derived from participant data. For Alternatives 1 and 2, estimates of future ship activities were based on anticipated evolutionary changes in the Navy’s force structure and mission assignments. Where there were no major changes in types of ships, estimates of future activities were based on the historical distribution of ship operations.

For surface ships, the durations of activities were estimated by taking an average over the total number of activities for each type of training. Emissions for baseline activities and for future activities were estimated on the basis of discussions with exercise participants. In addition, information provided by participants was used to develop a breakdown of time spent at each power level used during activities in which marine vessels participated.

Table 3.1-2: Emission Sources by Training Activity

Training Activity	Emissions Source			
	Aircraft	Vessel	Ordnance	Target/ Flare
Anti-Air Warfare (AAW)				
1 - Aircraft Combat Maneuvers (ACM)	X			
2 - Air Defense Exercise (ADEX)	X	X		
3- Surface-to-Air (S-A) Missile Exercise (MISSILEX)		X	X	X
4 - Surface-to-Air Gunnery Exercise (GUNEX)		X	X	X
5 - Air-to-Air MISSILEX	X		X	X
Anti-Surface Warfare (ASUW)				
6 - Visit, Board Search and Seizure (VBSS)	X	X		
7 - Air-to-Surface MISSILEX	X			
8 - Air-to-Surface Bombing Exercise (BOMBEX)	X		X	X
9 - Air-to-Surface GUNEX	X		X	X
10 - Surface-to-Surface GUNEX		X	X	X
11 - Maritime Interdiction (MI)	X	X		
12 - Sea Surface Control (SSC)	X	X		
13 – Sinking Exercise (SINKEX)	X	X	X	X
Anti-Submarine Warfare(ASW)				
14 - ASW Tracking Exercise (TRACKEX) - Helicopter	X			X
15 - ASW TRACKEX – Marine Patrol Aircraft (MPA)	X			X
16 - ASW TRACKEX- Extended Echo Ranging (EER)	X			X
17 - ASW TRACKEX - Surface Ship		X		X
18 - ASW TRACKEX - Submarine		X		X
Electronic Combat (EC)				
19 - EC Exercises	X	X		
20 - Chaff Exercises	X	X		X
21 - Counter-Targeting Exercises	X	X		
Naval Special Warfare (NSW)				
22 - NSW Training	X	X		
Strike Warfare (STW)				
23 - Air-to-Ground BOMBEX	X		X	X
24 - Personnel Recovery (PR)	X	X		X
Support Operations				
25 - Deck Landing Qualifications (DLQ)	X	X		

Emission factors for marine vessels were obtained from the database developed for Naval Sea Systems Command (NAVSEA) by JJMA Consultants (JJMA 2001). Emission factors were provided for each marine vessel type and operational mode (i.e., power level). The resulting calculations provided information on the time spent at each power level in each part of the TMAA, emission factors for that power level (in pounds [lb] of pollutant per hour), and total emissions for each marine vessel for each operational type and mode.

Submarine Activities

No U.S. submarines burn fossil fuel under normal operating conditions, so no air pollutants are emitted by their training activities.

Naval Gunfire and Missile Ordnance

Naval gunfire, missiles, bombs, and other types of ordnance used in training activities emit air pollutants. To estimate the amounts of air pollutants emitted by ordnance during its use, the numbers and types of ordnance used in each training activity were first totaled. Then generally accepted emissions factors for criteria air pollutants were applied to the total amounts. Finally, the total amounts of air pollutants emitted by each ordnance type were summed to produce total amounts of each criteria air pollutant under each alternative.

Summary of Proposed Action Emission Sources

Table 3.1-2 identifies potential sources of air pollutants for training activities included in the Proposed Action.

3.1.2.4 No Action Alternative

Criteria Air Pollutants

Table 3.1-3 lists criteria air pollutant and precursor emissions in the TMAA by general source category under the No Action Alternative. The air pollutant emitted in the greatest quantity is CO; most of the CO emitted under the No Action Alternative is from Air-to-Surface BOMBEX. Most of the NO_x emissions are from vessel and aircraft activities.

Table 3.1-3: Annual Air Pollutant Emissions under the No Action Alternative

Emission Source	Emissions, tons/year				
	CO	NO_x	HC	SO_x	PM_{10}
Aircraft	3.4	4.2	0.3	0.2	2.7
Marine Vessel	11.3	8.0	1.2	5.9	1.1
Ordnance	1.5	0.0	0.0	0.0	0.0
Total	**16.2**	**12.2**	**1.5**	**6.1**	**3.8**

Notes: HC=hydrocarbons

Under the No Action Alternative, the annual numbers of Navy training activities in the TMAA will remain at baseline levels. Emissions rates will remain constant for those pollutant sources that are not affected by other federal, state, or local requirements to reduce air emissions. Pollutants emitted in the TMAA may be transported ashore, possibly affecting air basins in southern and southeastern Alaska. The contributions of air pollutants generated in the TMAA to the air quality in Alaskan air basins are minor compared to the contributions of existing onshore emission sources because of the distances these offshore pollutants are transported and their substantial dispersion during transport.

Table 3.1-3 shows the total amounts of regulated air pollutants under the No Action Alternative generated by Navy training activities in the TMAA. Considering the low level of air pollutants emitted under the No Action Alternative and the pollutant dispersion that normally occurs during long-range transport, these sources will not substantially affect air quality in the closest State of Alaska air basins. Ambient concentrations of criteria air pollutants in Alaskan air basins will not change under the No Action Alternative.

Hazardous Air Pollutants

The USEPA has listed 188 HAPs that are regulated under Title III (Hazardous Air Pollutants), Section 112(g) of the CAA. HAPs are emitted by several processes associated with the No Action Alternative, including fuel combustion and ordnance detonations. Trace amounts of HAPs are emitted by combustion sources participating in GOA training activities, including aircraft, marine vessels, ground vehicles, ground support equipment, and ordnance. The amounts of HAPs emitted are small compared to the emissions of criteria pollutants; emission factors for most HAPs from combustion sources are roughly three or more orders of magnitude lower than emission factors for criteria pollutants (California Air Resource Board 2007). Emissions of HAPs from ordnance use are smaller still, with emission factors ranging from roughly 10^{-5} to 10^{-15} lb of individual HAP per item for cartridges to 10^{-4} to 10^{-13} lb of individual HAPs per item for mines and smoke canisters (USEPA 2006). The amounts of HAP emissions are roughly proportional to the amounts of criteria air pollutants emitted.

HAP emissions will be distributed over the entire range, and their concentrations will be further reduced by atmospheric mixing and other dispersion processes. Most of the training activities will occur 12 nm (22 km) or more offshore, where no sensitive receptors (i.e., residents, schools, hospitals, etc.) are located, so no health effects are anticipated from emissions of HAPs in the TMAA. Therefore, HAP emissions for the Proposed Action will not be quantitatively estimated in this EIS.

3.1.2.5 Alternative 1

Criteria Air Pollutants

Table 3.1-4 lists the estimated criteria air pollutant and precursor emissions in the TMAA under Alternative 1 by general source category. The air pollutant that would be emitted in the greatest quantity is CO; most of the CO emitted under Alternative 1 would be from Air-to-Surface BOMBEX. Most of the NO_x emissions would be from vessel and aircraft activities. Other than CO from live bombs, ordnance would be an insignificant source of air pollutants.

Table 3.1-4: Annual Air Pollutant Emissions under Alternative 1

Emission Source	Emissions, tons/year				
	CO	NO_x	HC	SO_x	PM_{10}
Aircraft	4.1	6.4	0.4	0.4	3.9
Marine Vessel	12.4	8.8	1.3	6.3	1.2
Ordnance	2.2	0.0	0.0	0.0	0.0
Total	**18.7**	**15.2**	**1.7**	**6.7**	**5.1**
Increase Over No Action Alternative	**2.5**	**3.0**	**0.2**	**0.6**	**1.3**

Under Alternative 1, the annual numbers of various Navy training activities in the TMAA would increase by about 12 percent. Criteria air pollutants would increase slightly, with the largest increases in emissions of CO (2.5 tons per year [TPY]) and NO_x (3.0 TPY). Pollutants emitted in the TMAA may be transported ashore, possibly affecting air basins in southern and southeastern Alaska. The contributions of air pollutants generated in the TMAA to the air quality in terrestrial air basins are minor, however, compared to the contributions of existing onshore emission sources because of the distances these offshore pollutants are transported and their substantial dispersion during transport.

Considering the low level of air pollutants emitted under Alternative 1 and the pollutant dispersion that normally occurs during long-range transport, these sources will not substantially affect the State's air quality. Ambient concentrations of criteria air pollutants in Alaskan air basins will not change under Alternative 1.

Hazardous Air Pollutants

Trace amounts of HAPs are emitted from sources participating in Alternative 1 activities, including aircraft, marine vessels, and ordnance. As noted for the No Action Alternative in Section 3.1.2.4, HAP emissions are not quantitatively estimated, but the increase in HAP emissions under Alternative 1 would be roughly proportional to the increase in emissions of criteria air pollutants. Therefore, the amounts that would be emitted as a result of Alternative 1 activities would be somewhat greater than those emitted under the No Action Alternative, but would remain very small compared to the emissions of criteria air pollutants.

HAP emissions will be distributed over the entire range, would rapidly disperse, and would be diluted through mixing in the atmosphere to a much lower ambient concentration. Most of the training activities would occur 12 nm (22 km) or more offshore, where no sensitive receptors (i.e., residents, schools, hospitals, etc.) are located, so no health effects would result from emissions of HAPs in the TMAA under Alternative 1.

Summary

Training activities in the TMAA under Alternative 1 would emit air pollutants for a few weeks per year. Air pollutant emissions under Alternative 1 would increase relative to the baseline (No Action Alternative) emissions. Air pollutant emissions from training activities would be released to the environment in a remote area with good ventilation and few existing sources of air pollutants. Training emissions would be rapidly dispersed over a large ocean area where few individuals would be exposed to them. Residual air pollutant effects during the large portion of the year when training was not being conducted would be negligible. Based on the estimated levels of air pollutant emissions presented in Table 3.1-4, no substantial air pollutant effects are expected under Alternative 1.

3.1.2.6 Alternative 2

Criteria Air Pollutants

Under Alternative 2, the annual numbers of various Navy training activities in the TMAA would increase by about 123 percent from No Action Alternative (baseline) levels. Air pollutant emissions rates also would increase substantially, relative to emissions under the No Action Alternative. Table 3.1-5 lists the estimated criteria air pollutant and precursor emissions in the TMAA by general source category under Alternative 2. The air pollutant that would be emitted in the greatest quantity is CO (27.4 TPY). Most of the CO emitted under Alternative 1 would be from Air-to-Surface BOMBEX, the annual number of which would double under Alternative 2. Under Alternative 2, CO emissions from vessel and aircraft operations in the open ocean (more than 12 nm [22 km] from land) also would substantially increase. Most of the NO_x emissions (22.6 TPY) would be from vessel and aircraft activities, and these emissions also would substantially increase relative to baseline emissions. Other than CO from live bombs, ordnance would be an insignificant source of air pollutants.

Table 3.1-5: Annual Air Pollutant Emissions under Alternative 2

Emission Source	Emissions, tons/year				
	CO	NO_x	HC	SO_x	PM_{10}
Aircraft Operations	8.0	12.5	0.9	0.7	7.6
Marine Vessel Operations	24.8	17.5	2.5	12.3	2.3
Ordnance	4.5	0.0	0.0	0.0	0.0
SINKEX	6.3	4.8	0.5	1.2	0.9
Total	**43.6**	**34.8**	**3.9**	**14.2**	**10.8**
Increase Over No Action Alternative	**27.4**	**22.6**	**2.4**	**8.1**	**7.0**

Pollutants emitted in the TMAA may be transported ashore, possibly affecting air basins in southern and southeastern Alaska. The contributions of air pollutants generated in the TMAA to the air quality in terrestrial air basins are minor, however, compared to contributions from existing onshore emission sources because of the distances these offshore pollutants are transported and their substantial dispersion during transport.

The criteria air pollutants emitted under Alternative 2 would be distributed over a large, well-ventilated area, where their effects on ambient air pollutant concentrations would be minor. Due to the air pollutant dispersion that normally occurs during long-range transport, these sources will not substantially affect the State's air quality. Ambient concentrations of criteria air pollutants in Alaskan air basins will not change under Alternative 2.

Hazardous Air Pollutants

Trace amounts of HAPs are emitted from sources participating in Alternative 2 activities, including aircraft, marine vessels, and ordnance. As noted for the No Action Alternative in Section 3.1.2.4, HAP emissions are not quantitatively estimated, but the increase in HAP emissions under Alternative 2 would be roughly proportional to the increase in emissions of criteria air pollutants. Therefore, the amounts emitted as a result of Alternative 2 activities would be substantially greater than those emitted under the No Action Alternative, but would remain small compared to the estimated emissions of criteria air pollutants under Alternative 2.

HAP emissions will be distributed over the entire range, would rapidly disperse, and would be diluted through mixing in the atmosphere to a much lower ambient concentration. Most of the training activities would occur 12 nm (22 km) or more offshore, where no sensitive receptors (i.e., residents, schools, hospitals, etc.) are located, so no health effects would result from emissions of HAPs in the TMAA under Alternative 1.

SINKEX

Alternative 2 would include SINKEX, in which several aircraft and vessels fire various types of ordnance at a ship hulk until it sinks. Estimated criteria air pollutant emissions from this activity are shown in Table 3.1-5. SINKEX would generate a substantial portion of the total air pollutants emitted under Alternative 2.

Summary

Training activities in the TMAA under Alternative 2 would emit air pollutants for a few weeks per year. The increase in air pollutant emissions under Alternative 2 would represent a substantial increase in air pollutant emissions relative to the baseline (No Action Alternative) emissions. Air pollutant emissions from training activities would be released to the environment in a remote area with good ventilation and few other existing sources of air pollutants. Training emissions would be rapidly dispersed over a large ocean area where few individuals would be exposed to them. Residual air pollutant effects during the large portion of the year when training was not being conducted would be negligible. Based on the estimated levels of air pollutant emissions presented in Table 3.1-5, no substantial air pollutant effects are expected under Alternative 2.

3.1.3 Mitigation

As described in Sections 3.1.2.4 to 3.1.2.6, annual emissions of criteria and hazardous air pollutants produced by the Proposed Action are well below a level that could degrade regional air quality. Therefore, no mitigation measures are required to reduce the impacts on the environment of air emissions from the Proposed Action.

3.1.4 Summary of Effects

Table 3.1-6 summarizes the effects of the No Action Alternative, Alternative 1, and Alternative 2 on air quality under both NEPA and EO 12114.

Table 3.1-6: Summary of Effects by Alternative

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
No Action Alternative	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to air quality would occur. • Overflights of ocean (0-12 nm) and land areas at altitudes above 3,000 ft AGL would not affect ground-level air quality.	• The No Action Alternative would maintain training activities and associated air pollutant emissions at baseline levels outside of U.S. territory.
Alternative 1	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to air quality would occur. • Overflights of ocean (0-12 nm) and land areas at altitudes above 3,000 ft AGL would not affect ground-level air quality.	• Outside of U.S. territory, air pollutant emissions would increase slightly, mainly from increased surface vessel and aircraft activities. • Although Alternative 1 would increase emissions of air pollutants over the No Action Alternative, emissions outside of U.S. territorial seas would not cause an air quality standard to be exceeded.

Table 3.1-6: Summary of Effects by Alternative (continued)

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
Alternative 2 (Preferred Alternative)	• Under Alternative 2, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to air quality would occur. • Overflights of ocean (0-12 nm) and land areas at altitudes above 3,000 ft AGL would not affect ground-level air quality.	• Outside of U.S. territory, air pollutant emissions would increase substantially, mainly from increased surface vessel and aircraft activities. • SINKEX would generate a substantial portion of the air pollutants that would be emitted under Alternative 2. • Although Alternative 2 would increase emissions of air pollutants over the No Action Alternative, emissions outside of U.S. territorial seas would not cause an air quality standard to be exceeded.

3.2 EXPENDED MATERIALS

3.2.1 Affected Environment

For purposes of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the Region of Influence (ROI) for expended materials is the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA). With the exception of Cape Cleare on Montague Island located over 12 nautical miles (nm) (22 kilometers [km]) from the northern point of the TMAA, the nearest shoreline (Kenai Peninsula) is located approximately 24 nm (44 km) north of the TMAA's northern boundary. The approximate middle of the TMAA is located 140 nm offshore. Areas inland from the coastline, including United States (U.S.) Air Force (Air Force) air ranges and U.S. Army (Army) training lands, are addressed in the *Alaska Military Operations Areas EIS* (USAF 1995), *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999) and the *Transformation of U.S. Army Alaska FEIS* (Army 2004). These documents analyzed Navy training activities in the inland GOA training lands, and provide analyses of baseline conditions and future levels of training activities. Training activities on the inland training lands under the No Action Alternative, Alternative 1, and Alternative 2 for this EIS are within the scope of those estimates.

3.2.1.1 Expended Materials

This section addresses expended materials, both hazardous and nonhazardous, that result from Navy training activities in the TMAA. Definitions in this section are not based on a specific regulation, such as the Resource Conservation and Recovery Act (RCRA). For this analysis, definitions incorporate information from several environmental laws and regulations for hazardous materials. Hazardous materials addressed in this document are broadly defined as substances that pose a substantial hazard to human health or the environment by virtue of their chemical or biological properties. Hazardous materials may be solid, liquid, semi-solid, or gaseous materials that alone or in combination may 1) cause or contribute to an increase in mortality or illness; or 2) pose a substantial present or potential hazard to human health or the environment when improperly applied, handled, treated, stored, transported, or disposed. In general, the degree of hazard posed by these materials is related to their quantity, concentration, bioavailability, or physical state. Hazardous materials are regulated under a variety of federal and state laws (see Section 3.2.2, Environmental Consequences).

In this section, the phrase "hazardous materials" refers collectively to hazardous materials, hazardous wastes, and individual components and constituents of larger objects or processes (e.g., missile warheads and fuel) that may be hazardous. Hazardous materials often are used in small amounts in high-technology weapons, ordnance, and targets because they are strong, lightweight, reliable, long lasting, or low cost. For this analysis, hazardous constituents are defined as components of expended materials that may contain hazardous materials or substances. Nonhazardous expended materials are defined as parts of a device that are made of nontoxic metals (e.g., steel, iron, aluminum), polymers (e.g., nylon, rubber, vinyl, and various other plastics), glass, fiber, or concrete. Sources of these non-hazardous materials include bombs, shells, and targets. A portion of these non-hazardous items represent persistent seabed litter but, because of their strong resistance to degradation and their chemical composition, they do not chemically contaminate the surrounding environment by leaching heavy metals or organic compounds.

Open ocean areas are typically considered to be relatively pristine with regard to hazardous substances. Hazardous substances are anthropogenic sources of material that could negatively affect the marine and land environment, and organisms inhabiting those environments. Hazardous substances are present in varying concentrations in marine waters and sediments from past activities such as ocean dumping, military activities (e.g., bombing ranges during World War II), commercial activities, and chemical spills.

No information is available, however, on the types and quantities of hazardous substances present in the TMAA.

Table 3.2-1 provides information on the types of training items used in the TMAA that may contain hazardous constituents. All training materials listed therein will be used under the No Action Alternative, except for training materials used in Anti-Submarine Warfare (ASW) exercises. The potential environmental effects of expended Navy training materials are primarily associated with the toxicity of hazardous constituents to marine biota. Hazardous materials may be contained in several components of expended materials, including outer casings, propellants, batteries, explosives, and pyrotechnics.

Hazardous Materials

Heavy Metals

Some metals are necessary for biological organisms to function properly, such as iron, zinc, copper, and manganese in humans. Heavy metals commonly of concern include lead, cadmium, mercury, and chromium. Zinc, copper, and manganese also may be of concern when exposure levels are high. In the GOA study area, heavy metals are present in manned and unmanned aircraft, bombs, shells, missiles, bullets, sonobuoys, batteries, electronic components, and anticorrosion compounds coating exterior surfaces of ordnance, including missiles, small-caliber rounds, torpedoes, and bombs. Most of these materials are inert and dense, and will settle to the bottom. There they will eventually be covered by sediment, coated by chemical processes (e.g., corrosion), or encrusted by marine organisms (e.g., barnacles).

Propellants

Hazardous chemicals include fuels and other propellants, and combustion byproducts of those fuels and propellants. These materials are present or may be generated by the use of aircraft, vessels, ordnance, and unmanned aircraft. Toxic components of fuel oils include aromatic hydrocarbons, such as benzene, toluene, and xylene, and polycyclic aromatic hydrocarbons such as naphthalene, acenaphthene, and fluoranthene. Like commercial and recreational watercraft, boat engines discharge petroleum products in their wet exhaust.

In general, the single largest hazardous constituent of missiles is solid propellant, such as solid double-base propellant, aluminum and ammonia propellant grain, and arcite propellant grain. The solid propellant is primarily composed of rubber (polybutadiene) mixed with ammonium perchlorate. In general, a surface-to-air missile typically consumes 99 to 100 percent of its propellant when it functions properly (Department of the Navy [DoN] 2009). Hazardous constituents, such as plastic-bonded explosives (PBX) high-explosive (HE) components, PBX-106 explosive, and PBX (AF)-108 explosive, are also used in igniters, explosive bolts, batteries (potassium hydroxide and lithium chloride), and warheads.

Explosives

Explosives are used in live bombs, spotting charges for training rounds, missiles, and sonobuoys. Most new military explosives are mixtures of plastic or other polymer binders and Royal Demolition Explosive (RDX, cyclotrimethylene trinitramine) and High Melting Explosive (HMX, cyclotetramethylene tetranitramine). Pentaerythritoltetranitrate (PETN) is used in blasting caps, detonation cord, and similar initiators of explosions. When live ordnance functions properly, 99.997 percent of the explosives contained therein are converted to inorganic compounds (U.S. Army Corps of Engineers [USACE] 2003).

Explosives become a concern when ordnance does not function correctly, and fails to detonate (failure) or detonates incompletely (low-order detonation). In these cases, all or a portion of the explosive remains unconsumed. Table 3.2-2 provides the failure and low-order detonation rates of various ordnance items.

Table 3.2-1: Hazardous Constituents of Expendable Training Materials, by Training Item

Training Item		Hazardous Constituent				
		Heavy Metal	Propellant	Battery	Explosive	Pyrotechnic
Missiles	AIM-7 Sparrow missile	✓	✓	✓	✓	
	AIM-9 Sidewinder missile	✓	✓	✓	✓	
	AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM)	✓	✓	✓	✓	
	Standard Missile-1	✓	✓	✓	✓	
	AGM-65 Maverick	✓	✓	✓	✓	
	AGM-84 Harpoon	✓	✓	✓	✓	
	AGM-84K Standoff Land Attack Missile – Expanded Response (SLAM-ER)	✓	✓	✓	✓	
	AGM-88 High Speed Anti-Radiation Missile (HARM)					
	AGM-114 Hellfire	✓	✓	✓	✓	
	AGM-119 Penguin					
Bombs	BDU-45 Practice (inert)[2]	✓			✓	
	MK-82 500-pound (lb) bomb (192.2 Net Explosive Weight [NEW]), HE[3]	✓			✓	
	MK-83 1,000-lb bomb (415.8 NEW), HE[3]	✓			✓	
	MK-84 2,000-lb bomb (944.7 NEW), HE[3]	✓			✓	
Naval Gun Shells	5"/54-caliber (cal) gun shell (inert)	✓	✓			
	5"/54-cal gun shell (live)	✓	✓		✓	
	76- millimeter (mm) gun shell (inert)	✓	✓			
	76-mm gun shell (live)	✓	✓		✓	
	57-mm gun shell	✓	✓		✓	
	25-mm gun shell	✓				
	20-mm gun shell	✓				
Small Arms Rounds	0.50-cal machine gun	✓	✓			
	7.62-mm projectile	✓	✓			
Targets and Pyrotechnics	BQM-74E unmanned aerial target[5]	✓		✓		
	LUU-2B paraflare[1]	✓				✓
	MK-58 Marine Marker[1]	✓				✓
	MK-39 Expendable Mobile Anti-Submarine Warfare Training Target (EMATT)	✓		✓		
Sonobuoys	SSQ-36 Bathythermograph (BT)	✓		✓		
	SSQ-53 Directional Frequency Analysis and Recording (DIFAR)	✓		✓		
	SSQ-62 Directional Command Activated Sonobuoy System (DICASS)	✓		✓		
	SSQ-77 Vertical Line Array Directional Frequency Analysis and Recording (VLAD)	✓		✓		
	SSQ-110A Extended Echo Ranging (EER)	✓		✓	✓	
Torpedoes	MK-48 Advanced Capability (ADCAP) torpedo	✓	✓	✓	✓	
Chaff	ALE-43 Dispenser (Aluminized glass roll)[4]				✓	

Notes: (1) target not recovered, (2) may contain a spotting charge, (3) lb in terms of total weight, (4) chaff is deployed using an explosive charge, (5) target recovered. Training materials that do not contain hazardous materials are not included

Table 3.2-2: Failure and Low-Order Detonation Rates of Military Ordnance

Ordnance	Failure Rate (Percent)	Low-Order Detonation Rate (Percent)
Guns / artillery	4.68	0.16
Hand grenades	1.78	n/a
High-explosive ordnance	3.37	0.09
Rockets	3.84	n/a
Submunitions	8.23	n/a

Source: Rand 2005

These materials can release small amounts of hazardous substances into the water or sediment as they degrade and decompose. Table 3.2-3 provides a list of hazardous constituents typically present in components of expended training materials.

Table 3.2-3: Hazardous Constituents of Training Materials, by Component

Training Application/Ordnance Element	Hazardous Constituent
Casings, assemblies, projectiles	Chromium Lead Tungsten Nickel Cadmium
Pyrotechnics Tracers Spotting charges	Barium chromate Potassium perchlorate Chlorides Phosphorus Titanium compounds
Oxidizers	Lead oxide
Delay elements	Barium chromate Potassium perchlorate Lead chromate
Propellants	Ammonium perchlorate
Fuses	Potassium perchlorate
Detonators	Fulminate of mercury Potassium perchlorate
Primers	Lead azide

Source: USACE 2007

Pyrotechnics

Pyrotechnic materials are used in pyrotechnic devices such as flares and markers. Hazardous pyrotechnic materials include magnesium and white and red phosphorus, which do not explode, but burn at high temperatures once ignited. Metals such as barium, sodium, nickel, and titanium are often incorporated into pyrotechnic materials to produce specific visual characteristics, such as color, smoke, or both. Perchlorates may be used as oxidizers and to enhance the visual characteristics of the item. Residues from pyrotechnic items that function as designed include metallic compounds and residual perchlorate compounds. Pyrotechnic items also may include igniters and fuses.

Fates of Expended Materials

Expended training materials that come to rest on the ocean floor may:

1) Lodge in oxygen-poor sediments (DoN 2008c);
2) Remain on the ocean floor and corrode; or
3) Remain on the ocean floor and become encrusted by marine organisms.

Rates of deterioration depend on the material and on the conditions in the immediately surrounding marine and benthic environment. Materials buried deep in ocean sediments tend to decompose at much lower rates than when exposed to seawater. With the exception of sonobuoy parts (see Sonobuoys later in this section), sediment burial appears to be the fate of most ordnance used in marine warfare.

Metals exposed to seawater generally begin to oxidize (corrode). This process creates a layer of corroded material around the object. This corrosion layer isolates the parent material from the corrosive seawater, a process that further slows movement of the metals into the adjacent sediments and the water column. This process is particularly true of aluminum. In a similar fashion, as materials become covered by marine organisms, the direct exposure of the material to seawater decreases and the rate of corrosion decreases. Dispersal of these materials in the water column is controlled by physical mixing and diffusion, both of which tend to vary with time and location. A recent study of similar Canadian military operations in the Strait of Georgia found that few biological impacts resulted from ordnance and other materials expended during its operations (Canadian Forces Maritime Experimental and Test Ranges [CFMETR] 2005).

In general, ordnance constituents appear to pose little risk to the marine environment. Military-grade explosives generally have low water solubility, so they do not readily dissolve in water and are, therefore, relatively immobile in water (Table 3.2-4). The degradation and dissolution of these materials are slowed by the physical structure and composition of blended explosives, which contain several chemical compounds, often with additional binding agents. Ordnance constituents of concern include nitroaromatics—principally trinitrotoluene (TNT), its degradation products, and related compounds and cyclonitramines, including RDX, HMX, and their degradation products. TNT degrades to dinitrotoluene (DNT) and to subsequent degradation products by bacterial activity (biodegradation). RDX is subject to photolysis and biodegradation once exposed to the environment.

Table 3.2-4: Water Solubility of Common Explosives

Compound	Water Solubility*
Salt (sodium chloride) [for comparison]	357,000
Ammonium perchlorate	249,000
Picric acid	12,820
Nitrobenzene	1,900
Dinitrobenzene	500
Trinitrobenzene	335
DNT	160-161
TNT	130
Tetryl	51
PETN	43
RDX	38
HMX	7
White phosphorus	4

Note: * Units are milligrams per liter (mg/L) at 20 degrees Celsius.
Source: DoN 2009

Additional sources of hazardous materials are expended training materials that are not completely consumed during use, such as flares and pyrotechnics, and explosives that fail to function properly. Explosives, which are designed to be consumed during use, have a high potential of environmental contamination because duds and low-order detonations account for a large percentage of hazardous materials due to the amounts of explosives used. Ordnance failure or low-order detonation means that hazardous materials, such as propellants, explosives, and batteries, are present in greater quantities because substances are not consumed during use. Expended training materials from ordnance that functions as designed are primarily metal casings.

Bombs

Bombing exercises typically involve one or more aircraft bombing a target that simulates a hostile surface vessel at sea. Bomb casings are made of steel, with fins of steel or aluminum. Based on standards established by American Society for Testing and Materials International, each steel bomb body or fin also may contain small percentages of carbon, manganese, phosphorus, sulfur, copper, nickel, chromium, molybdenum, vanadium, columbium, or titanium, although typically present at less than 1 percent by weight. The aluminum fins may also contain zinc, magnesium, copper, chromium, manganese, silicon, or titanium (DoN 2009). Bombs may be live or inert (so-called “practice” or “bomb dummy units”). The latter are bomb bodies filled with an inert material (e.g., concrete) and configured to have the same weight, size, center of gravity, and ballistics as a live bomb.

The main hazardous component of expended bombs is residual explosives. Most of the residual explosives result from incomplete (low-order) detonations or complete failure of the item to detonate. High-order detonations generally consume an estimated 99.997 percent of the explosives (USACE 2003). Bombs that are fail to function (i.e., “duds”) deposit large amounts of unconsumed explosives. The estimated failure rate for high explosives under test conditions is 3.37 percent (see Table 3.2-2), but the failure rate during training typically is higher because of operator inexperience. Most inert bombs contain a spotting charge, which is a small amount of explosive (usually two to three pounds) used to identify the point of impact.

Missiles

Missiles are fired by aircraft and ships at a variety of airborne and surface targets. Table 3.2-5 describes the explosives and propellants used in the types of missiles that will be used in the TMAA under all of the alternatives. Missiles may contain hazardous materials as normal parts of their functional components, including igniters, explosive bolts, batteries, warheads, and solid propellants. Chemicals released during missile launches are provided in Table 3.2-6, along with their estimated maximum concentrations.

Table 3.2-5: Explosives and Propellants in Selected Missiles – No Action Alternative

Type of Missile	Type of Propellant
AIM-7 Sparrow	Propellant is dual-thrust, solid-fuel rocket motor (Hercules MK-58); warhead is an 88-lb. (40-kilogram [kg]) WDU-27/B blast-fragmentation device.
AIM-9 Sidewinder	Propulsion system contains up to 44 lb. (20 kg) of solid double-base propellant; warhead contains approximately 10 lb. (4.5 kg) of PBX HE.
AIM-120 AMRAAM	Propellant is solid-fuel rocket motor (ATK WPU-6B booster and sustainer with RS hydroxyl-terminated polybutadiene solid propellant fuel); warhead contains 40 lb. (18 kg) of HE.
RIM-67A Standard Missile-1	Propellant is a two-stage, solid-fuel rocket (MK-30 sustainer motor and a Hercules MK 12 booster); warhead contains 137 lb (62 kg) of HE.

Source: Global Security 2008f

Table 3.2-6: Chemical Compounds Associated with Missile Launches

Resource	Chemical Compound	Maximum Environmental Concentration (mg/m^3)
Air	Al_2O_3 – alumina	0.021
	CO – carbon monoxide	39.11
	HCl – hydrochloric acid	0.012
	NO_x – oxides of nitrogen	0.009
Water	Jet propulsion fuel, Type 8	0.023

Notes: (mg/m^3) = milligrams per cubic meter
Source: USAF 1999

In general, the single largest hazardous constituent of missiles is the solid propellant. Missile propellants typically contain ammonium perchlorate (NH_4ClO_4), aluminum compounds, copper, and organic lead compounds. A surface-to-air missile typically consumes 99 to 100 percent of its propellant when it functions properly (DoN 2009). The remaining solid propellant fragments (less than one percent of initial propellant weight) sink to the ocean floor and undergo physical and chemical changes in the presence of seawater. Tests show that water penetrates only 0.06 inch (in) (0.14 centimeter [cm]) into the propellant during the first 24 hours of immersion, and that fragments slowly release ammonium and perchlorate ions (Fournier 2005). These ions rapidly disperse into the surrounding seawater, so local concentrations are extremely low.

For example, a Standard Missile-1 typically has 150 lb (68 kg) of solid propellant, resulting in less than 1.5 lb (0.7 kg) of propellant residual after training exercises. Assuming that all of the propellant on the ocean floor was in the form of 4-in (10-cm) cubes, only 0.42 percent of it would be wetted during the first 24 hours of immersion. If all of the ammonium perchlorate leached out of the wetted propellant, then approximately 0.01 lb (0.003 kg) would enter the surrounding seawater (DoN 2009). The leach rate would decrease over time as the concentration of perchlorate in the propellant declined. The aluminum in the propellant binder would eventually be oxidized by seawater to aluminum oxide. The remaining binder material and aluminum oxide would not pose a threat to the marine environment.

During aviation exercises, approximately 50 percent of missiles contain telemetry warheads (inert versions), and do not explode on contact with the target or ocean surface. Exploding warheads may be used in air-to-air missile exercises but, to avoid damaging the aerial target, the missile explodes in the air, disintegrates, and falls into the ocean. Live missiles used in air-to-surface exercises explode near the water surface. An estimated 99.997 percent of this material would be consumed in a high-order detonation. Missiles that are duds contain large amounts of unconsumed explosives, which are considered to be hazardous. The estimated failure rate for missiles is approximately the same as for bombs (3.37 percent).

Missile batteries are another possible source of contaminants. The batteries used for missiles are similar in type and size to those used for sonobuoys. Possible hazardous materials in batteries are described later in this section under Sonobuoys.

Targets

At sea, targets are usually remotely operated aerial, surface, or subsurface units, most of which are recovered for reuse. Targets and countermeasures proposed for the GOA study area are described below.

Aerial Targets

Aerial targets are used in several training warfare areas, and include targets used for both simulated and live-fire exercises. Possible expended or unrecovered targets include LUU-2B/B paraflares, Tactical Air Launched Decoy (TALDs), and BQM-74Es. LUU-2B/B and TALD targets are not recovered after training use. BQM-74E targets are normally recovered after training, but some individual BQM-74E targets may not be recovered for various reasons.

The LUU-2B/B is a flare that illuminates targets by burning magnesium at high temperature while suspended from a parachute. The LUU-2B is constructed of aluminum, and weighs about 30 lb (DoN 2001c). The flare material and portions of the assembly are usually consumed during flight (DoN 2001c). Hazardous materials in pyrotechnic compositions are discussed later in this section under Flares.

The TALD is an air-launched, gliding vehicle that emits signals to confuse air defense systems during aircraft Strike Warfare training. It is constructed of aluminum, and weighs about 400 lb (Global Security 2008a). TALDs contain two 38-volt thermal batteries, which are lost after training use. Thermal batteries may contain hazardous components similar to lithium batteries, and are discussed later in this section under Sonobuoys.

The BQM-74E is a remote-controlled, subsonic, jet-powered aerial target that can be launched from the air or surface, and recovered on land or at sea. The target generates signals for tracking purposes. It is powered by a jet engine, and thus contains oils, hydraulic fluid, batteries, and explosive cartridges. (DoN 2001b). Hazardous materials in aerial targets are mostly consumed during training use, and BQM-74E targets are recovered after training exercises, to the maximum extent possible.

Surface Targets

Surface targets are used for Anti-Surface Warfare exercises. MK-58 marine markers are pyrotechnic devices dropped on the water's surface during training exercises to mark a position on the ocean surface, primarily for Bombing Exercises. The chemical flame of a marine marker burns like a flare, but also produces smoke. The MK-58 marine marker is a tin tube that weighs about four lb, and produces a yellow flame and white smoke for 10 to 20 minutes. It contains a red phosphorous compound that is ignited by a seawater-activated battery (DoN 1996a). MK-58 marine markers are not recovered because they are mostly consumed during use. Hazardous materials in pyrotechnic compositions are discussed later in this section under Flares. Other surface targets used during training exercises (Killer Tomatoes and Spar Buoys) do not contain hazardous materials or are recovered after training use, to the maximum extent possible.

Underwater Targets

The MK-39 EMATT is an air- or surface-launched unmanned target that maneuvers underwater in the ocean, and emits magnetic or acoustic signals that are monitored by aircraft and surface vessels for training (see Appendix H for physical description of EMATT). The duration of EMATT activity is about three hours, and EMATTs are not recovered after training use. EMATTs use lithium-sulfur dioxide batteries, which may contain hazardous materials. Each EMATT contains a battery pack consisting of 15 "DD" size lithium-sulfur dioxide batteries, weighing approximately 6.2 lb (2.83 kg) (Peed et al. 1988).

Lithium batteries consist of an exterior nickel-plated steel jacket, sulfur dioxide, lithium metal, carbon, acetonitrile, and lithium bromide (DoN 2008a). The chemical reaction that generates electricity proceeds nearly to completion once the cell is activated, so only limited amounts of reactants are present when the battery life terminates. Lithium and bromine naturally occur in seawater. Lithium metal is extremely reactive with water, resulting in an exothermic reaction that generates soluble hydrogen gas and lithium hydroxide. Hydrogen gas enters the atmosphere, while lithium hydroxide ultimately disassociates into lithium ions and water (DoN 2008a). Sulfur dioxide ionizes in water, forming bisulfite. Bisulfite is easily oxidized into sulfate, which is present in large quantities in the ocean.

An evaluation of lithium-sulfide dioxide batteries in the marine environment (CFMETR 2005) concluded that: "The standard lithium-sulfur dioxide battery theoretically presents little or no acute or chronic danger to the marine environment. The battery consists of seven material components, and each has been considered in terms of environmental exposure. In each case, it was determined that immersion in seawater would result in the formation of either water-soluble or chemically inert waste products. These will be infinitely dispersible and virtually unsusceptible to significant accumulation." The ocean currents would greatly diffuse concentrations of the chemicals leached by EMATT batteries within a short period. Therefore, lithium batteries would not be expected to substantially affect water quality because of the low amount of reactants remaining after use and the low concentration of leaching materials.

The implementation of a Portable Undersea Training Range (PUTR) would be included under Alternative 1 and Alternative 2. The PUTR is a portable system with the capability to score, track, and provide feedback on underwater events. The PUTR consists of seven electronics packages to be temporarily installed on the ocean floor via concrete anchors. While the electronics packages would be recovered upon completion of training exercises, the concrete anchors would remain on the ocean floor. Each anchor is approximately 1.5 feet (ft) by 1.5 ft (0.46 meter [m] by 0.46 m), and would weigh approximately 3,000 lb (1,364 kg). Anchors would be constructed of either concrete or sand bags. Concrete and sand would be relatively inert in the marine environment, and would be covered with sand or sediment over time.

Flares

Flares are used as targets or markers; the previous section on surface targets describes their use and composition. Hazardous constituents are typically present in pyrotechnic residues, but are bound up in relatively insoluble compounds. Solid flare and pyrotechnic residues may contain, depending on their purpose and color, an average weight of up to 0.85 lb (0.4 kg) of aluminum, magnesium, zinc, strontium, barium, cadmium, nickel, and perchlorates (DoN 2009). As inert, incombustible solids with low concentrations of leachable metals, these residues typically are not characterized as hazardous materials. The perchlorate compounds present in the residues are relatively soluble, albeit persistent in the environment, and probably disperse quickly.

Chaff

Radiofrequency chaff is an electronic countermeasure designed to reflect radar waves and obscure aircraft, ships, and other equipment from radar tracking sources. Chaff is released or dispensed from military vehicles in cartridges or projectiles that contain millions of chaff fibers. Chaff is composed of an aluminum alloy coating on glass fibers of silicon dioxide. The coating is about 99.4 percent aluminum by weight, and contains negligible amounts of silicon, iron, copper, manganese, magnesium, zinc, vanadium, and titanium (USAF 1997). Chaff fibers are similar to a human hair in size and shape (USAF 1997). These aluminum-coated glass fibers (about 60 percent silica and 40 percent aluminum by weight) range in length from 0.8 to 7.5-cm, with a diameter of about 40 micrometers. For each chaff cartridge used, a plastic end-cap and Plexiglas piston are released into the environment, but these materials are not hazardous. The end-cap and piston are both round, and are 1.3 inches in diameter and 0.13 inch thick (Spargo 2007).

When chaff is deployed, a diffuse cloud of fibers undetectable to the human eye is formed. Chaff is a very light material that can remain suspended in air anywhere from 10 minutes to 10 hours. It can travel considerable distances from its release point, depending on prevailing atmospheric conditions (Arfsten et al. 2002). For example, Hullar et al. (1999) calculated that a 4.97-mile by 7.46-mile area (37.1 square miles or 28 square nautical miles [nm^2]) would be affected by deployment of a single cartridge containing 150 grams of chaff. The resulting chaff concentration would be about 5.4 grams (g) per nm^2. This concentration corresponds to fewer than 179,000 fibers per square nautical mile, or about one fiber per 200 square feet, assuming that each canister contains five million fibers.

Specific release points tend to be random, and chaff dispersion in air depends on prevailing atmospheric conditions. After falling from the air, chaff fibers would be expected to float on the ocean surface for some period, depending on wave and wind action. The fibers would be further dispersed by ocean currents as they float and slowly sink toward the bottom. The fine, neutrally buoyant chaff streamers would act like particulates in the water, temporarily increasing the turbidity of the ocean's surface, while the end caps and pistons would sink. The chaff fibers would quickly disperse and turbidity readings would return to normal. The expended material could also be transported long distances before becoming incorporated into the bottom sediments.

A review of numerous toxicological studies indicated that the principal components of chaff are unlikely to have significant effects on humans and the environment, based on the general toxicity of the components, the dispersion patterns, and the unlikelihood of the components to interact with other substances in nature to produce synergistic toxic effects (USAF 1997). In addition, available evidence suggests that chaff use does not result in significant accumulation of aluminum in sediments after prolonged training. Sediment samples collected from an area of the Chesapeake Bay where chaff had been used for approximately 25 years indicated that aluminum concentrations in sediments were not significantly different than background concentrations (Wilson et al. 2002).

The small explosive cartridge used to eject the chaff from a small tube may contain hazardous materials (Global Security 2008b). Chaff deployment charges contain approximately 0.49 g (0.02 ounces [oz]) of pyrotechnic materials (USAF 2001). Hazardous materials in pyrotechnic materials are discussed earlier in this section under Flares.

Naval Guns and Small Arms Fire

Naval gunfire exercises use naval gun shells, including 5-in (HE and inert), 76-mm (HE and inert), 57-mm, 25-mm, and 20-mm shells, and small arms rounds. Hazardous materials from shells and small-arms rounds are unexploded shells and metals contained in shell casing, ammunition jackets, and ammunition cores. Shells are composed of steel, brass, copper, tungsten, and other metals, all of which are relatively inert. Live 5-in shells are typically fused to detonate within 3 ft (0.91 m) of the water surface. Shell fragments, unexploded shells, and non-explosive ordnance rapidly decelerate in the water and settle to the ocean floor. Small arms fire includes 0.50-cal machine gun rounds and 7.62-mm projectiles, both of which may contain a lead core. Less than one percent of these materials consist of toxic metals such as lead (DoN 2009).

The presence of shell casings in the sediments would not be expected to substantially affect water quality because brass would undergo slow corrosion, even in a salty environment, and leached substances would be quickly diluted by ocean currents. Most of the ammunition expended during activities involving small arms fire is comprised of steel, with small amounts of aluminum and copper. Steel practice bullets may release small amounts of iron, aluminum, and copper into the sediments and the overlying water column as the bullets corrode. All three elements are widespread in the natural environment, although elevated levels can cause toxic reactions in exposed plants and animals. Any elevation of metals in sediments would be restricted to a small zone around the bullet, and any release to the overlying water column would be quickly diluted.

Close-in weapons systems (CIWS) use 20-mm cannon shells composed of either depleted uranium (DU) or tungsten. DU is "depleted" in that it has only one-third of the isotopes of U^{235} and 60 percent of the radiation as natural uranium (World Health Organization 2009). The Nuclear Regulatory Commission approved the Navy's license application, which clearly stated that CIWS DU rounds would be fired at sea and not recovered. Depleted uranium is not part of the Proposed Action for this EIS. The Navy phased out use of DU rounds in favor of tungsten rounds because of the superior flight characteristics of tungsten and its performance against missile casings. The Navy's transition to tungsten began in 1989, and most rounds with DU have been replaced. None of the surface combatant ships stationed in the Pacific Northwest have DU onboard, and Commander Pacific Fleet has directed that all Pacific Fleet ships offload all DU rounds at the earliest opportunity.

Tungsten has replaced DU in CIWS 20-mm rounds. Tungsten used for munitions is typically a tungsten alloy, where pure tungsten powder is combined with binding materials, such as nickel, iron, copper, or cobalt, that makes the tungsten grains ductile and easy to machine. Tungsten is a naturally occurring element, but not as a pure metal. Tungsten is typically released into the environment via weathering or mining of wolframite and scheelite (Agency for Toxic Substances and Disease Registry [ATSDR] 2005).

In water, tungsten metal and metal alloys will exist as insoluble solids, while tungsten compounds will exist either as ions or insoluble solids (ATSDR 2005). Tungsten compounds typically adsorb to suspended soils and sediment in the water column. Tungsten ions in ocean water have an estimate residence time of approximately 1,000 years, before it is removed from the aquatic phase by sedimentation or other processes (ATSDR 2005). Metallic tungsten dissolves in water, reaching concentrations up to 475-500 mg/L. The dissolution of tungsten is associated with a decrease in dissolved oxygen and pH in both aqueous and soil matrices (Strigul et al. 2005). The corrosion rates of tungsten alloys increase as pH increases, and also increase with exposure to chloride ions, which are abundant in salt water, in aqueous solution (U.S. Army 1987).

Tungsten is a heavy metal that can have negative effects on humans and other biological organisms. Tungsten alloys may have additional health effects associated with the alloyed metals. The two primary exposures are though inhalation and ingestion. Bullets impacting a hard target may release tungsten particles into the air, but such releases would be small. Some respiratory issues from tungsten have been reported, but reports were in environments where people were exposed to several heavy metals over prolonged periods (ATSDR 2005). Inhalation of tungsten particles by humans or other biological organisms would not be likely because of the distance offshore that training takes place. Reports of oral consumption of tungsten and tungsten alloys by humans or other biological organisms are limited. Rats implanted with pellets of weapons-grade tungsten alloy developed aggressive tumors surrounding the pellets (Kalinich et al. 2005). A study on the use of tungsten in shot for waterfowl hunting, adult mallards (*Anas platyrhynchos*) were fed several types of shot, including tungsten-iron and tungsten-polymer shot. None of the ducks that were fed either tungsten shot died during the 150-day trial (Mitchell et al. 2001). Significant liver hemosiderosis was present in some ducks for all types of shot, but it was determined that neither type of tungsten shot had deleterious health effects based on mortality, body weights, organ weights and histology of the liver and kidneys (Mitchell et al. 2001).

Sonobuoys

Sonobuoys are used for ASW training exercises under both Alternatives 1 and 2. Sonobuoys are expendable metal cylinders launched from aircraft and ships that collect and generate information about the marine environment and potential threats and targets. Sonobuoys consist of two main sections, a surface unit that contains the seawater battery and a metal subsurface unit (see Appendix H for physical descriptions of sonobuoys). The seawater battery is activated upon contact with the water. The subsurface assembly descends to a selected depth, the sonobuoy case falls away, and sea anchors deploy to stabilize the hydrophone (underwater microphone) (Global Security 2008e).

Sonobuoys are designed to be expended upon completion of training exercises. Scuttled sonobuoys sink to the ocean floor, where they are subjected to the corrosion and sedimentation caused by ocean currents. Occasionally, an expended sonobuoy may become flotsam if it fails to be scuttled. Sonobuoys as flotsam move with ocean currents until they either sink or are washed ashore. Scuttled sonobuoys contain a small amount of hazardous materials, but do not pose a threat to public safety, water quality, or biological resources. Hazardous materials leach slowly, and are not expected to substantially affect the environment.

Sonobuoys contain other metal and nonmetal components, such as metal housing (nickel-plated, steel-coated with polyvinyl chloride [PVC] plastics to reduce corrosion), batteries, lead solder, copper wire, and lead ballast that, over time, can release hazardous constituents into the surrounding water. Most of the other sonobuoy components are either coated with plastic to reduce corrosion or are solid metal. The slow rate at which solid metal components corrode in seawater translates into slow release rates into the marine environment. Once the metal surfaces corrode, the rates at which metals are released into the environment decrease. Releases of chemical constituents from metal and nonmetal sonobuoy components are further reduced by encrustation of exposed surfaces by benthic organisms. Therefore, toxic components of the sonobuoy do not substantially degrade marine water quality. Hazardous constituent contents of sonobuoys are provided in Table 3.2-7, based on the composition of similar sonobuoys used by the Navy for training off San Clemente Island.

Table 3.2-7: Sonobuoy Hazardous Constituents

Constituent	Weight (lb) per Sonobuoy
Copper thiocyanate	1.59
Fluorocarbons	0.02
Copper	0.34
Lead	0.94
Tin/lead plated steel	0.06
Total	2.95

Source: U.S. Department of the Navy, San Clemente Island Ordnance Database [No Date]

Approximately 0.04 lb (20 g) of lead solder are used in the internal wiring (solder) of each sonobuoy, and 0.85 lb (425 g) of lead are used for the hydrophone and lead shot ballast. Lead in sonobuoys is in an un-ionized metallic form that is insoluble in water, so the lead shot and solder are not released into the seawater. Various lead salts, which have low solubilities, likely form on the exposed metal surfaces. For these reasons, lead components of the sonobuoy do not substantially degrade marine water quality.

Batteries

Sonobuoys may contain up to three different types of batteries (seawater, lithium, and thermal), depending on the type of sonobuoy. Regardless of type, each sonobuoy contains a seawater battery housed in the upper, floating portion that supplies power to the sonobuoy. These seawater batteries contain 0.7 lb to 0.9 lb (300 to 400 g) of lead (DoN 2008a). In cases where the upper portion of the sonobuoy is lost to the seabed, the lead batteries are also lost. Chemical reactions within sonobuoy batteries proceed almost to completion once the cell is activated, and only a small amount of reactants remain when the battery life ends. These residual materials slowly dissolve, and are diluted by ongoing ocean and tidal currents. In addition, the exterior metal casing can become encrusted by marine organisms or coated by corrosion, thus slowing the rate of further corrosion. Also, many of the components of concern are coated with plastic to reduce corrosion, providing an effective barrier to water exchange. In instances where seawater corrodes the sonobuoy, that corrosion takes at least 40 years (Klassen 2005).

The approach used to evaluate the environmental effects of seawater batteries involved comparing the expected concentrations of potentially toxic battery constituents with U.S. Environmental Protection Agency (USEPA) water quality criteria that have been established for the protection of aquatic life (USEPA 2006) or the best available literature values that established conservative toxicity thresholds (Table 3.2-8). This assessment applies the findings from a study reported by Naval Facilities Engineering Command (NAVFAC) (DoN 1993, Appendix D) in a sonobuoy training document developed for activities at San Clemente Island, California. The study involved a laboratory experiment where activated seawater batteries were held in a 64-liter (17-gallon) seawater bath for eight hours to provide an empirical estimate of expected leach rates for metals of concern. Water column concentrations of metals at the end of the exposure can be used to derive average leaching rates, and can then be interpreted in the context of minimum current velocities to estimate maximum field exposures. The exposure scenario applied in the NAVFAC report represents reasonable and conservative assumptions that have been retained for this analysis. It is assumed that only one seawater battery will occupy the test volume within its eight-hour operating life span. No vertical turbulence is applied, and the horizontal ocean current flow is set at two inches per second (in/sec) (five centimeters per second [cm/sec]).

Table 3.2-8: Threshold Values for Safe Exposure to Selected Metals

Metal	Criteria (µg/L)	
	Acute (1-hour exposure)	Chronic (4-day mean exposure)
Lead	210	8.1
Silver	1.9	NA
Copper	4.8	3.1
Lithium[1]	6,000	NA

Notes: NA = no chronic value is available; µg/L = microgram per liter. (1) No EPA criteria available; values shown are based on published literature (Kszos et al., 2003)

Source: EPA 2006

The sonobuoy battery experiment employed lead chloride batteries over an eight-hour period. The concentration of lead at the end of the exposure in the bath was 0.2 mg/L (DoN 1993). Hence, the total amount of lead leached from the battery was (0.2 mg × 64 L =) 12.8 mg. As shown in Table 3.2-9, the rate is thus 1.6 milligrams per hour (mg/hr), or 0.000444 milligrams per second (mg/sec). Applying a highly conservative model, wherein all of the lead released in a single second is contained within 1 mL, the concentration would be 0.4 mg/L.

Table 3.2-9: Calculations to Characterize Maximum Lead Exposure Concentrations

Description of Calculation	Operation	Result
Total amount of lead leached from battery	0.2 mg/L x 64 L =	12.8 mg/8 hr
Per-hour rate	12.8 mg/8 hrs =	1.6 mg/hr
Per-second rate	1.6/hr/(60 min/hr × 60 sec/min) =	0.000444 mg/sec
Concentration into 1 mL	0.000444 mg/mL × 1,000 mL/L =	0.4 mg/L
Two-second dilution	0.4/2 =	0.2 mg/L or 200 µg/L

Source: DoN 2008b

Considering each milliliter as a discrete parcel, a reasonable dilution model at a current velocity of five cm/sec (two in/sec) assumes that the contaminated section is diluted by a factor of two per second. Thus, the lead released from the battery is diluted to 0.2 mg/L or 200 µg/L, in two seconds, which is less than the acute criteria of 210 µg/L, a criteria applied as a one-hour mean. Likewise, assuming the exponential factor of two dilutions, the concentration is less than the chronic limit (8.1 µg/L) in seven seconds.

Therefore, lead chloride batteries will not substantially degrade marine water quality. Table 3.2-9 provides a description and summary of the calculations performed to determine the potential effects of scuttled lead chloride batteries.

The relatively large differences in the propensity of lead ions (Pb^{+2}) to solubilize relative to copper (Cu^{+2}) and silver (Ag^{+}) ions assures that the potential effects of batteries containing silver chloride or copper thiocyanate are substantially lower than those of a lead chloride battery. While the copper thiocyanate battery also would release cyanide, a material often toxic to marine organisms, thiocyanate is tightly bound, and will form a salt or bind to bottom sediments. Therefore, the risk from thiocyanate is very low.

The AN/SSQ-62D and AN/SSQ-62E DICASS have been improved with the replacement of the standard lithium battery with a lithium iron disulfide thermal battery. An important component of the thermal battery is a hermetically sealed casing, which is Series 300 welded stainless steel 0.7- to 2.54-mm (0.03- to 0.1-in) thick and resistant to the battery electrolytes (DoN 2008b). The electrochemical system in the thermal battery includes an iron disulfide cathode and a lithium alloy anode. In addition, the electrolyte mixture includes chloride, bromide, and iodide salts of lithium and potassium. This mixture is inert and nonconductive until the battery is activated. Upon activation, the mixture becomes molten and highly conductive, allowing the cathode to interact efficiently with the anode. The thermal source is a mixture of iron powder and potassium perchlorate. In the case of extreme degradation of the battery housing on the ocean floor, risks from thermal batteries would be similar to those from lithium batteries (i.e., negligible) but less so because the iron alloy is less soluble.

Lithium batteries are used in DICASS sonobuoys but not in the explosive sonobuoy (AN/SSQ-110A). These batteries are contained within a metal casing housing sulfur dioxide, lithium metal, carbon, acetonitrile, and lithium bromide. The environmental fate of lithium batteries during and after training exercises has already been described in this section under Underwater Targets.

Detonation Byproducts

One type of explosive sonobuoy is proposed for use, the SSQ-110A. This sonobuoy is composed of two sections, an active (explosive) section and a passive section. The upper section is similar to the upper electronics package of the SSQ-62 DICASS sonobuoy, while the lower section consists of two payloads of explosive, weighing 4.2 lb (1.9 kg) each (Global Security 2008c). This explosive is composed of cyclo-1,3,5-tetramethylene-2,4,6-tetranitramine (HLX), which is 90-percent RDX, plus small amounts (less than 0.3 g) of PBX and hexanitrostilbene, a detonator component. Once in the water, the charges explode, creating a loud acoustic signal.

The explosion creates an air bubble of gaseous byproducts that travels to the surface and escapes into the atmosphere. Some of the gas, however, dissolves into the water column. The byproducts with the greatest toxicity are hydrogen fluoride compounds (H_xF_x), reaction byproducts associated with the binding agent used to stabilize the HLX. Natural exposure levels and effects in saltwater would need to be characterized to provide a basis for assessing effects on marine systems. Only a small percentage (0.63 percent) of the available H_xF_x explosion byproduct, however, dissolves in the water prior to the bubble reaching the surface, and the H_xF_x is rapidly diluted upon mixing with the adjacent water column (National Oceanic and Atmospheric Administration 2008).

Torpedoes

MK-48 ADCAP torpedoes would only be used in the TMAA under Alternative 2 (Preferred Alternative). Torpedoes typically contain hazardous materials such as propellants, petroleum products and lubricants, components of guidance systems and instrumentation, and explosives in warheads. The ADCAP torpedo is an acoustic homing torpedo used in force protection. It is 19 ft (5.8 m) long, with a 21-inch diameter, and weighs about 3,700 lb (1,680 kg). Although the hazardous materials list for the MK-48 is classified, the MK-48 torpedo contains approximately 851 lb (383 kg) of explosives and uses Otto Fuel II as a propellant. Most of the explosive is consumed upon detonation of the torpedo.

OTTO Fuel II propulsion systems are used in MK-48 torpedoes. Otto Fuel II is a liquid propellant composed of propylene glycol dinitrate and nitro-diphenylamine (76 percent), dibutyl sebacate (23 percent) and 2-nitrodiphenylamine as a stabilizer (2 percent), and may be toxic to marine organisms (DoN 1996b,c). There have been approximately 30,000 exercise test runs of the MK-48 torpedo over the last 25 years (DoN 1996c). Most of these launches have been on Navy test ranges, where there have been no reports of deleterious effects on marine water quality from OTTO Fuel II or its combustion products (DoN 1996b,c). Furthermore, Navy studies conducted at torpedo test ranges that have lower flushing rates than the open ocean did not detect residual OTTO Fuel II in the marine environment (DoN 1996b,c). Thus, no adverse effects are anticipated from use of this fuel.

Exhaust products from the combustion of OTTO Fuel II include NO_x, CO, carbon dioxide (CO_2), hydrogen (H_2), nitrogen (N_2), methane (CH_4), ammonia (NH_3), and hydrogen cyanide (HCN) (DoN 1996b,c). These combustion products are released to the ocean, where they are dissolved, disassociated, or dispersed in the water column. These combustion products are not expected to substantially affect the marine environment. Except for HCN, combustion products are not a concern (DoN 1996b,c) because:

- Most OTTO Fuel II combustion products, specifically water, CO_2, N_2, CH_4, and NH_3, occur naturally in seawater.
- Several of the combustion products are bioactive. N_2 is converted into nitrogen compounds through nitrogen fixation by certain cyanobacteria, providing nitrogen sources and essential micronutrients for marine phytoplankton. CO_2 and CH_4 are integral parts of the carbon cycle in the oceans, and are taken up by many marine organisms.
- CO and H_2 have low solubility in seawater and excess gases bubble to the surface.
- Trace amounts of NO_x may be present, but they are usually below detectable limits. NO_x in low concentrations are not harmful to marine organisms, and are a micronutrient source of nitrogen for aquatic plant life.
- Ammonia can be toxic to marine organisms in high concentrations, but releases from OTTO fuel are quickly diluted to negligible levels.

HCN does not normally occur in seawater and, at high concentrations, could pose a risk to both humans and marine biota. The USEPA acute and chronic national recommendation for cyanide in marine waters is 1.0 μg/L, or 1 part per billion (ppb) (DoN 1996b,c). HCN concentrations ranging from 140 to 150 ppb will be discharged from MK-48 torpedoes (DoN 1996c). These initial concentrations are well above the level recommended by USEPA for cyanide. However, because it is very soluble in seawater, HCN will be diluted to less than 1 μg/L at 17.7 ft (5.4 m) from the center of the torpedo's path when first discharged, and thus should pose no substantial threat to marine organisms.

Each torpedo also deploys a guidance wire with a flex hose during each run. The guidance wire is composed of copper and cadmium within a plastic coating, and is about 0.04 inch in diameter (0.1 cm) (DoN 2008b). The MK-48 torpedo uses either a Strong Flexible Hose (SFH) or Improved Flexible Hose (IFH). The flex hose is typically 250-ft long and less than a half inch in diameter, and will sink rapidly to the ocean floor once expended. The IFH is a multi-component design that consists of a stainless-steel spring overlaid with a polyester braid and then a layer of lead tape (DoN 1996b). The entire assembly is then overlaid with a stainless-steel wire braid. The IFH contains 24 kg (53 lb) of metallic lead. The SFH is constructed primarily of stainless steel, and contains no lead or other materials that may pose a threat to the marine environment (DoN 1996b).

The potential for the release of lead into the ocean bottom environment immediately surrounding the IFH to have adverse effects on pelagic and benthic organisms was analyzed. Benthic marine organisms that are near the IFH may be exposed to low concentrations of lead slowly released over time from the IFH. In marine biota, lead residues are generally highest near sources (e.g., disposal sites, dredging sites, mining areas), but no significant biomagnification of lead occurs in aquatic food chains (Eisler 1988).

3.2.1.2 Current Requirements and Practices

Releases or discharges of hazardous wastes or materials are heavily regulated through comprehensive federal and state processes. In addition, the International Convention for the Prevention of Pollution from Ships (MARPOL) prohibits certain discharges of oil, garbage, and other substances from vessels. The MARPOL convention is implemented by national legislation, including the Act to Prevent Pollution from Ships (33 U.S. Code [U.S.C.] 1901, et seq.) and the federal Water Pollution Control Act (Clean Water Act [CWA]"; 33 U.S.C. 1321, et seq.). These and other requirements are implemented by Navy guidance documents and manuals (e.g., Chief of Naval Operations Instruction [OPNAVINST] 5090.1C) that require hazardous materials to be stored and handled appropriately, both ashore and afloat.

At sea, Navy vessels are required to operate in a manner that minimizes or eliminates any adverse impacts to the marine environment. Environmental compliance policies and procedures applicable to shipboard activities afloat are defined in: the *Navy Environmental and Natural Resources Program Manual* (OPNAVINST 5090.1C), Chapter 4, "Pollution Prevention," and Chapter 22, "Environmental Compliance Afloat"; and Department of Defense (DoD) Instruction 5000.2-R (§C5.2.3.5.10.8, "Pollution Prevention") (DoN 2007). In addition, provisions in Executive Order (EO) 12856, *Federal Compliance With Right-To-Know Laws and Pollution Prevention Requirements*, and EO 13101, *Greening the Government through Waste Prevention, Recycling, and Federal Acquisition*, reinforce the CWA prohibition against discharge of harmful quantities of hazardous substances into U.S. waters out to 200 nm (371 km), and mandate stringent hazardous waste discharge and storage, dumping, and pollution prevention requirements.

3.2.2 Environmental Consequences

As noted in Section 3.2.1, the ROI for expended materials includes the TMAA. Navy training activities that occur within the Air Force inland Special Use Airspace and the Army inland training lands were evaluated under previous National Environmental Policy Act (NEPA) documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents are incorporated by reference. Environmental effects in the open ocean beyond the U.S. territorial seas (outside of 12 nm [22 km]) are analyzed in this EIS/OEIS pursuant to EO 12114.

3.2.2.1 Previous Analyses

Impacts related to expended materials and their hazardous constituents were previously evaluated in Section 1.6.2.2 of the *Alaska Military Operations Areas EIS* (USAF 1995); Section 3.0 of the *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007); Sections 3.8, 3.9, 4.8, and 4.9 of the *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999); and Sections 3.17, 4.4, 4.5, 4.6, 4.7, and 4.17 of the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

3.2.2.2 Regulatory Framework

Expended materials and hazardous materials are regulated by international, federal, and state laws and regulations. Navy training in the TMAA occurs beyond 12 nm from shore, which is beyond the State seaward and the territorial seas boundaries. Only regulations on the high seas, in the U.S. Exclusive Economic Zone, and in the contiguous zone are applicable. Most Federal and all State regulations are not applicable to expended materials during Navy training exercises in the TMAA, and are provided only for informational purposes.

International Regulation - MARPOL 73/78

MARPOL 73/78, the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978, is the primary international marine environmental convention. It is intended to minimize pollution of the seas, including oil, sewage, garbage, and harmful substances. MARPOL limits the dumping from ships based upon the type of materials expended, with plastics as the primary concern. Discharge restrictions are also based on distances of ships from coastal waters.

Federal Laws and Regulations

Federal laws and regulations applicable to Navy training in the TMAA are the Marine Protection, Research, and Sanctuaries Act, and the Oil Pollution Act. The RCRA, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Toxic Substances Control Act (TSCA), the Hazardous Materials Transport Act, and the Emergency Planning and Community Right to Know Act are not applicable because training takes place outside of the U.S. territorial seas; these regulations are provided only for informational purposes.

Marine Protection, Research, and Sanctuaries Act

The Marine Protection, Research, and Sanctuaries Act of 1972, also known as the Ocean Dumping Act, was enacted to regulate materials dumped into ocean waters that could endanger human health, welfare, and amenities, and the marine environment, ecological systems, and economic possibilities. The Ocean Dumping Act regulates the disposal of any material in the U.S. territorial seas or contiguous zones, as well as the marine disposal anywhere of waste and other material that originated in U.S. territory or was transported on American vessels or aircraft.

Oil Pollution Act

The Oil Pollution Act requires oil storage facilities and vessels to submit plans to the federal government describing how they will respond to the unplanned release of oil and other hazardous materials (33 U.S.C. 2701, et seq.). The OPA provides regulations for the prevention of the discharge of oil into the ocean waters out to the limits of the contiguous zone. Oil and hazardous releases are also reported and remediated according to current Navy policies.

Resource Conservation and Recovery Act

RCRA applies only to solid wastes, as those materials are defined in 40 Code of Federal Regulations (CFR) §261.2. RCRA defines a hazardous waste as a solid waste that can cause, or substantially contribute to, an increase in mortality or serious illness due to its quantity, concentration, or physical, chemical, or infectious characteristics, or which can pose a hazard to human health or the environment when improperly transported, managed, treated, stored, or disposed of (42 U.S.C. 6901, et seq.).

The Military Munitions Rule (MMR) identifies when military munitions become solid wastes under RCRA. Under the MMR, military munitions include: confined gaseous, liquid, and solid propellants; explosives; pyrotechnics; and chemical and riot agents. The MMR provides that the use of these munitions to train military personnel on a designated military range constitute the normal use of the product, so they are not solid wastes and are not subject to RCRA regulation. As defined by the MMR, a used or fired military munition is considered to be a solid waste only if "… the munition lands off-range and is not promptly rendered safe or retrieved" (40 CFR §266.202). Under the MMR, wholly inert items and non-ordnance training materials are not defined as military munitions.

Hazardous materials are considered solid wastes if they are used in a manner constituting disposal rather than for their intended purpose. Expended materials are considered solid waste under the RCRA when discarded materials are "abandoned." A material is abandoned if it is disposed of; burned or incinerated; or accumulated, stored, or treated before or instead of being disposed of.

Comprehensive Environmental Response, Compensation, and Liability Act

CERCLA – the Superfund program – defines hazardous material as any substance that, due to its quantity, concentration, or physical and chemical characteristics, poses a potential hazard to human health and safety or to the environment. CERCLA has established national policies and procedures to identify and clean-up sites contaminated by hazardous substances, including military installations. No CERCLA sites are located in the TMAA.

Toxic Substances Control Act

The TSCA requires reporting, record-keeping, and testing requirements, and restrictions related to chemical substances or mixtures. TSCA also address the use and disposal of specific chemicals, such as polychlorinated biphenyls (PCBs). PCB production was banned in 1973, but PCBs may be present in products manufactured before the ban. PCBs may be found in PVC coatings of electrical wiring, transformers, and hydraulic fluids.

Hazardous Materials Transportation Law

For air, sea, or land transportation, the U.S. Department of Transportation defines a hazardous material as a substance or material that is capable of posing an unreasonable risk to health, safety, and property when transported in commerce (49 U.S.C. 5101, et seq.; 49 C.F.R. 172.101, Appendix B). This law regulates the preparation, identification, and transportation process for hazardous materials.

Emergency Planning and Community Right-to-Know Act

The Emergency Planning and Community Right to Know Act requires federal, state, and local governments and industry to report on their use of hazardous and toxic chemicals (42 U.S.C. 116, et seq.).

Transport of Target Vessels (SINKEX)

Ship hulks used as targets for SINKEX are required to comply with 40 CFR §229.2, Transport of Target Vessels. This is a general permit for the Navy to transport vessels in ocean waters with the purpose of sinking the vessel. Vessel sinkings must be conducted in water at least 6,000 ft (1,830 m) deep and at least 50 nm (93 km) from land. Regulations require that measures be taken to ensure that the vessel sinks to the bottom rapidly and permanently, and does not pose a hazard to marine navigation. All materials that have the potential to degrade the marine environment are removed, to the maximum extent possible.

State Laws and Regulations

Alaska regulations on expended and hazardous materials are not applicable to Navy training in the TMAA because no training activities take place within State waters (up to three nm from shore). The following discussion of regulations is for informational purposes only.

Solid wastes and hazardous materials are regulated by the Alaska Department of Environmental Conservation (ADEC). Alaska has adopted the federal MMR by reference, but has not developed any state-specific military munitions regulations. The provisions of the MMR are regulated by the Waste Management Division of the ADEC. Solid waste regulations are established by Alaska Administrative Code Title 18, Chapter 60: Solid Waste. The Waste Management division enforces the State of Alaska's hazardous waste regulations, which can be found in Alaska Statutes Title 46, Chapter 3 (e.g., Section 296 [Hazardous Waste Disposal], Section 299 [Hazardous Waste Regulations]; and Section 308 [Transportation of Hazardous Waste], and in Chapter 9 [Hazardous Substance Release Control]). The

Navy complies with applicable state regulations under EO 12088, *Federal Compliance with Pollution Control Standards*; DoD Directive 4165.60, *Solid Waste Management*; and Navy guidelines for hazardous materials and wastes management.

Alaska oil pollution control regulations are found in the Alaska Statutes Title 46, Chapter 5 and Chapter 8. These regulations address issues with transportation and liability of petroleum products. Alaska has developed contingency plans for the State that describe the strategy for a coordinated federal, state, and local response to a discharge or substantial threat of discharge of oil or a release of a hazardous substance from a vessel, offshore facility, or onshore facility.

3.2.2.3 Approach to Analysis

Sources of Information

Relevant literature was systematically reviewed to complete this analysis of expended materials in the GOA. The review included journals, DoD reports and operational manuals, natural resource management plans and other technical reports published by government agencies, prior environmental documents for facilities and activities in the GOA, and work conducted by private businesses and consulting firms.

Methods

For each alternative, this document characterizes and quantifies the total amount of training materials, both hazardous and nonhazardous, that are expended annually during Navy training in the TMAA. Hazardous material weights are calculated based on assumptions identified in Section 3.2.1.1 for each expended training material. This analysis does not include materials expended during Navy training in the inland lands of the GOA because those activities are covered by Army and Air Force documents identified in Section 3.2.2.1.

This analysis assumes that expended training materials are deposited on 20 percent of the available training area (TMAA) (DoN 2009). The TMAA consists of an ocean area of approximately 42,146 nm^2 (145,482 square kilometers [km^2]). Deposition of expended materials across 20 percent of the training area would affect an area of approximately 8,430 nm^2 (29,100 km^2). This is a conservative assumption that is based on Navy personnel experience, which indicates that the distribution of training exercises within ocean training areas is not uniform.

Aircraft overflights occur under all of the alternatives. Aircraft overflights between the TMAA and the Alaska inland training areas would not involve expenditures of training materials. Therefore, aircraft overflights in the GOA will not be addressed further in this section.

3.2.2.4 No Action Alternative

The No Action Alternative is the baseline condition for Navy training in the TMAA. This section analyzes current levels of Navy training for annual expenditure of training materials and their hazardous constituents. Table 3.2-1 summarizes the training items that may present issues related to expended materials. The amounts and types of training materials expended under the No Action Alternative are described below. Table 3.2-10 provides the annual numbers and weights of expended materials under the No Action Alternative.

Table 3.2-10: Summary of Expended and Hazardous Training Materials – No Action Alternative

Type of Training Material	Number of Items	Material Weight (lb)		Hazardous Content (%)
		Total Expended	Hazardous	
Bombs	120	54,000	395	0.73
Missiles	22	6,770	56.4	0.83
Targets & pyrotechnics	252	3,610	27.2	0.75
Naval gun shells	10,564	10,700	1,320	12.3
Small arms rounds	5,000	180	1.80	1.00
Sonobuoys	24	936	70.8	7.56
Total	**15,982**	**76,200**	**1,870**	**2.45**

Notes: Numbers of training items are estimates. Weights and percentages are rounded to a maximum of three significant digits.

Bombs

Under the No Action Alternative, 120 bombs will be expended annually during training, of which 72 (about 60 percent) will be inert. Expended bombs will deposit approximately 54,000 lb (24,300 kg) of training materials per year, distributed over the TMAA at an average density of 6.4 lb per nm^2 (0.83 kg per km^2), assuming deposition of expended materials over 20 percent of the TMAA (42,146 nm^2 [145,482 km^2]). The primary hazardous material from bombs is residual explosives. Most of the residual explosives will result from bombs that are duds. Approximately 395 lb (180 kg) of explosives will be left unconsumed, which will deposit about 0.05 lb per nm^2 (less than 0.01 kg per km^2) of hazardous material in the TMAA. Practice bombs contain a small amount of explosives for use as a spotting charge. Upon impact, spotting charges will combust and be consumed, producing smoke in the process. Explosives are generally insoluble in water, and will leach slowly into the marine environment. Explosive material will break down on the ocean floor, and will not accumulate over time. Ocean currents will disperse leaching materials quickly. Bomb casings may contain anti-corrosion coatings and metals, but these substances typically constitute less than one percent of the casing's weight. Bomb casings will degrade slowly, and leaching will be further slowed by encrusting and sedimentation. The environmental fate of expended bombs is described in greater detail in Section 3.2.1.1. Due to the low areal density of expended materials and the low amount of hazardous material, expended bombs will have a minimal impact on the benthic environment.

Missiles

Twenty-two missiles will be used annually under the No Action Alternative. Approximately 50 percent of missiles used during aviation exercises are inert versions, and do not explode on contact with the target or ocean surface. Exploding warheads may be used in air-to-air missile exercises but, to avoid damaging the aerial target, the missile explodes in the air, disintegrates, and falls into the ocean. Live missiles used in air-to surface exercises explode near the water surface. Approximately 6,770 lb (3,050 kg) of expended materials from missiles will be deposited annually on the ocean floor, resulting in an average density of 0.8 lb per nm^2 (0.1 kg per km^2) per year. Hazardous materials from expended missiles consist of residual missile propellants and unconsumed explosives from missiles that are duds. Under the No Action Alternative, expended missiles will annually result in approximately 56.4 lb (25.6 kg) (approximately 38 lb [17 kg] of explosives and 18 lb [8.1 kg] of propellant) in the TMAA. These amounts of hazardous materials are not expected to have a substantial effect because of the large deposition area and subsequent dispersal by ocean currents. The deposition of the missile body in the water will have minimal effects on water quality because it will become encrusted through chemical processes and the growth of benthic organisms, slowing leaching.

The principal source of potential impacts on water and sediment quality will be unburned solid propellant residue and batteries. Solid propellant fragments will sink to the ocean floor and will undergo changes in the presence of seawater. The propellant concentration will decrease over time as the leaching rate decreases and further dilution occurs. The aluminum will remain in the propellant binder, and eventually will be oxidized by seawater to aluminum oxide. The remaining binder material and aluminum oxide will pose no threat to the marine environment (DoN 1996d).

Targets and Pyrotechnics

Table 3.2-11 summarizes the types and numbers of targets and pyrotechnics that will be used annually under the No Action Alternative. Targets used in training exercises will be recovered, unless otherwise noted.

Table 3.2-11: Targets and Pyrotechnics – No Action Alternative

Type of Target or Pyrotechnic	Number of Items
Targets	
TDU-34 towed target	2
TALD*	8
BQM-74E unmanned aircraft	2
Killer Tomato surface target	10
SPAR	10
Pyrotechnics	
LUU-2B/B*	12
MK-58 Marine Marker*	20
Chaff*	212
Total number used	**276**
Total not recovered	**252**
Total expended weight (lb)	**3,610**

*Not recovered

Under the No Action Alternative, LUU-2B/B illuminating flares, TALDs, chaff, and MK-58 marine markers will not be recovered, resulting in approximately 3,610 lb (1,640 kg) of expended training materials per year. Illuminating flares and marine markers are consumed during use. Flares typically contain approximately 0.85 lb of residual pyrotechnic material, which is considered to be hazardous. Flare use under the No Action Alternative will deposit approximately 27.2 lb (12.4 kg) of hazardous materials annually in the TMAA. Smoke from marine markers rapidly diffuses by air movement. The marker itself is not designed to be recovered, and will eventually sink to the bottom and become encrusted or incorporated into the sediments. Phosphorus contained in the marker will settle to the ocean floor, where it will react with the water to produce phosphoric acid until all phosphorus is consumed. Combustion of red phosphorus produces phosphorus oxides, which have a low toxicity to aquatic organisms. Red phosphorus released during training is not anticipated to substantially affect the marine environment (DoN 2006).

TALDs will result in approximately 16 expended thermal batteries per year, which contain chemicals considered to be hazardous. Expended thermal batteries will not have a substantial impact to the environment because chemical reactions in batteries continue until battery life ends, with only a small amount of reactants remaining. Remaining chemicals, most of which are abundant in the ocean, will leach slowly, and will be diluted by ocean and tidal currents. The environmental fates of batteries are described in Section 3.2.1.1.

Chaff will only be used during Electronic Combat exercises. Approximately 540 lb (245 kg) of chaff will be expended under the No Action Alternative. The environmental fate of chaff is described in Section 3.2.1.1. Chaff fibers will be widely dispersed and will not result in harmful concentrations. The only hazardous material associated with chaff is the pyrotechnic deployment charge (approximately 0.02 oz [0.48 g] of pyrotechnic material for each charge) (USAF 2001). This amount of pyrotechnic material will not affect water or sediment quality because most of the material will be consumed during combustion and the remaining amounts will be dispersed over a large area.

Infrequently, a recoverable target may be lost. In those cases, the hazardous materials of concern include propellant, petroleum products, metals, and batteries. Small concentrations of fuel and ionic metals released during battery operation could enter the water and contaminate limited areas; however, they are not a source of substantial environmental degradation. The potential impact of expended batteries is discussed in Section 3.2.1.1.

Most target fragments will sink quickly in the ocean. Expended material that sinks to the ocean floor will gradually degrade, be overgrown by marine life, or be incorporated into bottom sediments. Floating nonhazardous expended material may be lost from target boats, and will either degrade over time or wash ashore as flotsam. An extensive study conducted at CFMETR near Nanoose, British Columbia concluded that, in general, the direct impact of debris accumulation on the ocean floor appeared to be minimal, and had no detectable effects on wildlife or sediment quality (CFMETR 2005). Under the No Action Alternative, no measurable impact on the environment will occur within the study area because the majority of targets will be recovered after use and the majority of expended materials are inert, and will be buried in bottom sediments.

Naval Gun Shells

Under the No Action Alternative, 10,564 shells will be fired annually, with only 40 HE shells (10 76-mm shells and 30 5-inch shells). The majority of expended shells will be 20-mm and 25-mm shells. The total weight of expended naval shells will be approximately 10,700 lb (4,860 kg) per year. Navy training in the TMAA will annually deposit approximately 1,320 lb (600 kg) of hazardous material from shells in the TMAA, which will be approximately 0.16 lb per nm^2 (0.02 kg per km^2). Hazardous materials of gun shells are explosive materials (from duds) and heavy metals in projectiles. Most of the hazardous material is from tungsten in CIWS 20-mm shells. Tungsten alloys will be in insoluble forms, and will settle to the ocean floor and be covered by sediment. Metals will leach slowly, but the amounts of other metals associated with tungsten alloy (copper, cobalt, nickel, iron) will be too small to have a substantial effect on the marine sediment. The degradation of tungsten could increase pH in the surrounding sediment but, with less than one expended 20-mm round per nm^2 (0.27 rounds per km^2) in 20 percent of the TMAA, would not have substantial effects. Hazardous materials are discussed in detail in Section 3.2.1.1.

Live 5-in shells are typically fused to detonate within 3 ft (0.9 m) of the water surface. Shell fragments rapidly decelerate through contact with the surrounding water, and settle to the ocean floor. The impact of naval shells on the environment under the No Action Alternative will be negligible because of the relatively small sizes of the training materials and their broad distribution within the TMAA. The environmental fate of naval gun shells on the ocean bottom will be similar to that of bombs (see discussion above).

Small Arms Rounds

Under the No Action Alternative, 5,000 rounds of small-caliber ammunition (7.62-mm and 0.50-cal) will be expended per year. The combined weight of these expended small arms will be approximately 181 lb (81 kg). Eighty percent of the small-caliber ammunition will be 7.62-mm rounds. Hazardous materials from small arms rounds (heavy metals in projectiles) will weigh less than two lb (less than one kg), which will not have an effect on the marine environment. Hazardous materials are discussed in detail in Section 3.2.1.1. Expended materials from small-caliber ammunition are relatively inert in the marine environment. Expended rounds may release small amounts of lead, antimony, iron, aluminum, and copper into the sediments and the overlying water column as they corrode. The rate of corrosion will be low, however, and releases to the overlying water column will be diluted by ocean and tidal currents.

Sonobuoys

The SSQ-36 BT sonobuoy will be used under the No Action Alternative. The SSQ-36 BT is designed to record the thermal gradient of the water at various depths (Global Security 2008d). The impacts of sonobuoys on the environment are described in Section 3.2.1.1. Under the No Action Alternative, 24 SSQ-36 BT sonobuoys will be expended per year. The estimated weight of expended materials from sonobuoys will be 936 lb (421 kg). Table 3.2-12 provides the weight of hazardous materials for sonobuoys expended under the No Action Alternative. Hazardous materials are discussed in detail in Section 3.2.1.1.

Table 3.2-12: Hazardous Materials from Expended Sonobuoys – No Action Alternative

Constituent	Hazardous Material Weight (lb)	
	Per Sonobuoy	Total
Copper thiocyanate	1.59	38.1
Fluorocarbons	0.02	0.48
Copper	0.34	8.16
Lead	0.94	22.6
Tin/lead plated steel	0.06	1.44
Total	**2.95**	**70.8**

Note: Under the No Action Alternative, 24 sonobuoys would be expended

Approximately 71 lb (32 kg) of hazardous materials from sonobuoys will be deposited in the TMAA under the No Action Alternative. Sonobuoys contain other metal and nonmetal components, such as metal housing (nickel-plated, steel-coated with PVC plastics to reduce corrosion), batteries, lead solder, copper wire, and lead used for ballast that, over time, can release hazardous constituents into the surrounding water. This level of deposition will not affect marine conditions because most of the hazardous materials are in insoluble forms. Leaching from metals will be slow. Lead has a low solubility in water and leaching is further decreased by encrusting through chemical and natural processes. Lead from expended sonobuoys will degrade slowly, and will not exceed USEPA's maximum acute concentration (210 µg/L) or maximum chronic concentration (8.1 µg/L) for lead (USEPA 2006). The quality of the water and sediments immediately surrounding an expended sonobuoy may be affected by chemicals leached from the item, but ocean currents will quickly disperse chemicals to nontoxic levels. Thus, expended sonobuoys under the No Action Alternative will not have a substantial effect on the environment.

Summary – No Action Alternative Effects

Under the No Action Alternative, Navy training exercises will annually expend an estimated 15,982 training items or 76,200 lb (34,600 kg) of training materials in the TMAA (see Table 3.2-10). Over 97 percent of the expended items will be naval gun shells or small arms rounds. The density of expended materials distributed over 20 percent of the TMAA will be approximately 1.92 items per nm^2 (0.55 items per km^2) or 9.0 lb per nm^2 (1.2 kg per km^2) per year. Assuming Navy training under the No Action Alternative remained consistent for the next 20 years, the Navy will expend approximately 762 tons, resulting in an ocean floor concentration of 181 lb per nm^2 (23.8 kg per km^2). Most of these materials are relatively inert in the marine environment, and will degrade slowly. Only a small amount of annually expended materials are considered to be hazardous. The density of hazardous materials within the affected areas will be approximately 0.22 lb per nm^2 (0.03 kg per km^2) per year. The majority of these materials will be residual explosive, which break down slowly. Any leaching chemicals will be quickly dispersed by ocean currents, and will not be present in harmful concentrations. Thus, expended materials under the No Action Alternative will not substantially affect marine resources.

3.2.2.5 Alternative 1

This section describes the annual amounts and types of training materials proposed under Alternative 1, compared to annual amounts under the No Action Alternative. Alternative 1 would increase training tempo and introduce ASW training in the TMAA, which would increase in the amount of expended materials. The numbers and weights of training materials that would be expended annually under Alternative 1 are provided in Tables 3.2-13 and 3.2-14.

Table 3.2-13: Numbers and Weights of Expended Training Materials – Alternative 1

Type of Training Material	Quantities of Training Materials by Alternative				Increase under Alternative 1 (%)	
	Alternative 1		No Action Alternative			
	Number	Weight (lb)	Number	Weight (lb)	Number	Weight
Bombs	180	79,900	120	54,000	50	48
Missiles	33	10,200	22	6,770	50	50
Targets and pyrotechnics	322	5,610	252	3,610	28	55
Naval gun shells	13,188	13,800	10,564	10,700	25	28
Small arms rounds	5,700	210	5,000	180	14	17
Sonobuoys	793	30,900	24	936	3,200	3,200
PUTR	7	2,100	NA	NA	NA	NA
Total	**20,223**	**143,000**	**15,982**	**76,200**	**26**	**87**

Note: Numbers of training items are estimates. Weights and percentages are rounded to a maximum of three significant digits.

Table 3.2-14: Expended Materials Considered Hazardous – Alternative 1

Type of Training Material	Weight of Material (lb)[1]		Hazardous Content (%)
	Expended	Hazardous	
Bombs	79,900	617	0.77
Missiles	10,200	84.5	0.83
Targets and pyrotechnics	5,610	190	3.39
Naval gun shells	13,800	1,650	12.0
Small-caliber rounds	210	2.10	1.00
Sonobuoys	30,900	2,340	7.57
PUTR	2,100	0	0
Total	**143,000**	**4,890**	**3.42**

Notes: Weights of expended materials and hazardous contents (%) are estimates, and are rounded to three significant digits. (1) Weights of hazardous materials are based on available information and may not include hazardous weight of all expended materials.

Bombs

Under Alternative 1, an additional 60 bombs would be expended annually, a 50-percent increase over the No Action Alternative. A 48-percent increase (from 54,000 lb [24,300 kg] to 79,900 lb [36,000 kg]) in the weight of training materials expended annually would occur under Alternative 1. The amount of unconsumed explosives would increase from 390 lb (176 kg) per year under the No Action Alternative to 617 lb (278 kg) per year under Alternative 1. This level of deposition would result in approximately 0.07 lb per nm^2 (0.01 kg per km^2) per year of hazardous material in the TMAA. Residual explosive materials would break down slowly, and would not be expected to accumulate. Sixty percent of the bombs used during training exercises would be inert. While inert bombs would contain a small amount of explosives (spotting charge), this amount would be negligible because it would be consumed upon contact with land or water. Given the potential impacts of bombs, as described for the No Action Alternative, and the low amount of hazardous materials, this increase over the No Action Alternative would not have measurable effects in the TMAA.

Missiles

Under Alternative 1, an additional 11 missiles (33 total) would be used over the No Action Alternative, a 50-percent increase over the No Action Alternative. The weight of expended materials would increase by the same percentage (from 6,770 lb [3,050 kg] to 10,200 lb [4,590 kg] per year). Expended hazardous materials would also increase by 50 percent, with 85 lb (38 kg) (57 lb [26 kg] of explosives and 28 lb [13 kg] of propellants being deposited annually in the TMAA. Explosives would leach slowly in the marine environment, and would not be expected to affect water or sediment quality because of the low quantity of material. Missile casings would have a minimal effect on the environment because their relatively inert materials would corrode, and become encrusted by benthic organisms and chemical processes. Hazardous materials would be deposited on the TMAA when missiles suffer ordnance failure or low-order detonations. The small increase in the weight of hazardous materials under Alternative 1 would not have a substantial effect on the environment because of its low density in the TMAA. Contaminants would leach slowly, and would be dispersed rapidly by ocean and tidal currents.

Targets and Pyrotechnics

Table 3.2-15 shows the types and numbers of targets and pyrotechnics that would be expended annually in the TMAA under Alternative 1.

Of the targets and pyrotechnics that would be used under Alternative 1, 322 items would not be recovered annually, which would be a 28-percent increase over the No Action Alternative. Unrecovered targets would deposit 5,610 lb (2,520 kg) of expended materials per year on the ocean floor, a 55-percent increase over the No Action Alternative. Most of the remaining targets and countermeasures are recovered after use, and these are constructed of relatively inert materials. If targets were lost, they would become buried in bottom sediments or wash up onshore.

Pyrotechnics would mostly be consumed by chemical reactions that produce smoke. Residual pyrotechnic materials from flares would weigh approximately 66 lb (30 kg). This amount of material, spread over 20 percent of the TMAA, would have minimal impacts on the marine environment. Ocean currents would quickly disperse materials, reducing concentrations below harmful concentrations. The use of chaff would not increase under Alternative 1 from that under the No Action Alternative. Chaff would not affect water or sediment quality, as described under the No Action Alternative.

TALDs used during training exercises would expend 24 thermal batteries per year. Thermal batteries would have effects on the marine environment similar to those of lithium batteries. Most of the hazardous materials in batteries would be consumed during activation. The steel casing would become encrusted through natural processes, further slowing any leaching of hazardous materials. This amount of expended batteries would not be expected to affect the marine environment.

Table 3.2-15: Targets and Pyrotechnics – Alternative 1

Types of Targets and Pyrotechnics	Number of Items		Increase Under Alternative 1	
	Alternative 1	No Action Alternative	Number	Percent (%)
Targets				
TDU-34 towed target	3	2	1	50
TALD*	12	8	4	50
BQM-74E unmanned aircraft	2	2	0	0
Killer Tomato surface target	12	10	2	20
SPAR	12	10	2	20
MK-39 EMATT*	20	0	20	NA
Pyrotechnics				
LUU-2B/B*	18	12	6	50
MK-58 Marine Marker*	60	20	40	200
Chaff*	212	212	0	0
Total number used	**351**	**276**	**75**	**27**
Total not recovered	**322**	**252**	**70**	**28**
Total expended weight (tons)	**5,610**	**3,610**	**2,000**	**55**

* Not recovered, NA = Not applicable

The use of EMATTs for ASW exercises would deposit 120 lb (56 kg) of expended lithium batteries per year in the TMAA. As described in Section 3.2.1.1, lithium batteries would not have substantial effects on marine conditions because most of the chemical components are abundant in seawater. The leaching rate of chemicals through the steel casing would be further slowed by encrusting from benthic organisms and natural processes. Thus, Under Alternative 1, no measurable impact on the environment would occur from the use of targets and countermeasures.

Naval Gun Shells

Under Alternative 1, there would be a 25-percent increase in expended shells compared to the No Action Alternative. HE shells would slightly increase to 56 shells from 40 under the No Action Alternative. Alternative 1 would deposit 13,800 lb (6,270 kg) of expended materials per year on the ocean floor, an increase of 28 percent over the No Action Alternative. Approximately 1,650 lb (750 kg) of this material would be hazardous. Hazardous materials would be heavy metals in projectiles and residual explosives, but any effect would be limited to the immediate surroundings of the expended round. Tungsten alloys in 20-mm rounds would not be expected to substantially affect marine water or sediment quality because the 20-mm rounds would have an areal density of less than 1.2 rounds per nm^2 (0.34 per km^2). Hazardous materials are discussed in detail in Section 3.2.1.1. This amount of hazardous materials would have an insignificant effect on marine resources. Given the inert nature of the majority of expended materials and the wide distribution across the training area, Alternative 1 would not have a measurable impact on the environment.

Small Arms Rounds

Under Alternative 1, 14 percent more small-caliber rounds (from 5,000 to 5,700 rounds) would be expended per year compared to the No Action Alternative. Expended small arms round would result in approximately 210 lb (95 kg) of expended material, but hazardous materials would only account for approximately 2.1 lb (0.9 kg) of the annually expended materials. Hazardous materials are discussed in detail in Section 3.2.1.1. Leached lead and antimony would increase the concentration of toxic chemicals in the immediate vicinity of expended small-caliber rounds, but these substances would quickly be dispersed by ocean and tidal currents. Given the generally inert nature of these materials, their low amounts of hazardous materials, their small size, and their wide distribution across the TMAA, the increase under Alternative 1 would not have a measurable impact on the environment.

Sonobuoys

Alternative 1 would introduce new ASW training exercises to the TMAA. ASW training would introduce a new target (MK-39 EMATT) and new types of sonobuoys. Table 3.2-16 summarizes the types and numbers of sonobuoys proposed for use under Alternative 1.

Table 3.2-16: Types and Numbers of Sonobuoys – Alternative 1

Type of Sonobuoy	Number of Items		Increase under Alternative 1 (%)
	Alternative 1	No Action Alternative	
SSQ-36 BT (passive)	60	24	150
SSQ-53 DIFAR (passive)	500	0	NA
SSQ-62 DICASS (active)	133	0	NA
SSQ-77 VLAD (passive)	60	0	NA
SSQ-110A IEER (explosive) or SSQ-125 AEER (Tonal)	40	0	NA
Total number used	**793**	**24**	**3,200**
Total weight (lb)	**30,900**	**936**	**3,200**

Notes: Numbers and weights of training items are estimates, and weights and percentages are rounded to three significant digits, NA = Not applicable. IEER - Improved Extended Echo Ranging Sonobuoy. AEER - Advanced Extended Echo Ranging Sonobuoy

Under Alternative 1, 793 sonobuoys would be expended annually. An even distribution of expended training materials over 20 percent of the TMAA would result in approximately 0.1 expended sonobuoys per nm^2 per year. Sonobuoys used during training would result in approximately 30,900 lb (13,900 kg) of expended material. Their annual density by weight would be about 3.7 lb per nm^2 (0.5 kg per km^2). The hazardous materials in the expended sonobuoys would weigh approximately 2,340 lb (Table 3.2-17).

Table 3.2-17: Hazardous Materials Content of Expended Sonobuoys – Alternative 1

Constituent	Hazardous Material Weight (lb)		Increase under Alternative 1 (%)
	Alternative 1	No Action Alternative	
Copper thiocyanate	1,260	38.1	3,200
Fluorocarbons	15.9	0.48	3,200
Copper	270	8.16	3,200
Lead	745	22.6	3,200
Tin/lead plated steel	47.6	1.44	3,200
Total	2,340	70.8	3,200

There would be a substantial increase in hazardous materials under Alternative 1, but the density would remain low (approximately 0.28 lb per nm^2 [0.04 kg per km^2] per year). This level of deposition of expended sonobuoys would have a minimal impact on ocean water resources under Alternative 1. Lead concentrations would not be expected to exceed USEPA standards because of the large area within which sonobuoys would be deployed and the dilution of leached lead by ocean currents. Detonation byproducts from explosive sonobuoys used under Alternative 1 would not have a substantial impact because of the large training area and the low number of explosive sonobuoys used during training exercises. Expended batteries would not substantially affect the marine environment because most of the hazardous constituents are consumed during use. The remaining hazardous materials would slowly leach, and would quickly be dispersed by ocean currents, resulting in concentrations of hazardous materials below harmful concentrations.

Portable Undersea Training Range

The PUTR would require the installation of seven anchors for the electronic components. Upon completion of training, these anchors would remain on the ocean floor. Each anchor weighs approximately 300 lb, which would result in approximately 2,100 lb of expended materials. Anchors would be made of concrete or sand bags, which would be covered by sand or sediment over time. There would be no hazardous materials associated with anchors and, thus, there would be minimal effects on the marine environment.

Summary –Alternative 1 Effects

Under Alternative 1, 20,223 items would be expended each year, with a deposition rate of 2.40 items per nm^2 (0.69 items per km^2) per year (see Table 3.2-13). Over 93 percent of the expended items would be naval gun shells or small arms rounds. Under Alternative 1, Navy training exercises would result in approximately 143,000 lb (65,000 kg) of expended materials per year in the TMAA. The density of expended materials distributed over 20 percent of the TMAA would be about 16.9 lb per nm^2 (2.23 kg per km^2) per year. Assuming Navy training under Alternative 1 would remain consistent for the next 20 years, the Navy would expend approximately 1,430 tons, for a total concentration of about 339 lb per nm^2 (44.7 kg per km^2). Most of these materials would be relatively inert in the marine environment, but would degrade slowly.

Only a small amount of expended materials would be considered hazardous (Table 3.2-14). Alternative 1 would result in an increase in the hazardous material of about 160 percent, but would only deposit approximately 0.58 lb per nm^2 (0.08 kg per km^2) of hazardous material across 20 percent of the TMAA. The majority of these materials would be residual explosives, which break down slowly. Any leaching chemicals would be quickly dispersed by ocean currents, and would not be expected to result in harmful concentrations. Thus, expended materials under Alternative 1 would not substantially affect marine resources.

3.2.2.6 Alternative 2 (Preferred Alternative)

Table 3.2-1 summarizes the types of training items that could present issues related to hazardous materials under Alternative 2. The numbers and weights of materials expended annually under Alternative 2 are provided in Table 3.2-18 and Table 3.2-19. Additionally, Alternative 2 would include two SINKEX events, with one occurring during each Carrier Strike Group exercise. During SINKEX, a decommissioned surface ship is towed to a deep-water location and sunk using a variety of ordnance. Each SINKEX event may include the use of one MK-48 ADCAP torpedo, which is only used at the end of SINKEX if the target is still afloat. The following discussion compares the numbers and types of training materials that would be expended annually under Alternative 2, the Preferred Alternative, to those under the No Action Alternative.

Bombs

Under Alternative 2, an additional 240 bombs, for a total of 360, would be used per year, a 200-percent increase over the No Action Alternative. Approximately 160,000 lb (72,000 kg) of bombs would be deposited on the ocean floor. This level of deposition would result in a density of approximately 19 lb per nm^2 (2.5 kg per km^2) of expended material per year over 20% of the TMAA. Eighty-two percent of the bombs would be inert, and the small amount of explosives contained in the spotting charge would be minimal. The amount of hazardous materials expended would increase from 390 lb per year under the No Action Alternative to 1,130 lb per year under Alternative 2. Alternative 2 would deposit approximately

0.13 lb per nm^2 (0.02 kg per km^2) per year of hazardous material in the TMAA. Hazardous materials are discussed in detail in Section 3.2.1.1. Explosives would leach slowly, and ocean currents would disperse leaching materials. Hazardous materials from bombs would be spread over a large area, and would break down. Explosive material would not accumulate on the ocean floor. Although this level of deposition would be a measureable increase over the No Action Alternative, the low areal density of hazardous materials would not be expected to affect water or sediment quality in the TMAA. Given the potential impacts of expended bombs under the No Action Alternative, this increase would have no measurable impact on the environment.

Table 3.2-18: Numbers and Weights of Expended Training Materials – Alternative 2

Type of Training Material	Quantity of Training Materials				Increase under Alternative 2 (%)	
	Alternative 2		No Action Alternative			
	Number	Weight (lb)	Number	Weight (lb)	Number	Weight
Bombs	360	160,000	120	54,000	200	200
Missiles	66	20,300	22	6,770	200	200
Targets/Pyrotechnics	644	11,200	252	3,610	160	210
Naval gun shells	26,376	27,500	10,564	10,700	150	160
Small arms rounds	11,400	420	5,000	180	130	130
Sonobuoys	1,587	61,900	24	936	6,500	6,500
PUTR	7	2,100	0	0	NA	NA
SINKEX[1]	858	67,800	0	0	NA	NA
Total	**41,298**	**352,000**	**15,982**	**76,200**	**160**	**360**

Notes: Weights of expended materials are estimates, and weights and percentages are rounded to three significant digits. (1) Due to the variability in weight of available ship hulks, the expended weight for SINKEX does not incorporate ship hulks, NA = Not applicable

Table 3.2-19: Expended Materials Considered Hazardous – Alternative 2

Type of Training Material	Weight of Material (lb)[1]		Hazardous Content (%)
	Total Expended	Hazardous	
Bombs	160,000	1,130	0.70
Missiles	20,300	169	0.83
Targets and pyrotechnics	11,200	381	3.40
Naval gun shells	27,500	3,310	12.0
Small-caliber rounds	420	4.20	1.00
Sonobuoys	61,900	4,680	7.56
PUTR	2,100	0	0
SINKEX	67,800	655	0.97
Total	**352,000**	**10,300**	**2.93**

Notes: Weights of expended materials are estimates, and are rounded to three significant digits. (1) Weights of hazardous materials are based upon available information, and may not include hazardous weight of all expended materials, NA = Not applicable

Missiles

Under Alternative 2, an additional 44 missiles (66 total) per year would be used over the No Action Alternative, a 200-percent increase. The weight of expended materials from missiles would increase at the same rate, resulting in 20,300 lb (9,140 kg) of expended materials from missiles, or 2.4 lb per nm^2 (0.3 kg per km^2), deposited per year in the TMAA. Hazardous material would make up 169 lb [77 kg] per year of the expended material from missiles. The density of hazardous materials would be approximately 0.02 lb per nm^2 (less than 0.01 kg per km^2). Hazardous materials would consist of explosives from dud missiles and missile propellants. Hazardous materials are discussed in detail in Section 3.2.1.1. Explosives from missiles would not be expected to affect water or sediment quality because of the small amount of hazardous material and its low density within the training area. Since most missiles (approximately 50 percent) would not employ explosive warheads, the increase over the No Action Alternative would not have measurable effects on the TMAA marine environment.

Targets and Pyrotechnics

Table 3.2-20 shows the types and numbers of targets and pyrotechnics that would be used annually under Alternative 2.

Table 3.2-20: Targets and Pyrotechnics – Alternative 2

Type of Target or Pyrotechnic	Number of Items		Increase Under Alternative 2	
	Alternative 2	No Action Alternative	Numerical	Percent (%)
Targets				
TDU-34 towed target	6	2	4	200
TALD*	24	8	16	200
BQM-74E unmanned aircraft	4	2	2	100
Killer Tomato surface target	24	10	14	140
SPAR	24	10	14	140
MK-39 EMATT*	40	0	40	NA
Pyrotechnics				
LUU-2B/B*	36	12	24	200
MK-58 Marine Marker*	120	20	100	500
Chaff*	424	212	212	100
Total number used	**702**	**276**	**426**	**150**
Total not recovered	**644**	**252**	**392**	**160**
Total expended weight (lb)	**11,200**	**3,610**	**7,610**	**210**

Notes: * Not recovered, NA = Not applicable. Percentages are estimates, and are rounded to two significant digits

Seventy-nine percent of the targets and pyrotechnics used under Alternative 2 would not be recovered. Unrecovered targets would deposit approximately 11,200 lb (5,040 kg) per year of expended materials in the TMAA. The density of expended targets and pyrotechnics within the affected areas would be approximately 1.3 lb per nm^2 (0.2 kg per km^2). Of the unrecovered expended materials, a large portion (about 68 percent) of expended materials would be pyrotechnics, which are mostly consumed by chemical reactions. Most of the expended materials would be relatively inert in the marine environment, with only 380 lb (170 kg) per year of expended materials considered to be hazardous, consisting of approximately 130 lb (59 kg) of residual pyrotechnic materials and 250 lb (113 kg) of batteries from EMATTs per year. This annual increase in the amounts of hazardous materials deposited in the TMAA would be expected to have minimal effects on the marine environment because of its density (0.05 lb per nm^2 [less than 0.01 kg per km^2]). Hazardous materials would be dispersed by ocean currents, and would not be expected to be at harmful concentrations.

TALD targets would not be recovered after training exercises. Under Alternative 2, TALDs would result in 48 expended thermal batteries per year (information on weight of batteries was not available). The effects of thermal batteries would be similar to those identified for lithium batteries. Batteries may contain hazardous materials, but would not be expected to have an effect on the marine environment because most hazardous constituents would be consumed during battery activity. Remaining hazardous materials would be leached slowly through the steel shell, and would not result in harmful concentrations because leached materials would be dispersed quickly by ocean currents.

Under Alternative 2, 1,080 lb (490 kg) of chaff would be used per year, an increase of 100 percent from the No Action Alternative. Chaff is generally nontoxic, and relatively inert in the marine environment. The constituents of chaff and their environmental fates are described in Section 3.2.1.1. Most of the remaining targets and countermeasures would be recovered after use, and these are constructed of mostly inert materials. Should they be lost at sea, they would become buried in bottom sediments or wash up onshore. Under Alternative 2, no measurable impact on the marine environment would result from expended chaff within the TMAA.

Naval Gun Shells

Under Alternative 2, the number of gun shells used would increase from 10,564 shells per year in the No Action Alternative to 26,376 shells per year under Alternative 2. The number of HE shells would increase from 40 under the No Action Alternative to 112 under Alternative 2. Alternative 2 would deposit 27,500 lb (12,500 kg) per year of expended materials on the ocean floor, with approximately 3,310 lb (1,500 kg) per year of that material considered to be hazardous. Hazardous materials are discussed in detail in Section 3.2.1.1. This amount of material would be expected to have negligible effects on the marine environment because effects would be limited to the immediate vicinity of the expended rounds. Annual increases in the amounts of hazardous materials would not cause harmful concentrations of heavy metals in the surrounding water column because of their low density (0.39 lb per nm^2 [0.05 kg per km^2]) and dispersal of leaching material by ocean currents. Tungsten rounds would not have substantial effects on the marine environment because expended 20-mm rounds would have an areal density of approximately 2.4 rounds per nm^2 (0.69 rounds per km^2). Given the inert nature of these materials and their wide distribution across the study area; these increases would not have measurable effects on the environment.

Small Arms Rounds

Alternative 2 would increase the deposition rates of small arms rounds by 130 percent, from 5,000 to 11,400 rounds per year. Expended small arms rounds would weigh 420 lb (190 kg). Hazardous materials would account for approximately 4.2 lb (1.9 kg) per year of expended small arms materials. Hazardous materials from small arms rounds would have a negligible effect on the marine environment. Hazardous materials are discussed in detail in Section 3.2.1.1. Leached lead and antimony would increase the concentrations of toxic chemicals in the immediate vicinity of expended small-caliber rounds, but these substances would quickly be dispersed by ocean and tidal currents. Given the relatively inert nature of these materials, with the exceptions of lead and antimony, their small size, and their wide distribution across the study area, this increase would have no measurable impact on the environment.

Sonobuoys

Under Alternative 2, 1,587 sonobuoys would be used per year. Assuming deposition of expended materials over 20 percent of the TMAA, the increase in their annual density would be approximately 0.2 sonobuoy per nm^2 (0.1 per km^2). Sonobuoys expended during training would deposit approximately 61,900 lb (27,900 kg) of material within the TMAA each year. About 4,680 lb (2,108 kg) of expended sonobuoys would be considered hazardous materials, which would result in approximately 0.56 lb per nm^2 (0.07 kg per km^2) of hazardous material per year. Hazardous materials are discussed in detail in Section 3.2.1.1. Table 3.2-21 compares the types and numbers of sonobuoys proposed under Alternative 2 to those under the No Action Alternative. Table 3.2-22 provides the weights of hazardous constituents for sonobuoys used under Alternative 2.

Table 3.2-21: Types and Numbers of Sonobuoys – Alternative 2

Type of Sonobuoy	Number of Items		Increase under Alternative 2 (%)
	Alternative 2	No Action Alternative	
SSQ-36 BT	120	24	400
SSQ-53 DIFAR (passive)	1,000	0	NA
SSQ-62 DICASS (active)	267	0	NA
SSQ-77 VLAD (passive)	120	0	NA
SSQ-110A IEER (explosive) or SSQ-125 AEER (Tonal)	80	0	NA
Total number used	**1,587**	**24**	**6,500**
Total weight (lb)	**61,900**	**936**	**6,500**

Notes: Numbers and weights of training items are estimates, and weights and percentages are rounded to three significant digits, NA = Not applicable

Table 3.2-22: Hazardous Materials from Expended Sonobuoys – Alternative 2

Constituent	Hazardous Material Weight (lb)		Increase under Alternative 2 (%)
	Alternative 2	No Action Alternative	
Copper thiocyanate	2,520	38.1	6,500
Fluorocarbons	31.7	0.48	6,500
Copper	540	8.16	6,500
Lead	1,490	22.6	6,500
Tin/lead plated steel	95.2	1.44	6,500
Total	**4,680**	**70.8**	**6,500**

Under Alternative 2, there would be a 6,500-percent increase in the amount of expended and hazardous materials from sonobuoys. However, this level of deposition of sonobuoys would have a minimal impact on marine environment because of the low density of hazardous materials (less than one lb per nm^2) per year. These materials would leach slowly, and would not result in harmful concentrations because of dispersion by ocean currents. Hazardous materials are discussed in detail in Section 3.2.1.1. As previously discussed for the No Action Alternative and Alternative 1, expended sonobuoys and their hazardous constituents would not result in adverse effects on the marine environment.

Portable Undersea Training Range

Under Alternative 2, PUTR would require the same number of anchors (seven) to be placed on the ocean floor as under Alternative 1. Anchors would be made of concrete or sand, and would not contain any hazardous materials. Any effects on the marine environment would be the same as under Alternative 1.

SINKEX

Under Alternative 2, two SINKEX would occur, with one occurring with each summertime activity. Table 3.2-23 provides a list of ordnance used during SINKEX.

Ordnance use during SINKEX would vary, based on training requirements and training conditions. For example, a MK-48 ADCAP torpedo would only be used at the conclusion of SINKEX if the target vessel was still afloat. This analysis assumes that the greatest number of each type of ordnance would be used during 2 SINKEX events under Alternative 2. Therefore, an estimated 858 ordnance items would be expended annually during 2 SINKEX events under Alternative 2.

Table 3.2-23: Ordnance Used during SINKEX

Ordnance Category	Ordnance Type	Number of Items
Missiles	AGM-65 Maverick	6
	AGM-84 Harpoon	10
	AGM-88 HARM	4
	AGM-114 Hellfire	2
	AGM-119 Penguin	2
	Standard Missile-1	2
	Standard Missile-2	2
Bombs	MK-82 (inert)	6
	MK-82 (live)	14
	MK-83	8
Naval Gun Shells	5-in gun shells	800
Torpedoes	MK-48 ADCAP torpedo	2
Targets	Surface Ship Hulk	2
	Total	**858**
	Total Expended Weight (lb)	**67,800**[1]

Notes: Numbers are cumulative for two separate SINKEX events.(1) Due to the variability in weight of available ship hulks, the total expended weight does not incorporate ship hulks

These expenditures would result in approximately 67,800 lb (30,500 kg) per year of expended materials. These materials would be used in a small area, resulting in a high density of expended materials, relative to other training events. For example, if each SINKEX activity were contained within 8 nm^2 (assuming an 8-hour event and a 1.0-nm-per-hour current), then the density of deposited materials on the ocean floor would be about 4,238 lb (1,926 kg) per nm^2. Each year, two of these relatively high-density areas of expended training materials would be created.

Most of these expended training materials would be relatively inert, with approximately 650 lb (290 kg) per year of hazardous material. Hazardous materials from expended ordnance would be residual explosives, propellant, and heavy metals (mostly lead). These materials would be in solid forms, and would leach slowly because of their low solubility. Ocean currents would disperse leaching materials to non-toxic concentrations. Therefore, this amount of hazardous materials would not be expected to affect the marine environment.

Under Alternative 2, two MK-48 ADCAP torpedoes would be expended during SINKEX events. Most of the expended material would be relatively inert in the marine environment. Hazardous materials information on MK-48 ADCAP torpedoes is confidential, but torpedoes (in general) could contain explosives, heavy metals, and propellants (OTTO Fuel II). Explosives and propellant would be mostly consumed during torpedo activation and detonation. Heavy metals would be in solid forms, and would leach at a slow rate because of natural processes (encrusting). The low number of torpedoes used under Alternative 2 would not result in substantial effects to the marine environment.

Alternative 2 would expend two surface vessels per year during SINKEX events. For SINKEX, the vessels used as targets are selected from a list of U.S. Navy approved vessels that have been cleaned in accordance with USEPA guidelines. By rule, SINKEX can only be conducted at least 50 nm (93 km) offshore and in water at least 6,000 feet (1,830 m) deep (40 CFR §229.2). USEPA considers the contaminant levels that would be released during the sinking of a target to be within the standards of the

Marine Protection, Research, and Sanctuaries Act (16 U.S.C. 1341, et seq.). As with other inert materials, the vessel would become encrusted by chemical processes and biological organisms. Therefore, vessels used as targets would not pose a hazard to ocean water resources.

Summary –Alternative 2 Effects

Under Alternative 2, there would be an increase in the number and weight of expended materials in the TMAA. Over 91 percent of the expended items would be naval gun shells or small arms rounds. The weight of expended materials under Alternative 2 would increase to 352,000 lb (160,000 kg) per year (360-percent increase over the No Action Alternative), with the largest percentage increase from expended sonobuoys. Navy training under Alternative 2 would deposit approximately 41 lb of expended material per nm^2 (5.4 kg per km^2) per year over 20 percent of the TMAA. Assuming Navy training under Alternative 2 would remain consistent for the next 20 years, the Navy would expend approximately 3,520 tons, for a total concentration of approximately 835 lb per nm^2 (110 kg per km^2). Expended bombs would account for most of the weight of expended materials, but the majority of this weight would be relatively inert material used as filler for practice bombs, such as concrete or sand. Under Alternative 2, approximately 10,300 lb (4,680 kg) per year of hazardous material would be expended (Table 3.2-19). Assuming deposition of expended materials on 20 percent of the TMAA, the increase in density of deposited hazardous materials would be approximately 1.2 lb per nm^2 (0.2 kg per km^2) per year.

Alternative 2 would also two SINKEX training activities. Materials expended annually during both SINKEXs are provided in Table 3.2-23. Target vessels expended during training would be cleaned according to USEPA standards, and would be relatively inert in the marine environment. Approximately 67,800 lb of ordnance would be expended annually, with less than one percent consisting of hazardous materials. The majority of materials expended during SINKEX training would be inert in the marine environment. SINKEX training would result in a relatively high areal density of expended and hazardous materials, within those portions of the TMAA used for this activity, compared to the overall areal density within the TMAA that would result from all other training exercises under Alternative 2.

3.2.3 Mitigation

As summarized in Section 3.2.4, the alternatives would contribute small amounts of hazardous materials to the environment. Given the large size of the training area and the expected fate and transport of the constituents, hazardous materials released to the environment by the Proposed Action are not likely to be present at detectable concentrations. Current Navy protective measures, such as hazardous waste management procedures, identified in Section 3.2.1.2, would continue to be implemented. No additional mitigation measures would be required under the Preferred Alternative.

3.2.4 Summary of Effects

Table 3.2-24 summarizes the effects of the No Action Alternative, Alternative 1, and Alternative 2 in terms of expended materials, including hazardous materials, under both NEPA and EO 12114.

Table 3.2-24: Summary of Effects by Alternative

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	Executive Order 12114 (Non-U.S. Territorial Seas, >12 nm)
No Action Alternative	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). No significant impacts related to expended materials will occur. • Aircraft overflights will not involve expenditures of training materials.	• Approximately 76,200 lb (34,600 kg) of training materials will be expended per year, with a density of 9.0 lb per nm^2 (1.2 kg per km^2) per year. • Approximately 1,870 lb (850 kg) of hazardous materials would be distributed at an estimated 0.22 lb per nm^2 (0.03 kg per km^2) per year. • Expended materials under the No Action Alternative will not have a substantial effect on the environment.
Alternative 1	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). No significant impacts related to expended materials would occur. • Aircraft overflights would not involve expenditures of training materials.	• Increase in training would deposit approximately 143,000 lb (65,000 kg) of expended materials, with a density of 16.9 lb per nm^2 (2.23 kg per km^2) per year. • Approximately 4,890 lb (2,220 kg) of hazardous materials would be distributed at an estimated 0.58 lb per nm^2 (0.08kg per km^2) per year. • Expended materials under Alternative 1 would not have a substantial effect on the marine environment.
Alternative 2 (Preferred Alternative)	• Under Alternative 2, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). No significant impacts related to expended materials would occur. • Aircraft overflights would not involve expenditures of training materials.	• There would be a large increase in the weight of expended materials (352,000 lb [160,000 kg]). • Hazardous materials would account for 2.9 percent (10,300 lb [4,680 kg]) per year of expended material, but density of these materials would be approximately 1.2 lb per nm^2. • SINKEX training would result in approximately 67,800 lb per year of expended materials, of which one percent would be considered hazardous. SINKEX would result in a relatively high areal density of expended materials on portions of the TMAA. • Expended materials under Alternative 2 would not have a substantial effect on the marine environment.

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3.3 WATER RESOURCES

3.3.1 Affected Environment

For purposes of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the Region of Influence (ROI) for water resources consists of the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA). Areas inland from the coastline, including United States (U.S.) Air Force (Air Force) air ranges and U.S. Army (Army) training lands, are addressed in the *Alaska Military Operations Areas EIS* (USAF 1995), *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999) and the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

In general, water resources include the following components:

- Water bodies, including lakes, ponds, rivers, groundwater, the ocean, and transitional areas such as wetlands and estuaries;
- Water processes, including ocean currents, seasonal changes in precipitation and resulting runoff, percolation from surface to aquifers, and biological, physical, and chemical changes that occur as water moves through the hydrologic cycle;
- Water uses, including drinking, recreation, commerce such as transportation and fishing, and plant and animal habitat;
- Water quality, including the chemical and physical composition of groundwater and fresh and marine surface waters, as affected by natural conditions and human activities; and
- The topography of the ocean bottom (bathymetry) that influences currents and sediment movement.

3.3.1.1 Ocean Water Resources

Alaska's water resources, including the GOA, are generally in pristine condition because of the low intensity of use in this remote area (U.S. Environmental Protection Agency [USEPA] 2004). Marine water resources in the study area are affected by ocean currents, climate and weather patterns, and bathymetry. Ocean currents influence conditions in the study area by altering surface water temperatures, transporting and depositing sediments, and concentrating or diluting the resources on which marine life depends. Similarly, prevailing winds change with the season and alter the movement of surface waters. During spring and summer, southerly winds push surface waters away from the coast and bring cold, nutrient-rich waters from deeper areas, a process known as upwelling. These processes sustain active fisheries for a variety of fish and marine invertebrates, influence weather patterns and the hydrologic cycle of much of the western United States, and play a vital role in the economy of many coastal communities.

Pacific Ocean

The TMAA is located in the Northeast Pacific Ocean off the mountainous coast of southern Alaska. The temporary boundaries of TMAA form a roughly rectangular area oriented from northwest to southeast, approximately 300 nautical miles (nm) (556 kilometers [km]) long by 150 nm (278 km) wide, situated south of Prince William Sound and Kenai Peninsula and east of Kodiak Island. Covering approximately 42,146 square nautical miles (nm^2) (145,482 square kilometers [km^2])of ocean, the TMAA spans both coastal and deepwater habitats ranging from approximately 426 feet (ft) (130 meters [m]) to over 12,000 ft (3,660 m) in depth. The GOA forms a large, semicircular bight opening southward into the North Pacific Ocean. The GOA is characterized by a broad and deep continental shelf containing numerous troughs, seamounts, and ridges. The region receives high amounts of freshwater input, experiences numerous storms, and exhibits highly variable environmental conditions (Department of Navy [DoN] 2006).

Continental Shelf

The GOA shoreline is bordered by a deep continental shelf subject to persistent coastal downwelling. The GOA continental margin is extremely irregular, having been shaped by glacial forces, plate tectonics, and ocean currents. Bottom depths along the shelf range from 490 ft to 660 ft (150 to 200 m). The continental shelf encompasses approximately 1.1×10^5 nm^2 (3.7×10^5 km^2) of ocean floor. The width of the continental shelf varies from 3 to 110 nm (5 to 200 km) at different points along the GOA (DoN 2006).

Seamounts

Seamounts are isolated underwater mountains rising 3,000 to 10,000 ft (900 to 3,000 m) above the surrounding ocean bottom. Seamounts are found in all oceans, but are most numerous in the Pacific Ocean, which has over 2,000. The significant seamounts in the TMAA are the Dall, Pratt, Giacomini, Ely, Quinn, and Surveyor Seamounts (Figure 3.3-1). These seamounts, except for Dall Seamount, are part of the Kodiak-Bowie Seamount chain, which is a chain of extinct volcanoes that formed over the Bowie Hotspot as the tectonic plate shifted. Seamounts provide a unique habitat for both deep-sea and shallow-water organisms because of their large ranges of depth, hard substrate, steep vertical gradients, convoluted surfaces, variable currents, clear oceanic waters, and geographic isolation. Upwelling often occurs around seamounts because currents push cold water from the depths up the slopes of the seamounts, bringing fresh nutrients to the surface.

Submarine Canyons

Submarine canyons have steep walls, winding valleys, narrow V-shaped cross-sections, steps, and considerable irregularity along the sea floor. Many troughs and canyons in the GOA transect the continental shelf (DoN 2006). They are the flooded remains of terrestrial canyons cut by large rivers fed by glacial meltwater. The floors of submarine canyons are primarily mud, with isolated sandy patches. Currents flowing through submarine canyons transport sediment from the coast to the deep ocean, forming sediment fans where they open to the abyssal plain.

The major troughs within the TMAA, Stevenson and Amatuli, are located on the eastern edge of Kodiak Island. These troughs are broad, U-shaped valleys that extend from near the shoreline to the shelf break. All of the troughs are relatively straight, running in a northwest to southeast orientation, and are often located between two broad submarine banks. The troughs along Kodiak Island range in depth from 490 ft to 980 ft (150 m to 300 m). The slope of the ocean floor in these troughs is gradual, rarely exceeding two degrees (DoN 2006).

The Aleutian Trench runs along the shelf margin in the Gulf of Alaska and is one of the deepest portions of the eastern North Pacific. It stretches from the southern coastline of Alaska to waters of the northeastern coast of Siberia. The trench is approximately 2,000 nm (3,700 km), with an average width of 27 nm (50 km) and a maximum depth of 25,300 ft (7,700 m) (DoN 2006). The Aleutian Trench is a tectonic subduction zone, where the Pacific Plate is subducted under the North American Plate.

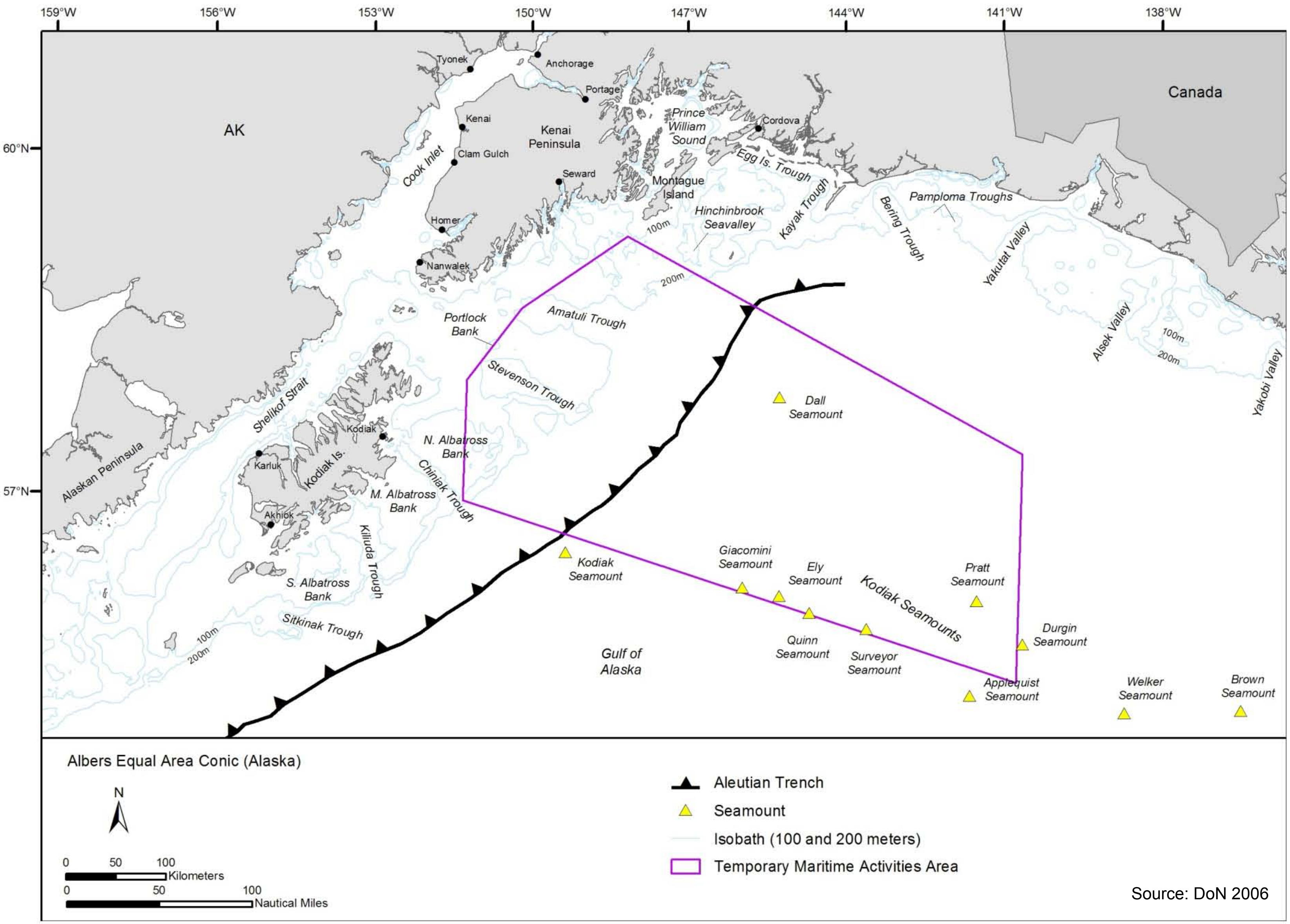

Figure 3.3-1: Major Geological Features of the TMAA and Vicinity

Abyssal Plain

The abyssal plain is a relatively flat area of the deep ocean floor beyond the foot of the continental slope. Depths vary from 9,800 to 16,000 ft (3,000 to 5,000 m) (DoN 2006). The abyssal plain is relatively flat and featureless because fine-grained sediments, mostly silt and clay, have filled in the originally uneven surface of oceanic crust. Most of this sediment is deposited by currents that have been channeled from the continental margins along submarine canyons. The remainder of the sediment is dust blown out to sea from land and the remains of small marine plants and animals that sink from the upper layer of the ocean, known as pelagic sediment.

Climate

The GOA remains ice-free for the entire year, with the warmest sea surface temperatures in August and the coldest sea surface temperatures in February and March. Portions of bays and inlets may be covered by ice or may have floating glacial ice during the coldest months.

El Niño

El Niño Southern Oscillation (El Niño) events affect the GOA; these events can initiate large shifts in global climate, atmospheric circulation, and oceanographic processes. El Niño conditions typically last 6 to 18 months, but can persist for longer periods. El Niño events cause global changes over time scales of months to years. El Niño is caused by the interannual changes in sea level pressures between the eastern and western hemispheres of the tropical Pacific Ocean. The trade winds weaken in the central and western Pacific Ocean, and cause the normal east-to-west surface water transport to decrease. The result is a rise in the sea surface temperature across the mid- to eastern Pacific Ocean (DoN 2006).

La Niña

La Niña is the opposite phase of El Niño in the Southern Oscillation cycle, and is usually associated with the opposite climatic effects. La Niña is characterized by strong trade winds that push the warm surface waters back across to the western Pacific Ocean. Under these conditions, along with increased upwelling along the eastern Pacific Ocean coastline, the thermocline in the eastern Pacific Ocean becomes shallower (DoN 2006). (The thermocline is that portion of the water column between a relatively warm surface zone and a colder deep-water zone, in a thermally stratified [layered] body of water, where the temperature decreases rapidly with increasing depth).

Arctic Oscillation

The Arctic Oscillation (AO), which affects the GOA, varies based on atmospheric changes in the polar region and mid-latitudes. It varies between negative and positive phases on a decadal scale. The negative phase generally consists of higher-than-normal pressure over the polar region, while the positive phase consists of intense low pressure (USEPA 2004). The low-pressure system results in stormy weather, with high winds and increased precipitation, as well as elevated sea levels and warmer water temperatures. Under these conditions, the wind-induced cross-shelf transport and the Alaska Coastal Current (ACC) increase (DoN 2006).

Ocean Currents

The general ocean circulation in the GOA is dominated by the counter-clockwise Alaska Gyre, centered at approximately 52º to 53º north (N) and 145º to 155º west (W). The Gyre includes the Alaska Current (AC), the Alaskan Stream (AS), and the North Pacific Current (NPC). Nearshore flow is dominated by the ACC (DoN 2006).

North Pacific Current

The NPC, also called the West Wind Drift, flows along the southern boundary of the GOA at a velocity of 2 to 6 inches per second (in/sec) (5 to 15 centimeters per second [cm/sec]). The NPC originates in northern Japan, and flows eastward toward North America. The NPC diverges off of the western coast of North America; the northward flow becomes the AC, while the southward flow becomes the California Current. Along the Aleutian Islands, some water from the AS re-circulates into the NPC (DoN 2006).

Alaska Current

The AC is a northward-flowing, warm-water current offshore of the continental shelf. The AC is broad, 54 to 220 nm (100 to 400 km) wide, and highly variable. It is the dominant transport system of surface waters in the GOA. The AC flows adjacent to the coast of North America at velocities between 30 and 100 cm/sec (DoN 2006). The AC frequently meanders and eddies along the shelf break, most frequently in the fall. Eddies propagate shoreward as the AC proceeds north, with troughs or trenches from the shelf break creating clockwise eddies toward shore (DoN 1993). These eddies cause a variety of ocean currents near the edge of the continental shelf. The AC flows northward along the coast of Alaska to the head of the GOA, where the current follows the curve of the shoreline and forms the AS. Shifts in regional climate also can play a role in the AC. For example, during an El Niño event, the AC destabilizes, increasing the variability in flow volume and direction (DoN 2006).

The AC originates in the western Pacific Ocean, and marine pollution and floating refuse from Asia, from open ocean dumping and from accidents at sea, can be swept northward and westward around the shelf edge in the GOA. Trash from the international fishing industry operating 200 miles offshore is commonly found on beaches in the region (DoN 2006).

Alaska Coastal Current

The ACC is the primary element of shelf circulation in the GOA. This current originates along the continental shelf of British Columbia. In some years, however, the ACC may start as far south as the Columbia River. The ACC flows west throughout the year along the inner third of the continental shelf, which is approximately 19 nm (35 km) from shore. It is fed by winds, runoff from glaciers, snowmelt, rainfall, and freshwater discharge. The width, speed, and depth of the ACC vary with location along the coast. Late fall and early winter are periods of maximum transport because of accumulated freshwater discharge and strong winds. ACC velocities may exceed 39 in/sec (100 cm/sec) during this period. Minimum transport occurs in the early summer, prior to the spring melt, when local wind stress is weak. The ACC provides a sizeable and ecologically important transition zone between the nearshore and oceanic communities (DoN 2006).

Alaskan Stream

The AS, which forms at the head of the GOA, is the extension of the AC, and flows westward along the Alaska Peninsula. The AS is narrow (185 nm [100 km]) and swift (18 to 48 in/sec [45 to 123 cm/sec]), affecting the upper 1,600 ft (500 m) of the water column. Periods of low pressure during the AO affect the velocity of the AS; velocities increase northeast of Kodiak Island and decrease southwest of the island (DoN 2006).

Ocean Water Parameters

Ocean water parameters of interest include temperature, salinity, dissolved oxygen, nutrients, and alkalinity (pH). These parameters influence the rates of chemical and biological processes and the mobility of various substances, such as dissolved metals.

Temperature

The GOA can be generally characterized by two surface temperature regimes throughout the year. Relatively warm surface water occurs over the continental shelf, while colder water is found farther offshore beyond the shelf break. Surface temperatures within the AC vary by approximately 20 degrees Fahrenheit (°F) (10 degrees Celsius [°C]) throughout the year. On the inner shelf, mean monthly sea surface temperatures (SSTs) range from approximately 38°F (3.5°C) in March to 57°F (14°C) in August. Across the shelf, changes in SSTs are generally small (approximately 4°F [2°C]). The overall difference in annual temperature diminishes with depth, with the annual range being only 2°F (1°C) at depths greater than 490 ft (150 m). During winter, intense circulation over the GOA produces easterly coastal winds and downwelling, which results in a well-mixed water column over the continental shelf. Stratification develops during summer because of decreased winds, increased freshwater discharge, and increased solar radiation (DoN 2006).

Anomalous warmer SSTs in the GOA often are associated with El Niño events. El Niño events do not always result in an immediate shift in SSTs in the North Pacific Ocean; SST anomalies were detected in the region one year after the onsets of the 1976, 1982, 1986, and 1992 El Niño events. During positive AOs, the GOA experiences above-average SSTs. Negative AOs result in below-average SSTs (DoN 2006).

Salinity

The North Pacific Ocean is less saline than the North Atlantic Ocean. Fresh water entering the North Pacific Ocean inhibits the development of deep water masses, which affects oceanic heat transport. The annual average fresh water influx is approximately 8.1×10^5 cubic feet per second (ft^3/sec) (23,000 cubic meters per second [m^3/sec]). This runoff enters the marine environment through many small drainage systems. The discharges peak in early fall and decrease rapidly during winter, when precipitation is stored as snow. A secondary runoff peak occurs in spring and summer from snowmelt in the region. This discharge, approximately 20 percent greater than the mean annual Mississippi River discharge, accounts for nearly 40 percent of the freshwater flows into the GOA. The phasing and magnitude of these freshwater flows are important, because salinity primarily affects horizontal and vertical density gradients in the northern GOA. Seasonal variability in the upper layers of the offshore Alaska Gyre reflects the effects of wind-induced mixing and heat exchange with the atmosphere (DoN 2006).

The vertical salinity structure of the GOA and Alaska Gyre consists of a seasonally varying upper layer extending from the surface to approximately 330 ft (100 m) depth, a halocline (a strong, vertical salinity gradient) that extends from 330 ft to 660 ft (100 m to 200 m) depth, where the salinity increases from 33 to 34 practical salinity units (psu), and a deep layer extending to approximately 3,300 ft (1,000 m), where the salinity increases slowly to 34.4 psu. Beneath the deep layer, the salinity increases gradually to a maximum value of approximately 34.7 psu at the ocean bottom. The halocline is a permanent feature of the subarctic North Pacific Ocean. It is formed by the high rates of precipitation and runoff, in conjunction with large-scale circulation processes of the North Pacific Ocean. The strong density gradient of the halocline limits vertical exchange between the saline and nutrient-rich deep water and the upper layer (DoN 2006).

During the winter, salinities in the upper layer of ocean water range from 32.5 to 32.8 psu. The upper layer in the northern GOA is less saline and colder than the upper layer in the southern GOA. During spring, the upper layer gradually becomes less saline and warms because wind speeds decrease and solar heating increases. Salinities reach a minimum of approximately 25 psu in August. Decreasing wind speeds allow intrusion of high salinity waters from the oceanic regions of the GOA onto the shelf. The summer mixed layer includes a weak secondary halocline, a vertical salinity gradient, centered at approximately 98 ft (30 m) depth. As atmospheric cooling and wind-mixing increase in fall, the seasonal water density gradient erodes rapidly and the physical properties of the upper layer revert to winter conditions (DoN 2006).

Dissolved Oxygen, Nutrients, and pH

The major chemical parameters of marine water quality include dissolved oxygen, nutrient concentrations, and pH. The major ions present in seawater include sodium, chloride, potassium, calcium, magnesium, and sulfate.

Surface waters are usually saturated or supersaturated with dissolved oxygen as a result of photosynthetic activity and wave mixing. Below the surface, dissolved oxygen generally remains between 0.4 and 0.6 milliliter per liter (mL/L). Anaerobic (no oxygen) conditions are found in bottom sediments and at the water-sediment interface in deep ocean basins (Dailey et al. 1993).

Nutrients are chemicals or elements necessary to produce organic matter. In marine systems, basic nutrients include dissolved nitrogen, phosphates, and silicates. Dissolved inorganic nitrogen occurs in ocean water as nitrates, nitrites, and ammonia, with nitrates as the dominant form. The nitrate concentration of nearshore water varies from 0.1 to 10.0 micrograms per liter (µg/L). The lowest concentrations typically occur in summer. At a depth of 33 ft (10 m), the concentration of phosphate ranges from 0.25 to 1.25 µg/L, while the concentration of silicate ranges from 2.0 to 15 µg/L (Dailey et al. 1993).The marine environment has relatively stable pH (between 7.5 and 8.5) because of the presence of dissolved elements, particularly carbon and hydrogen. Most of the carbon in the sea is present as dissolved inorganic carbon that originates from the complex interaction of dissolved carbon dioxide (CO_2) and water. This CO_2-carbonate equilibrium system is the major buffering system in seawater, meaning that it keeps pH stable.

Existing Ocean Water Quality

There is little information on open ocean water quality, but some studies suggest that deep water is generally of higher quality than surface waters. Water quality in the marine environment is determined by complex interactions between physical, chemical, and biological processes. Physical processes include regional currents and tidal flows, seasonal weather patterns and temperature, sediment characteristics, and unique local conditions.

Chemical processes involve salinity, pH, dissolved minerals, oxygen, nutrient levels, and pollutants. Biological processes involve the influence of living things on the physical and chemical environment, such as the uptake, conversion, and excretion of materials during growth, reproduction, and decomposition. These processes operate and interact continuously, creating a dynamic system. Changes in these conditions alter the viability of habitat at certain locations and water depths to various organisms. For instance, excessive nutrients (eutrophication) can lead to algal blooms, subsequent die-offs, and declines in dissolved oxygen (hypoxia) to the point where fish can no longer survive.

Contaminants found in marine environments include suspended solids, sediment, nutrients and organic debris, metals, synthetic organic compounds such as pesticides and plastics, and pathogens. The sources of these contaminants include commercial and recreational vessels, oil spills, industrial and municipal discharges (point source pollution), legal and illegal ocean dumping, poorly or untreated sewage, and runoff from urban and agricultural areas (nonpoint source pollution). Conduits for contamination include streams, rivers, and air currents that carry materials from inland areas to the sea. Alaska coastal resources are generally considered to be pristine because of the low population density and the distance of most of its coastline from major urban and industrial areas (USEPA 2004).

Potential pollutants should be viewed in the context of their “bioavailability,” that is, the capacity of material to be taken up by living organisms through physical contact or ingestion. If a pollutant is not available to the organisms in the ecosystem, then it does not have an environmental impact. Factors that influence bioavailability include the ocean water parameters noted previously (i.e., temperature, salinity, dissolved oxygen, nutrients, and pH). In sediments, bioavailability is influenced by particle size, organic carbon content, the presence of iron oxyhydroxides and iron sulphides, and the presence of other metals.

<u>Ocean Sediment Parameters</u>

A variety of ocean floor sediment compositions are found within the GOA. Sediment types include gravely sand, silty mud, muddy to sandy gravel, and hard rock. The northeastern GOA continental shelf is mainly composed of clay silts from the Copper River or glacial deposition. The western area has steep slopes and visible scouring. There are many banks and reefs with primarily coarse or rocky bottoms, while basins and other depressions may accumulate bottom sediments (National Oceanographic and Atmospheric Administration [NOAA] 2005).

The mountains surrounding the GOA are geologically young, and provide plentiful sources of sediment to the marine environment. Glacial scouring of the underlying bedrock also provides an abundance of fine-grained sediments to the Gulf of Alaska shelf and basin. The Bering and Malaspina glaciers are major sources of glacial sediments in the Gulf of Alaska. The Alsek and Copper Rivers in the northern GOA, and the Knik, Matanuska, and Susitna Rivers that feed Cook Inlet all contribute sediment as well (DoN 2006). The majority of rivers along the Pacific Coast drain small, steep watersheds that produce large amounts of sand-sized sediment. Submarine canyons are major conduits for sediment transport to the open ocean. The remainder of the sediment is composed of dust blown out to sea from land, and the remains of small marine plants and animals that sink from the upper layer of the ocean. The Continental Rise in the eastern GOA is an accumulation of sediments from the continental shelf; these fine sediments are generally transported west.

Existing Ocean Sediment Quality

Several factors influence the extent and severity of sediment contamination in aquatic systems. Fine-grained (less than 0.63 micrometer [μm]), organic-rich sediments bind some toxicants, such as heavy metals, so strongly that their threat to organisms is greatly reduced. Conversely, these fine-grained sediments are also easily resuspended and transported to distant locations. Thus, silty sediments high in total organic carbon are potential sources of contamination. But such statements do not apply equally to all potential pollutants. Metals such as lead and large organic molecules such as polycyclic aromatic hydrocarbons and polychlorinated biphenyls tend to remain in sediments. More soluble chemicals tend to remain as ions in the pore water surrounding the sediments (Canadian Forces Maritime Experimental and Test Ranges [CFMETR] 2005). At this time, there are no data on sediment quality within the TMAA.

3.3.1.2 Current Requirements and Practices

At sea, Navy vessels are required to operate in a manner that minimizes or eliminates any adverse impacts on the marine environment. Environmental compliance policies and procedures applicable to shipboard operations afloat are defined in Chief of Naval Operations Instruction (OPNAVINST) 5090.1C, Chapter 3, “Pollution Prevention,” and Chapter 19, “Environmental Compliance Afloat” (DoN 2007a); Department of Defense (DoD) Instruction 5000.2-R (§C5.2.3.5.10.8, “Pollution Prevention”). In addition, provisions in Executive Order (EO) 12856, *Federal Compliance With Right-To-Know Laws and Pollution Prevention Requirements*, and EO 13101, *Greening the Government through Waste Prevention, Recycling, and Federal Acquisition* reinforce the prohibition in the Clean Water Act (CWA) against discharge of harmful quantities of hazardous substances into or upon U.S. waters out to 200 nm (371 km), and mandate stringent hazardous waste discharge, storage, dumping, and pollution prevention requirements. Table 3.3-1 provides information on Navy Standard Operating Procedures and Best

Management Practices for shipboard management, storage, and discharge of hazardous materials and wastes, and on other pollution protection measures intended to protect water quality. Onshore policies and procedures related to spills of oil and hazardous wastes are detailed in OPNAVINST 5090.1C, Chapter 12. (DoN 2007a).

Shipboard waste-handling procedures governing the discharge of nonhazardous waste streams have been established for commercial and Navy vessels. These categories of wastes include solids (garbage) and liquids such as "black water" (sewage), "gray water" (water from deck drains, showers, dishwashers, laundries, etc.), and oily wastes (oil-water mixtures). Table 3.3-1 summarizes the waste stream discharge restrictions for Navy vessels at sea.

Table 3.3-1: Waste Discharge Restrictions for Navy Vessels

Zone (nm from shore)	Type of Waste	
	Black Water (Sewage)	**Gray Water**
U.S. Waters (0-3 nm)	No discharge.	If vessel is equipped to collect gray water, pump out when in port. If no collection capability exists, direct discharge permitted.
U.S. Contiguous Zone (3-12 nm)	Direct discharge permitted.	Direct discharge permitted.
>12 nm from shore	Direct discharge permitted.	Direct discharge permitted.
Zone	**Oily Waste**	
U.S. Waters (0-3 nm)	Discharge allowed if waste has no visible sheen. If equipped with Oil Content Monitor (OCM), discharge < 15 parts per million (ppm) oil.	
U.S. Contiguous Zone (3-12 nm)	Same as 0-3 nm.	
>12 nm from shore	If equipped with OCM, discharge < 15 ppm oil. Vessels with oil/water separator but no OCM must process all bilge water through the oil-water separator.	
Zone	**Garbage (Plastic)**	**Garbage (Non-plastic)**
U.S. Waters (0-3 nm)	No discharge.	No discharge.
U.S. Contiguous Zone (3-12 nm)	No discharge.	Pulped or comminuted food and pulped paper and cardboard waste may be discharged >3nm
12-25 nm from shore	No discharge.	Bagged shredded glass and metal waste may be discharged >12nm[1]
> 25 nm from shore	No discharge	Direct discharge permitted[2]

Note: (1) Submarines may discharge compacted, sinkable garbage between 12 nm and 25 nm provided that the depth of water is greater than 1,000 fathoms.
(2) Surface ships shall use pulpers and shredders for all discharges of food products, paper, cardboard, glass and metal wastes
Source: DoN 2007a

3.3.2 Environmental Consequences

The ROI for water resources includes the GOA TMAA (Section 3.3.1). Navy training activities within Air Force inland Special Use Airspace and Army inland training lands were evaluated under previous National Environmental Policy Act (NEPA) documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents are incorporated by reference. Environmental effects in the open ocean beyond the U.S. territorial seas (outside of 12 nm [22 km]) are analyzed in this EIS/OEIS pursuant to EO 12114.

3.3.2.1 Previous Analyses

Impacts related to water resources were previously evaluated in Section 3.1 of the *Alaska Military Operations Area EIS* (USAF 1995); Section 3.0 of the *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007); Sections 3.8, 3.9, 4.8, and 4.9 of the *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999); and Sections 3.5, 3.6, 4.5, and 4.6 of the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

3.3.2.2 Regulatory Framework

Marine ecosystems in the study area developed around, and are sustained by, the chemical, physical, and biological processes and the seasonal patterns in each environment. The health of these systems, as well as human use of the water resources in the study area, is monitored and protected by international, federal, State, and local laws and regulations. The following subsections describe the legal and regulatory framework applicable to military training activities in the GOA. International, federal, and State regulations on solid waste and hazardous materials are described in Section 3.2, Expended Materials.

International

MARPOL 73/78, the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978, is the primary international marine environmental convention. MARPOL 73/78 is designed to minimize pollution from ships. It contains six major annexes or sections: I-Oil, II-Noxious Liquid Substances in Bulk, III-Harmful Substances Carried by Sea in Packaged Form, IV-Sewage from Ships, V-Garbage from Ships, and VI-Air Pollution from Ships. Discharges from ships are restricted within specified distances from shore. On the open seas, natural bacterial action is considered adequate for dealing with raw sewage. The U.S. is not party to Annex IV-Sewage from Ships (USEPA 2009); however, the Navy regulates discharges from vessels under OPNAVINST 5090.1C (Table 3.3-1).

Federal

The principal federal law protecting water quality is the Federal Water Pollution Control Act, more commonly known as the CWA (33 U.S. Code [U.S.C.] 1251 et seq.), which is enforced by the USEPA. In addition, NOAA oversees coastal and marine water resources under CWA, the Coastal Zone Management Act (CZMA), the Marine Plastic Pollution Research and Control Act (MPPRCA), and the Oil Pollution Act (OPA). NOAA also is responsible for managing and protecting coastal and marine habitats through its National Marine Fisheries Service (NMFS).

Clean Water Act

The goal of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation’s waters, including coastal and marine waters. The USEPA establishes National Ambient Water Quality Criteria (USEPA 2006) for priority and non-priority pollutants. These criteria for aquatic life and human health include both seawater and freshwater concentrations. These criteria are published for enforcement through Section 304(a) of the CWA. Various CWA sections govern point sources and nonpoint sources of pollution. Oil and hazardous substances are regulated by CWA §311 out to the boundary of the contiguous zone. Point sources include industrial and publicly owned facilities, such as those for wastewater treatment (CWA §402). Discharges from point sources require permits under the National Pollutant Discharge Elimination System. Military vessels are not considered point-source dischargers under the CWA (Section 502[6]).

CWA also created Uniform National Discharge Standards that regulate incidental liquid discharges from military vessels operating in inland waters and the ocean out to 12 nm (22 km). This program is jointly administered by the DoD, USEPA, and U.S. Coast Guard. Twenty-five vessel discharges requiring control standards have been identified under Phase I of the program. Phase II involves developing performance standards and control procedures for those discharges. The program also established processes that USEPA and states must follow to establish no-discharge zones in which any release of a specified discharge is prohibited. At this writing, there are no designated no-discharge zones within the GOA TMAA.

Coastal Zone Management Act

The federal CZMA (16 U.S.C. 1451, et seq.) is a voluntary state-federal partnership that encourages states to adopt programs that meet federal goals of protecting and restoring coastal zone (CZ) resources, including protecting coastal waters from nonpoint source pollution (16 U.S.C. 1455[b]). The program is administered by NOAA. The CZMA requires participating coastal states to develop management programs that demonstrate how they will carry out their obligations and responsibilities in managing their coastal areas. Upon federal approval of a state’s coastal zone management program, the state benefits by becoming eligible for federal CZ grants. Activities that occur in the CZ or affect CZ resources are regulated by the adjoining state after federal approval of its coastal zone management plan. The state also gains review authority over certain federal activities in the CZ, and the consistency of those activities with the CZ management plan.

Marine Plastic Pollution Research and Control Act

The MPPRCA of 1987 (33 U.S.C. §§ 1901 et seq.) regulates the discharge of garbage, primarily plastics, into the ocean. Under this federal statute, the discharge of any plastic materials (including synthetic ropes, fishing nets, plastic bags, and biodegradable plastics) into the ocean is prohibited. The discharge of other materials, such as floating dunnage (cargo packing materials), food waste, paper, rags, glass, metal, and crockery, is also regulated by the MPPRCA. Ships are permitted to discharge these types of refuse depending on their distance from shore. It is illegal to dump most garbage within 3 nm of shore. From 3 to 12 nm (5.6 to 22 km), it is illegal to dump plastic or any garbage greater than one inch (in) in size. It is illegal to dump dunnage and plastics within 12 to 25 nm (22 to 46 km) of shore. An additional component of the MPPRCA requires that all ocean-going, U.S.-flagged vessels greater than 40 ft (12.2 m) in length or manned, fixed, or floating platforms subject to U.S. jurisdiction keep records of garbage discharges and disposals.

Oil Pollution Act

The OPA (33 U.S.C. §§ 2701 et seq.), passed in 1990, increased the protection of our nation’s oceans by amending the CWA and including new policies relating to oil spill prevention and cleanup methods. The OPA provides regulations for the prevention of the discharge of oil into the ocean waters out to the limits of the contiguous zone (out to 25 nm). Any party that is responsible for a vessel, offshore facility, or deepwater port that could cause an oil spill must maintain proof of financial responsibility for potential damage and removal costs. OPA identifies the parties that are liable in a variety of oil spill circumstances and what damage and removal costs must be paid. The President has the authority to use the Oil Spill Liability Trust Fund to cover these costs when necessary. Any cost for which the fund is used must be in accordance with the National Contingency Plan, which is an oil and hazardous substance pollution prevention plan established by the CWA. Federal, state, Indian tribe, and foreign trustees must assess the natural resource damages that occur from oil spills in their trusteeships, and develop plans to restore the damaged natural resources. The Act also establishes an Interagency Coordinating Committee on Oil Pollution Research to research and develop plans for natural resource restoration and oil spill prevention.

Marine Protection, Research, and Sanctuaries Act

The Marine Protection, Research, and Sanctuaries Act of 1972, also known as the Ocean Dumping Act, regulates materials dumped into ocean waters that could endanger human health, welfare, and amenities, and the marine environment, ecological systems, and economic possibilities. The Ocean Dumping Act regulates the disposal of any material in the U.S. territorial seas or contiguous zones, as well as the marine disposal anywhere of waste and other material that originated in U.S. territory or was transported on U.S.-registered vessels or aircraft.

Transport of Target Vessels

Ship hulks used as targets for Sinking Exercises (SINKEX) are required to comply with 40 Code of Federal Regulations (CFR) §229.2, Transport of Target Vessels. This is a general permit for the Navy to transport vessels in ocean waters for the purpose of sinking the vessel. Vessel sinkings must be conducted in water at least 6,000 ft (1,830 m) deep and at least 50 nm (93 km) from land. Regulations require that measures be taken to ensure that the vessel sinks to the bottom rapidly and permanently, and does not pose a hazard to marine navigation. Materials that could degrade the marine environment are removed, to the maximum extent possible.

State and Local

Navy training in the TMAA occurs more than 12 nm (22 km) from shore, which is beyond the State of Alaska's regulatory jurisdiction. Therefore, State and local regulations on water quality do not apply to Navy training in the TMAA. The following section is provided only for informational purposes.

Water Quality and Pollution Standards

State regulation of water quality is enforced by the Alaska Department of Environmental Conservation (ADEC). The ADEC establishes water quality standards, which may not be consistent with USEPA standards, for enforcement through the Water Quality Standards program. State standards focus on specific water constituents that affect water quality in Alaska. These standards are used to enforce the CWA, but are not effective until approval by USEPA. Protected classes of water bodies are identified in 18 Alaska Administrative Code 70.020, where marine water supply, recreation, propagation of aquatic life and wildlife, and harvest and consumption of raw mollusks and other raw wildlife are all considered under the Water Quality Standards program. The marine water quality standards address fecal coliform bacteria, dissolved gases, petroleum hydrocarbons, oil, grease, and other constituents.

Sediment Management Standards

Alaska does not have a sediment quality management program. Due to the extensive shoreline, very little sediment testing is conducted on a regional scale. The State has begun researching cost-effective methods for testing sediment quality, but no actions have been taken. No State standards have been developed.

Coastal Zone Management

The Alaskan Legislature enacted the Alaska Coastal Management Act in 1977 (Chapter 84 State Legislature of Alaska 1977), which established the Alaska Coastal Management Plan (ACMP). The CZ extends from 3 nm (5.6 km) offshore to inland areas necessary to control the shoreline, and where land uses would have a substantial effect on coastal resources. The ACMP addresses a variety of issues, including the sustainability of fisheries, impacts of mining, transportation needs and impacts, and other areas of concern within the CZ. The Alaska Department of Natural Resources is the primary authority for the ACMP. Twenty-eight of Alaska's 33 coastal districts are revising their plans to be consistent with the new enforceable policies, updated in 2003 and 2005. The ACMP is described and its applicability to Navy training in the TMAA is discussed in Section 1, Purpose and Need of Proposed Action.

Sources of Information

A systematic review of relevant literature was conducted to complete this analysis of water resources in the study area, including journals, DoD reports and operational manuals, natural resource management plans and other technical reports published by government agencies, prior environmental documents for facilities and activities in the study area, and work conducted by private businesses and consulting firms.

3.3.2.3 No Action Alternative

This section analyzes the circumstances under which water quality in the TMAA could be affected by expended materials during training under the No Action Alternative. The No Action Alternative is the baseline for Navy training in the TMAA. Under the No Action Alternative, training exercises are conducted once per year for a short period (up to 14 days). Potential impacts on water quality will result from expended training materials in the marine environment. Expended materials that contain hazardous constituents may affect water quality because hazardous materials can be released during use (i.e. combustion byproducts), directly deposited into the marine environment (i.e. residual explosive material), or leach from expended materials after deposition. Expended training materials may contain several sources of hazardous chemicals, such as missiles that contain heavy metals, propellant, batteries, and explosives. The following section addresses substances of concern, the training materials in which they are found, and their potential impacts on water quality. Detailed analyses of expended and hazardous materials, their possible pathways for insertion into the marine environment, and their environmental fates are provided in Section 3.2, Expended Materials.

This analysis assumes that 99 percent of expended training materials are deposited on 20 percent of the available training area (DoN 2009). This is a conservative assumption that is based on Navy personnel experience, which indicates that the distribution of training activities within sea training areas is not uniform. The TMAA is an ocean area of approximately 42,146 nm^2 (145,482 km^2). Twenty percent of the TMAA is approximately 8,430 nm^2 (29,100 km^2).

Aircraft overflights occur under all of the alternatives. Aircraft transiting between the TMAA and Alaska inland training areas would not expend any training materials. Therefore, aircraft overflights associated with Navy training in the GOA will not be further addressed in this section.

Heavy Metals

Heavy metals are present in vessels, manned and unmanned aircraft, bombs, shells, missiles, bullets, sonobuoys, batteries, and electronic components, and as anticorrosion compounds coating exterior surfaces (e.g., missiles, vessels). Heavy metals that may be present in expended materials include lead, antimony, brass, copper, nickel, chromium, and cadmium. The USEPA recommends application of a 24-hour acute limit and 4-day chronic limit. Neither limit can be exceeded more than once every 3 years, on the average. Water quality criteria for several pollutants expected to result from expended materials during Navy training are provided in Table 3.3-2.

Fuels and Propellants

Hazardous chemicals include fuels and other propellants, and combustion byproducts of those fuels and propellants (Section 3.2, Expended Materials). These materials are present in or may be generated by the use of aircraft, vessels, and self-propelled machines such as Expendable Mobile Anti-Submarine Warfare (ASW) Training Targets (EMATTs) and unmanned aerial vehicles.

Table 3.3-2: Threshold Values for Safe Exposure to Selected Metals

Metal	Criteria (µg/L)	
	Acute (24-hr exposure)	Chronic (4-day mean exposure)
Lead	210	8.1
Silver	1.9	n/a
Copper	4.8	3.1
Cadmium	40	8.8
Nickel	74	8.2
Silver	1.9	n/a
Lithium[1]	6,000	n/a

n/a = no chronic value is available; µg/L = micrograms per liter; hr = hour
(1) No USEPA criteria available; values shown are based on literature (Kszos et al. 2003)
Source: USEPA 2006

Explosives

Explosives are contained in live bombs, missiles, and one type of sonobuoy. Most new military explosives are mixtures of plastic or other polymer binders and Royal Demolition Explosive (RDX, cyclotrimethylene trinitramine) or High Melting Explosive (cyclotetramethylene tetranitramine). Pentaerythritol tetranitrate is used in blasting caps, detonation cord, and similar initiators of explosions. Explosives that fail to function as designed (duds) or are low-order detonations result in residual explosives. Dud and low-order detonation rates are discussed in Section 3.2, Expended Materials.

Non-Hazardous Expended Materials

Non-hazardous expended materials include the parts of a device that are made of nontoxic metals (e.g., steel, iron, aluminum) or polymers (e.g., nylon, rubber, vinyl, and various other plastics); as well as glass and concrete. These materials are used in inert bombs, inert shells, and targets. While these items represent persistent seabed litter, they do not chemically contaminate the environment by leaching heavy metals or organic compounds because of their strong resistance to degradation and their chemical composition. Most of these objects will settle to the bottom. There they will lodge in deep sediments and eventually be covered by sediment. The expended materials may become coated by corrosion (e.g., rust on metal surfaces) or encrusted by marine organisms (e.g., coral), slowing chemical leaching. Therefore, these materials are not subject to further analysis.

Other Factors Influencing Marine Water and Sediment Quality

The open ocean and nearshore environments are complex and dynamic systems of physical, chemical, and biological components. These components continually influence each other, and are also influenced by other factors. This complexity can make accurately identifying the source of a particular material or predicting the ultimate fate of specific materials expended during training a challenge. For example:

- Many contaminants are conveyed into marine systems by the wind or by surface runoff, such as from rivers.
- Once training materials are deposited, natural physical, chemical, and biological processes can re-suspend, transport, and redeposit these materials in areas far removed from their original source.
- The properties of seawater, such as temperature, salinity, pH, dissolved oxygen concentration, and hardness, affect the mobility and the toxicity of contaminants. The presence of other substances in seawater, such as extremely small particles (< 0.63 µm), bicarbonates, sulfides, phosphates, and other metals, also affect the mobility and the toxicity of contaminants.

Materials Expended During Training in the TMAA – No Action Alternative

Table 3.3-3 summarizes the number of items, the weight of expended materials, and the weight of hazardous materials that will be deposited on the ocean floor in the TMAA.

Table 3.3-3: Training Materials Expended Per Year – No Action Alternative

Type of Training Material	Number of Items	Weight of Material (lb)		Hazardous Content (%)
		Expended Materials	Hazardous Materials	
Bombs	120	54,000	395	0.73
Missiles	22	6,770	56.4	0.83
Targets and pyrotechnics	252	3,610	27.2	0.75
Naval gun shells	10,564	10,700	1,320	12.3
Small arms rounds	5,000	180	1.80	1.00
Sonobuoys	24	936	70.8	7.56
Total	**15,982**	**76,200**	**1,870**	**2.45**

Note: Weights of expended and hazardous materials are estimates, and are rounded to three significant digits.

Bombs

Approximately 120 bombs per year will be expended in the TMAA under the No Action Alternative, resulting in approximately 54,000 pounds (lb) (24,300 kilograms [kg]) of expended materials. Assuming a distribution of expended materials over 20 percent of the TMAA, the deposition rate of expended bombs will be approximately 6.4 lb of material per nm^2 (0.83 kg per km^2) per year. Bombs used during training exercises will deposit approximately 395 lb (180 kg) per year of hazardous materials (residual explosives and heavy metals). This rate will increase the amounts of hazardous materials deposited in the TMAA by less than 0.05 lb per nm^2 (less than 0.01 kg per km^2) per year. The majority of bombs (60 percent) will be inert. They will settle to the ocean bottom, and become encrusted by chemical processes and marine organisms. Inert bombs may contain explosive spotting charges. The amounts will be small, however, and will be consumed upon contact with land or water. Therefore, inert bombs will present no hazard to ocean water resources. Live bombs will have no measurable impact on ocean water resources because most of their hazardous constituents will be consumed upon detonation and a low percentage (approximately 3.37 percent [Rand 2005]) would be duds.

Missiles

Table 3.3-4 describes the types of explosives and propellants for selected types of missiles used in the TMAA under the No Action Alternative.

In general, the single largest hazardous constituent of missiles is solid propellant, such as solid double-base propellant, aluminum and ammonia propellant grain, and arcite propellant grain. The solid propellant is primarily composed of rubber (polybutadiene) mixed with ammonium perchlorate. Hazardous constituents, such as Plastic Bonded Explosive (PBX) high-explosive (HE) components, PBX-106 explosive, and PBX (AF)-108 explosive, are also used in igniters, explosive bolts, batteries (potassium hydroxide and lithium chloride), and warheads. Testing has demonstrated that water penetrates only 0.06 in (0.15 cm) into solid propellants during the first 24 hours of immersion, and that fragments will very slowly release ammonium and perchlorate ions (DoN 2007a). These ions will be rapidly diluted and disperse in the surrounding water such that local concentrations will be extremely low.

Table 3.3-4: Explosives and Propellants in Selected Missiles – No Action Alternative

Type of Missile	Number Expended	Type of Propellant
AIM-7 Sparrow	6	Propellant is dual-thrust, solid-fuel rocket motor (Hercules MK-58); warhead is an 88-lb (40 kg) WDU-27/B blast-fragmentation device.
AIM-9 Sidewinder	8	Propulsion system contains up to 44 lb (20 kg) of solid double-base propellant; warhead contains approximately 10 lb (4.5 kg) of PBX HE.
AIM-120 AMRAAM	6	Propellant is solid-fuel rocket motor (ATK WPU-6B booster and sustainer with RS hydroxyl-terminated polybutadiene (solid propellant fuel); warhead contains 40 lb (18 kg) of HE.
RIM-67A Standard Missile-1	2	Propellant is a two-stage, solid-fuel rocket (MK-30 sustainer motor and a Hercules MK 12 booster); warhead contains 137 lb (62 kg) of HE.

Source: Global Security 2008a

Another concern is when ordnance does not function correctly—it either does not detonate ("dud") or does not detonate completely (low-order detonation), and some of the explosive remains. As with propellants, these materials can release small amounts of hazardous materials into the water as they degrade and decompose. Table 3.3-5 provides a list of these items.

Table 3.3-5: Ordnance Constituents of Concern

Training Ordnance	Constituent of Concern
Pyrotechnics, Tracers, and Spotting charges	Barium chromate and Potassium perchlorate
Oxidizers	Lead oxide
Delay Elements	Barium chromate, Potassium perchlorate, and Lead chromate
Propellants	Ammonium perchlorate
Fuses	Potassium perchlorate
Detonators	Fulminate of mercury and Potassium perchlorate
Primers	Lead azide

Source: United States Army Corps of Engineers 2007

Twenty-two missiles will be used annually under the No Action Alternative, and no missiles will be recovered after training exercises. The total weight of missiles expended will be 6,770 lb (3,050 kg) each year. If deposited on 20 percent of the training area, this will be a deposition rate of 0.8 lb per nm^2 (0.1 kg per km^2) per year. Approximately 56.4 lb (25.6 kg) of expended missile material (approximately 38 lb [17 kg] of residual explosives and 18 lb [8.1 kg] of residual propellant) would be considered hazardous. Residual explosives and solid propellants will slowly leach hazardous substances, but would not result in concentrations considered to be harmful. Missile casings are relatively inert, and will corrode in the marine environment. Corrosion and benthic organisms will encrust the missile body, further slowing degradation. Thus, expended training materials will not impact water resources.

Targets and Pyrotechnics

Table 3.3-6 summarizes the types and numbers of targets and pyrotechnics that will be used in the TMAA under the No Action Alternative. About 276 targets and pyrotechnics will be used annually during training exercises, and 252 (91 percent) will not be recovered after training use. Twenty marine markers and 12 LUU-2B/B illuminating flares will be used, and will be mostly consumed as heat and smoke during use. Approximately 27 lb (12 kg) of residual pyrotechnic material will be expended in the TMAA per year during Navy training. Pyrotechnics make up 97 percent of the unrecovered targets and pyrotechnics.

Table 3.3-6: Types and Numbers of Targets and Pyrotechnics – No Action Alternative

Type of Target or Pyrotechnic	Number of Items
Targets	
TDU-34 towed target	2
Tactical Air-Launched Decoy (TALD)*	8
BQM-74E unmanned aircraft	2
Killer Tomato surface target	10
SPAR	10
Pyrotechnics	
LUU-2B/B*	12
MK-58 Marine Marker*	20
Chaff*	212
Total number used	**276**
Total not recovered	**252**
Total Expended Weight (lb)	**3,610**

*Not recovered

Under the No Action Alternative, 540 lb (245 kg) of chaff will be used per year. All components of the aluminum coating are present in seawater in trace amounts, except magnesium, which is present at 0.1 percent. The stearic acid coating is biodegradable and nontoxic. The potential for chaff to have a long-term adverse impact on water quality is very unlikely, and chemicals leached from the chaff will also be diluted by the surrounding seawater, thus reducing the potential for concentrations to build up to levels that can affect sediment quality and benthic habitats. Further analysis of chaff and its environmental effects is provided in Section 3.2, Expended Materials.

Even though chaff dipoles contain aluminum and other trace metals that can ultimately be leached from the chaff, the amount of chaff needed to raise environmental concentrations of these metals above background levels far exceeds the number than can be realistically deposited in a given area of land or body of water. Chaff is generally resistant to chemical weathering, and likely remains in the environment for long periods. Chaff is much like aluminosilicate minerals, so its influence on the physical environment will be small, and likely limited to settling with bottom geology (DoN 2007b). Ocean waters are in constant contact with crustal materials, so there is little reason to believe that small amounts of chaff would affect either water or sediment composition (Hullar et al. 1999).

Naval Gun Shells

Under the No Action Alternative, 10,564 gun shells will be expended each year. Assuming a distribution of expended materials over 20 percent of the TMAA, the deposition rate of expended naval gun shells will be approximately 1.26 items per nm^2 (0.36 items per km^2) per year. Navy training in the TMAA will deposit an estimated 1,320 lb (600 kg) of hazardous material from shells (heavy metals) in the TMAA. Expended training materials from naval gun shells are relatively inert. Expended materials may contain heavy metals, but effects on water and sediment quality will be limited to a small area around the expended round. Expended materials will settle to the sea bottom, where they will become encrusted by chemical processes and marine organisms. Metals will leach slowly, and will not pose a hazard to ocean water resources because leached constituents will be rapidly dispersed by ocean currents.

Small Arms Rounds

Five thousand small arms rounds will be expended per year under the No Action Alternative, which will result in approximately 180 lb of expended material. Assuming a distribution of expended materials over 20 percent of the TMAA, small arms expended materials will result in a deposition rate of 0.6 item per nm^2 (0.17 item per km^2) per year. The weight of expended small arms rounds will be minimal (180 lb [81kg]), with about 2 lb (less than one kg) of hazardous material (heavy metals) from Navy training exercises in the TMAA. This deposition will have minimal impacts on ocean water resources because its density is low and the materials are relatively inert.

Sonobuoys

The No Action Alternative will use SSQ-36 Bathythermograph (BT) sonobuoys, which monitor water temperature. Sonobuoys consist of two main sections: a surface unit that contains the seawater battery and a metal subsurface unit. Sonobuoy components of concern for water resources are the seawater batteries, lithium batteries, battery electrodes, metal housing, lead solder, copper wire, and lead used for ballast. Sonobuoys also expend inert materials, such as parachutes and nylon wire.

Batteries

Each sonobuoy contains a seawater battery, housed in the upper, floating portion, which supplies power to the sonobuoy. These seawater batteries contain about 300 grams of lead, in addition to battery electrodes composed of lead chloride, cuprous thiocyanide, or silver chloride. In cases where the upper portion of the sonobuoy is lost to the seabed, the lead batteries are also lost. Silver chloride, lithium, or lithium iron disulfide thermal batteries are used to power subsurface units. The lithium-sulfur batteries used typically contain lithium sulfur dioxide and lithium bromide, but may also contain lithium carbon monofluoroxide, lithium manganese dioxide, sulfur dioxide, and acenitrile (a cyanide compound). During battery operation, the lithium reacts with the sulfur dioxide to form lithium dithionite. Lithium iron disulfide thermal batteries are used in Directional Command Activated Sonobuoy System (DICASS) sonobuoys. An important component of the thermal battery is a hermetically sealed casing of welded stainless steel 0.03- to 0.1-in thick that is resistant to the battery electrolytes (Klassen 2005).

The evaluation of the potential effects associated with seawater batteries includes comparing the expected concentrations of potentially toxic battery constituents with USEPA water quality criteria established for the protection of aquatic life or with conservative toxicity thresholds available from the literature. Chemical reactions of sonobuoy batteries proceed almost to completion once the cell is activated, and only a small amount of reactants remain when the battery life ends. These residual materials will slowly dissolve and become diluted by ongoing ocean and tidal currents. Given the mobility of the most soluble battery constituent, lead chloride, there is a low potential for substantial accumulations of contaminants in sediments. As the outside metal case corrodes, it becomes encrusted by seawater processes and marine organisms, thus slowing the rate of further corrosion. Many of the components of concern are coated with plastic to reduce corrosion, providing an effective barrier to water exchange. In instances where seawater causes the body of the sonobuoy to corrode, that corrosion will take at least 40 years (Klassen 2005).

Lithium always occurs as a stable mineral or salt, such as lithium chloride or lithium bromide (Ksozos 2003). Lithium is naturally present in freshwater, soil, and sediment. A study demonstrated that sodium ions in saltwater mitigate the toxicity of lithium to sensitive aquatic species. (Fathead minnows [*Pimephales promelas*] and water fleas [*Ceriodaphnia dubia*] were unaffected by lithium concentrations as high as 6 milligrams per liter [mg/L] in the presence of tolerated concentrations of sodium). In the marine environment, therefore, where sodium concentrations are at least an order of magnitude higher than tolerance limits for the tested freshwater species, lithium would be essentially nontoxic. Because of these factors, lithium batteries would not adversely affect marine water quality. One estimate concluded that 99 percent of the lithium in a battery would be released to the environment over 55 years. The release will result in a dissolved lithium concentration of 83 mg/L in the immediate area of the breach in the sonobuoy housing. At a distance of 5.5 mm from the breach, the concentration of lithium will be about 15 mg/L, or 10 percent of typical seawater lithium values (150 ppm); thus it would be difficult to distinguish the additional concentration due to the lithium leakage from the background concentration (Klassen 2005).

Two studies involved on-site or laboratory studies of batteries expended from U.S. Coast Guard aid-to-navigation sites (USEPA 2001, Borener and Maughan 1998). Sediment samples were taken adjacent to and near the navigation sites, and were analyzed for all metal constituents in the batteries. Results indicated that metals were either below or consistent with background levels or compared favorably with NOAA sediment screening levels, "reportable quantities" under the Comprehensive Environmental Response, Compensation, and Liability Act §103(a), or USEPA toxicity procedures.

A study by the Navy (DoN 1993) examined the impact of materials released by activated seawater batteries in sonobuoys that freely dissolve in the water column (e.g., lead, silver, and copper ions), as well as nickel-plated steel housing, lead solder, copper wire, and lead shot used for sonobuoy ballast. The study concluded that constituents released by saltwater batteries, as well as the decomposition of other sonobuoy components, did not exceed state or federal standards, and that the reaction products are short-lived in seawater. A detailed description of this study is provided in Section 3.2, Expended Materials.

The impacts of lead and lithium (among other materials) were studied at the CFMETR near Nanoose Bay, British Columbia, Canada (CFMETR 2005). These materials are common to EMATTs, Acoustic Device Countermeasures, sonobuoys, and torpedoes. The CFMETR study noted that lead is a naturally occurring heavy metal in the environment. Cores taken of marine sediments in the test range show a steady increase in lead concentration from the bottom of the core to a depth of approximately 8 in (20 cm). Sediments found at this depth were deposited during the late 1970s and early 1980s, and their elevated lead concentrations were attributed to deposition of atmospheric lead derived from a gasoline additive. The sediment cores showed a general reduction in lead concentration with decreasing depth, coincident with the phasing out of lead-based additives in gasoline by the mid-1980s. The study also noted that studies at other ranges have shown minimal impacts of lead ballasts because they are usually buried deep in marine sediments where they are not biologically available. The study concluded that there would be no effects from the lead ballasts due to the low probability of mobilization (CFMETR 2005).

Regarding lithium, cores of marine sediments taken in the test range showed fairly consistent lithium concentrations with depth, indicating little change in lithium deposition with time. Compared with ambient lithium concentrations from outside the range, the report concluded that "it is difficult to demonstrate an environmental impact of lithium caused by CFMETR" (CFMETR 2005).

Lead in Sonobuoys

Sonobuoys contain other metal and nonmetal components, such as metal housing (nickel-plated, steel-coated with polyvinyl chloride plastics to reduce corrosion), batteries, lead solder, copper wire, and lead used for ballast that, over time, can release hazardous constituents into the surrounding water. Most of the other sonobuoy components are either coated with plastic to reduce corrosion or are solid metal. The slow rate at which solid metal components are corroded by seawater translates into slow release rates into the marine environment. Once the metal surfaces corrode, the rate of metal released into the environment decreases. Releases of chemical constituents from all metal and nonmetal sonobuoy components are further reduced by natural encrustation of exposed surfaces. Therefore, corrosive components of the sonobuoy do not substantially degrade marine water quality. Sonobuoy hazardous components are analyzed in Section 3.2, Expended Materials.

Under the No Action Alternative, 24 SSQ-36 BT sonobuoys will be expended each year. These expended materials will weigh approximately 936 lb (421 kg), and will be deposited on the ocean floor at a rate of 0.11 lb per nm^2 (0.01 kg per km^2) per year. Approximately 71 lb (32 kg) per year of hazardous materials will be deposited by sonobuoy use in the TMAA. This rate of hazardous materials deposition is not expected to affect water resources. The effects of sonobuoy batteries will be as described in this section. Expended sonobuoys may contaminate nearby water and sediment, but ocean and tidal currents will disperse these chemicals quickly. Thus, with the low concentration of expended training materials in the study area, sonobuoy use under the No Action Alternative in GOA will not have substantial effects on water resources.

Summary – No Action Alternative Effects

Table 3.3-3 provides a summary of expended materials that will be deposited on the floor of the ocean in the TMAA. Under the No Action Alternative, 15,982 items will be expended each year during training exercises. Assuming a distribution of expended materials over 20 percent of the TMAA, the deposition rate of expended materials will be 1.92 items per nm^2 (0.55 items per km^2) per year. The weight of all expended materials will be approximately 76,200 lb (34,600 kg) tons per year, at a density of 9.0 lb per nm^2 (1.2 kg per km^2) of ocean per year. Assuming Navy training under the No Action Alternative would remain consistent for the next 20 years, the Navy will expend approximately 762 tons, at a density of 181 lb per nm^2 (23.8 kg per km^2) of ocean. Of the expended materials, only a small amount would be considered hazardous (approximately 2.45 percent or 1,870 lb [850 kg]). Given that many of these materials are relatively inert, this level of deposition will have minimal impacts on ocean water resources.

3.3.2.4 Alternative 1

Under Alternative 1, there would be an increase in training tempo in the TMAA, which would increase the amount of expended training materials. Alternative 1 would introduce ASW training exercises that would use additional sonobuoys and underwater targets. This section analyzes the possible impacts of water quality from training in the TMAA under Alternative 1. Table 3.3-7 summarizes the expended materials for Navy training under Alternative 1. Table 3.3-8 shows the weight of hazardous materials in each type of training material and the percentage of hazardous materials in the total expended materials weight.

Table 3.3-7: Training Materials Expended Annually – Alternative 1

Type of Training Material	Alternative 1		No Action Alternative		Increase under Alternative 1 (%)	
	Number	Weight (lb)	Number	Weight (lb)	Number	Weight
Bombs	180	79,900	120	54,000	50	48
Missiles	33	10,200	22	6,770	50	50
Targets & pyrotechnics	322	5,610	252	3,610	28	55
Naval gun shells	13,188	13,800	10,564	10,700	25	28
Small arms rounds	5,700	210	5,000	180	14	17
Sonobuoys	793	30,900	24	936	3,200	3,200
PUTR	7	2,100	NA	NA	NA	NA
Total	**20,223**	**143,000**	**15,982**	**76,200**	**26**	**87**

Note: Weights of expended materials are estimates, and are rounded to three significant digits; PUTR: Portable Undersea Training Range

Table 3.3-8: Expended Materials Considered Hazardous – Alternative 1

Type of Training Material	Weight of Material (lb)[1]		Hazardous Content (%)
	Expended Material	Hazardous Material	
Bombs	79,900	617	0.77
Missiles	10,200	84.5	0.83
Targets and pyrotechnics	5,610	190	3.39
Naval gun shells	13,800	1,650	12.0
Small-caliber rounds	210	2.10	1.00
Sonobuoys	30,900	2,340	7.57
PUTR	2,100	0	0
Total	**143,000**	**4,890**	**3.42**

Note: Weights of expended materials are estimates, and are rounded to three significant digits
(1) Weights of hazardous materials are based upon available information, and may not include hazardous weight of all expended materials.

<u>Materials Expended During Training – Alternative 1</u>

Bombs

Under Alternative 1, 180 bombs would be expended each year in the TMAA (a 50-percent increase over the No Action Alternative). Alternative 1 would increase the amount of bombs by 60, of which 36 would be inert. Inert bombs may contain spotting charges, but the small amount of explosives would have negligible impacts on the environment. Navy training in the TMAA would result in approximately 79,900 lb (36,000 kg) of expended bomb material each year Assuming expended materials from bombs would be deposited on 20 percent of the TMAA, their deposition rate would be approximately 9.51 lb per nm^2 (2.76 lb per km^2) of ocean per year. The amount of hazardous material (unconsumed explosives) would increase from 390 lb per year under the No Action Alternative to 617 lb per year under Alternative 1. This rate of deposition would increase the concentration of hazardous materials on portions of the ocean bottom in the TMAA by approximately 0.07 lb per nm^2 (0.01 kg per km^2). Expended materials would settle to the sea bottom. Materials would corrode and become encrusted through chemical processes and marine organisms. Chemical leaching rates would decrease and, therefore, pose no hazard to ocean water resources. The additional use of bombs under Alternative 1 would have no measurable adverse impacts because the density of expended bombs on the ocean floor would be low and relatively inert materials would be the majority of the expended material weight.

Missiles

Under Alternative 1, 33 missiles would be expended per year, an increase of 11 over the No Action Alternative. The weight of expended materials would be 10,200 lb (4,590 kg), with a deposition rate of approximately 1.21 lb per nm^2 (0.16 kg per km^2) of ocean per year. Hazardous materials would also increase by 50 percent, with 85 lb (38 kg) (57 lb [26 kg] of explosive and 28 lb [13 kg] of propellant) of hazardous materials being deposited per year in the TMAA. As noted under the No Action Alternative, no expended missiles would be recovered. The primary constituents of concern in missiles (i.e., solid propellant) would be expended in the marine environment if the missile failed to function properly. Solid propellants decompose very slowly in the marine environment. Ocean and tidal currents would disperse these materials to undetectable concentrations under Alternative 1. Thus, there would be no substantial impact on water resources.

Targets and Pyrotechnics

Table 3.3-9 compares the types and numbers of targets and pyrotechnics under Alternative 1 to those under the No Action Alternative.

Table 3.3-9: Targets and Pyrotechnics Expended Annually – Alternative 1

Type of Target or Pyrotechnic	Number of Items		Increase under Alternative 1	
	Alternative 1	No Action Alternative	Numerical	Percent
Targets				
TDU-34 towed target	3	2	1	50
TALD*	12	8	4	50
BQM-74E unmanned aircraft	2	2	0	0
Killer Tomato surface target	12	10	2	20
SPAR	12	10	2	20
MK-39 EMATT*	20	0	20	0
Pyrotechnics				
LUU-2B/B*	18	12	6	50
MK-58 Marine Marker*	60	20	40	200
Chaff*	212	212	0	0
Total number used	**351**	**276**	**75**	**27**
Total not recovered	**322**	**252**	**70**	**28**
Total Expended Weight (lb)	**5,610**	**3,610**	**2,000**	**55**

Note: * not recovered

Under Alternative 1, the number of targets and pyrotechnics used in the TMAA would increase by 27 percent (75 items). Targets and pyrotechnics not recovered represent 92 percent of all training materials. The weight of expended targets would increase by 55 percent, but the density of expended materials on the ocean floor would be low because of the large area of the TMAA. A new type of target (MK-39 EMATT) would be used during ASW exercises. The use of EMATTs for ASW exercises would expend 120 lb (56 kg) per year of lithium batteries. Approximately 22 percent of unrecovered items are flares (MK-58 and LUU-2B/B), the bulk of which are consumed as heat and smoke. Annual residual pyrotechnic materials from flares would weigh approximately 66 lb (30 kg). No additional chaff would be used under Alternative 1, and chaff effects would be similar to effects under the No Action Alternative. Given the small amount of hazardous materials and the inert nature of most components, these training materials would not have a measurable impact on ocean water resources.

Naval Gun Shells

Alternative 1 proposes a 25-percent increase in the number of naval gun shells (13,188 gun shells or 13,800 lb [6,270 kg]) over the No Action Alternative. Assuming that expended materials would be deposited on 20 percent of the TMAA, the deposition rate of expended materials would be approximately 1.57 gun shells or 1.64 lb per nm^2 (0.45 gun shell or 0.22 kg per km^2) of ocean per year. Approximately 1,650 lb (750 kg) per year of these materials would be hazardous. Naval gun shells are generally inert in the marine environment. Expended shells may contain heavy metals, such as lead, but these metals would be a small percentage of the shell. The shells would settle to the ocean bottom and corrode, becoming encrusted by chemical processes and marine organisms. Any effects would be limited to the immediate area around the expended shell; ocean currents would disperse leached substances quickly. Therefore, expended materials from naval gun shells under Alternative 1 would not affect ocean water resources.

Small Arms Rounds

Under Alternative 1, 5,700 small-caliber rounds would be expended each year in the TMAA, a 14-percent increase over the No Action Alternative. Assuming that expended training materials would be deposited on 20 percent of the TMAA, expended small arms would have a deposition rate of approximately 0.7 item per nm^2 (0.20 item per km^2) of ocean per year. Expended training materials would result in 210 lb (95 kg) per year of material being deposited on the ocean floor, of which approximately 2.1 lb (0.9 kg) per year would be considered hazardous. Given the inert nature of the majority of these items, this rate of deposition would not have a substantial impact on ocean water resources.

Sonobuoys

Alternative 1 would introduce ASW as a new training mission area to the TMAA. ASW would use sonobuoys to assist aircraft and surface vessels in locating submarines. Table 3.3-10 shows the types and numbers of sonobuoys proposed under Alternative 1.

Table 3.3-10: Sonobuoys Expended Annually – Alternative 1

Type of Sonobuoy	Number of Items		Increase under Alternative 1 (%)
	Alternative 1	No Action Alternative	
SSQ-36 BT (passive)	60	24	150
SSQ-53 DIFAR (passive)	500	0	NA
SSQ-62 DICASS (active)	133	0	NA
SSQ-77 VLAD (passive)	60	0	NA
SSQ-110A IEER (explosive) or SSQ-125 AEER (Tonal)	40	0	NA
Total Number	**793**	**24**	**3,200**
Total Weight (lb)	**30,900**	**936**	**3,200**

Notes: Numbers and weights of training items are estimates, and are rounded to three significant digits; NA = Not applicable; DIFAR: Directional Frequency Analysis and Recording; VLAD: Vertical Line Array Directional Frequency Analysis and Recording; IEER: Improved Extended Echo Ranging Sonobuoy; AEER: Advanced Extended Echo Ranging Sonobuoy.

Under Alternative 1, 793 sonobuoys would be expended each year. Assuming that expended sonobuoys would be deposited on 20 percent of the TMAA, the deposition rate would be approximately 0.1 expended sonobuoy per nm^2 (0.03 sonobuoy per km^2) of ocean per year. Expended sonobuoys would weigh 30,900 lb (13,900 kg) per year, with a deposition rate (by weight) of approximately 3.7 lb per nm^2 (0.47 kg per km^2) of ocean per year. Hazardous materials of expended sonobuoys would weigh approximately 2,340 lb (1,050 kg), increasing the concentration of these materials on the ocean floor in the TMAA by approximately 0.28 lb per nm^2 (0.04 kg per km^2) each year. The expended sonobuoys would be relatively inert in the marine environment, becoming encrusted by corrosion and benthic organisms; these natural processes would decrease leaching rates, and ocean and tidal currents would disperse hazardous constituents as they leached. Hazardous materials would be dispersed over large areas of ocean bottom. Therefore, expended sonobuoys would have a negligible impact on ocean water resources under Alternative 1.

Explosive Sonobuoys – Potential Impacts of Detonation Byproducts

One type of sonobuoy, the SSQ-110A IEER sonobuoy used in ASW training under Alternatives 1 and 2, would contain two 4.2-lb explosive charges (Global Security 2008b). The explosives contain 90 percent RDX and small amounts of PBX and hexanistrostilbene, a detonator component. The most toxic byproducts are the hydrogen fluoride compounds (H_xF_x), but only a small percentage (0.63 percent) of the H_xF_x byproduct is expected to dissolve in the water prior to reaching the surface. Ocean and tidal currents would rapidly disperse byproducts. Further discussion of the materials produced by sonobuoy detonations is provided in Section 3.2, Expended Materials.

Given this dilution and the large area within which the sonobuoys would be deployed, the adverse impacts of detonation byproducts would be negligible. Leaching chemicals, such as lead and lithium, would result in water and sediment toxicity surrounding each expended sonobuoy. The effect would be limited to the immediate area of the leaching source because mixing and dispersion by ocean currents would quickly dilute chemicals to concentrations below harmful levels. SSQ-110A sonobuoys would make up 5.5 percent of the expended sonobuoys during training exercises. With a deposition rate of 0.1 expended sonobuoy per year per nm^2 of ocean, any impact on water resources would be negligible.

Portable Undersea Training Range

The PUTR would require the installation of seven anchors. Upon completion of training, these anchors would remain on the ocean floor. Each anchor would weigh approximately 300 lb, which would result in approximately 2,100 lb of expended materials. Anchors would be made of concrete or sand bags, which would be covered by sand or sediment over time. No hazardous materials would be associated with these anchors and, thus, effects on the marine environment would be minimal.

Summary – Alternative 1 Impacts

A summary of expended materials under Alternative 1 is provided in Table 3.3-7. Under Alternative 1, 20,223 items would be expended each year, a 26-percent increase over the No Action Alternative. Assuming a distribution of these materials over 20 percent of the TMAA, the deposition rate of expended items would be 2.40 items per nm^2 (0.69 items per km^2) of ocean per year. Alternative 1 would increase the expended materials weight by 87 percent over the No Action Alternative. Deposition of expended materials in the TMAA would be approximately 143,000 lb (65,000 kg) or approximately 16.9 lb per nm^2 (2.23 kg per km^2) of ocean per year. Assuming Navy training under Alternative 1 would remain consistent for the next 20 years, the Navy would expend approximately 1,430 tons of training material, with a total concentration of about 339 lb per nm^2 (44.7 kg per km^2). Many of these items are relatively inert, and would settle to the sea floor.

Alternative 1 would result in an increase in expended hazardous materials of about 160 percent (4,890 lb [2,220 kg]), but would only deposit approximately 0.58 lb of hazardous materials per nm^2 (0.08 kg per km^2) of ocean per year within 20 percent of the TMAA. The metals would corrode, eventually becoming encrusted through chemical processes and marine organisms, and would pose no hazard to ocean water resources. Leaching would decrease as surfaces become encrusted through natural processes. Hazardous materials from explosive constituents would be mostly consumed upon detonation, and would not affect water quality. The remaining hazardous materials have low solubility in water, and would leach hazardous materials at rates below harmful concentrations.

3.3.2.5 Alternative 2 (Preferred Alternative)

Under Alternative 2, Carrier Strike Group exercises would take place two times per year, compared to once per year under the No Action Alternative and Alternative 1. This increase in training tempo would increase the amount of expended training materials. Under Alternative 2, SINKEX would occur in the TMAA. During SINKEX, a decommissioned surface ship is towed to a deep-water location and sunk using a variety of ordnance. A summary of training materials expended annually under Alternative 2 is provided in Table 3.3-11. Table 3.3-12 shows the weights of hazardous materials for each type of training material and the percentage of hazardous materials in the total expended materials weight.

Materials Expended during Training in the TMAA – Alternative 2

Bombs

Under Alternative 2, 360 bombs would be expended each year in the TMAA (a 200-percent increase over the No Action Alternative). One hundred forty-four of the additional 240 bombs (60 percent) expended under Alternative 2 would be inert. With expended materials deposited on 20 percent of the TMAA, the deposition rate of expended materials would be approximately 0.04 item or 19.0 lb per nm^2 (0.01 item or 2.5 kg per km^2) of ocean per year.

Table 3.3-11: Training Materials Expended Annually – Alternative 2

Type of Training Material	Alternative 2		No Action Alternative		Increase under Alternative 2 (%)	
	Number	Weight (lb)	Number	Weight (lb)	Number	Weight
Bombs	360	160,000	120	54,000	200	200
Missiles	66	20,300	22	6,770	200	200
Targets & pyrotechnics	644	11,200	252	3,610	160	210
Naval gun shells	26,376	27,500	10,564	10,700	150	160
Small-caliber rounds	11,400	420	5,000	180	130	130
Sonobuoys	1,587	61,900	24	936	6,500	6,500
PUTR	7	2,100	NA	NA	NA	NA
SINKEX[1]	858	67,800	NA	NA	NA	NA
Total	**41,298**	**352,000**	**15,982**	**76,200**	**160**	**360**

Notes: Weights of expended materials are estimates, and are rounded to three significant digits, NA = Not applicable; (1) Due to the variability in weight of available ship hulks, the expended weight for SINKEX does not include the ship hulk weight.

Table 3.3-12: Percent of Expended Material Considered Hazardous – Alternative 2

Type of Training Material	Weight of Materials (lb)[1]		Hazardous Content (%)
	Expended Material	Hazardous Material	
Bombs	160,000	1,130	0.70
Missiles	20,300	169	0.83
Targets and pyrotechnics	11,200	381	3.40
Naval gun shells	27,500	3,310	1.31
Small-caliber rounds	420	4.20	1.00
Sonobuoys	61,900	4,680	7.56
PUTR	2,100	0	0
SINKEX	67,800	655	0.97
Total	**352,000**	**10,300**	**2.93**

Notes: Weights of expended materials are estimates, and are rounded to three significant digits; (1) Weights of hazardous materials are based upon available information, and may not include the hazardous weight of all expended materials; NA = Not applicable

Bombs used under Alternative 2 would deposit approximately 160,000 lb (72,000 kg) of expended material, and 1,130 lb (510 kg) per year of hazardous materials. Alternative 2 would deposit approximately 0.13 lb of hazardous materials per nm^2 (0.02 kg per km^2) of ocean per year in the TMAA. Inert bombs would contain spotting charges; the small amount of explosives would not have a substantial effect on water quality. Expended materials would settle to the sea bottom and corrode. This would cause the metals to become encrusted by chemical processes and marine organisms and, therefore, pose no hazard to ocean water resources. The use of live bombs would have no measurable adverse impacts on water quality because these items would be dispersed over large areas of ocean and because their hazardous constituents would be mostly consumed upon detonation.

Missiles

Under Alternative 2, 66 missiles would be used each year, an increase of 44 over the No Action Alternative. Expended material weight from missiles would increase 200 percent over the No Action Alternative to 20,300 lb (9,140 kg) tons per year. Distributed over 20 percent of the TMAA, missile use during training would deposit 2.4 lb (1.1. kg) of expended training material per nm^2 (0.3 kg per km^2) of ocean per year. As noted under the No Action Alternative, missiles used during training would not be recovered. The constituent of concern in missiles (i.e., solid propellant) becomes hazardous to water resources only if missiles fail to function properly, and such materials decompose very slowly in the marine environment. Ocean and tidal currents would disperse these materials to undetectable levels; thus, there would be no substantial impact on water resources under Alternative 2.

Targets and Pyrotechnics

Table 3.3-13 compares the types and numbers of targets and pyrotechnics for the study area under Alternative 2 compared to the No Action Alternative.

Table 3.3-13: Targets and Pyrotechnics Expended Annually – Alternative 2

Type of Target or Pyrotechnic	Number of Items		Increase under Alternative 2	
	Alternative 2	No Action Alternative	Numerical	Percent
Targets				
TDU-34 towed target	6	2	4	200
TALD*	24	8	16	200
BQM-74E unmanned aircraft	4	2	2	100
Killer Tomato surface target	24	10	14	140
SPAR	24	10	14	140
MK-39 EMATT*	40	0	40	0
Pyrotechnics				
LUU-2B/B*	36	12	24	200
MK-58 Marine Marker*	120	20	100	500
Chaff*	424	212	212	100
Total number used	**702**	**276**	**426**	**150**
Total not recovered	**644**	**252**	**392**	**160**
Total Expended Weight (lb)	**11,200**	**3,610**	**7,610**	**210**

Notes: * Not recovered; Percentages are estimates, and are rounded to three significant digits.

Under Alternative 2, the number of targets and pyrotechnics used would increase by 150 percent (426 items) over the No Action Alternative. Items not recovered would represent about 92 percent of all training materials (644 items per year), and 90 percent of these items would be pyrotechnics. Expended targets would deposit 11,200 lb (5,040 kg) per year of expended material on the sea floor, an increase of 210 percent over the No Action Alternative. Most of the expended materials would be relatively inert in the marine environment, with 381 lb (170 kg) per year of expended materials (approximately 130 lb [59 kg] of residual pyrotechnic materials and 250 lb [113 kg] of batteries from EMATTs) considered to be hazardous. This rate of hazardous materials deposition would have minimal effects on the marine environment because of its low density (0.05 lb per nm^2 [less than 0.01 kg per km^2]) in the TMAA.

Chaff use would increase to 1,080 lb (490 kg) per year under Alternative 2, but would not affect water resources because of the large dispersal area and its inert composition. Expended chaff would have similar effects to those described under the No Action Alternative. Given the number of items and the relatively inert nature of the components, these training materials would not have a measurable impact on ocean water resources.

Naval Gun Shells

Alternative 2 proposes a 150-percent increase in naval gun shells over the No Action Alternative. A total of 26,376 gun shells would be expended annually under Alternative 2, resulting in approximately 27,500 lb (12,500 kg) of expended material. Assuming expended materials would be deposited over 20 percent of the TMAA, approximately 3.26 lb of expended material per nm^2 (0.43 kg per km^2) of ocean would be deposited annually in the TMAA. Approximately 3,310 lb (1,500 kg) per year of this material would be hazardous. This amount of material would have negligible effects on the marine environment because effects would be limited to the immediate area around expended shells. Hazardous materials would not cause harmful concentrations of heavy metals in the surrounding water column because of their low concentration (0.39 lb per nm^2 [less than 0.05 kg per km^2]) and rapid dispersal of leached hazardous substances by ocean currents. The expended shells would settle to the sea bottom, and would degrade as described under the No Action Alternative. Under Alternative 2, the naval gun shells would have no substantial impact because they consist of relatively inert materials that degrade slowly in the environment.

Small Arms Rounds

Under Alternative 2, 11,400 small arms rounds would be used each year, an increase of 130 percent over the No Action Alternative. Alternative 2 would deposit less than 1.4 expended rounds per nm^2 (0.39 items per km^2) of ocean per year, assuming deposition on 20 percent of the TMAA. The total expended weight of small arms rounds would be 420 lb (190 kg) per year, and approximately 4.2 lb (1.9 kg) per year of hazardous materials. Given the inert nature of the majority of these items, this level of deposition would have a negligible impact on ocean water resources.

Sonobuoys

Table 3.3-14 compares the types and numbers of sonobuoys proposed under Alternative 2 compared to the No Action Alternative.

Table 3.3-14: Sonobuoys Expended Annually – Alternative 2

Type of Sonobuoy	Number of Items		Increase under Alternative 2 (%)
	Alternative 2	No Action Alternative	
SSQ-36 BT	120	24	400
SSQ-53 DIFAR (passive)	1,000	0	NA
SSQ-62 DICASS (active)	267	0	NA
SSQ-77 VLAD (passive)	120	0	NA
SSQ-110A IEER (explosive) or SSQ-125 AEER (Tonal)	80	0	NA
Total Number	**1,587**	**24**	**6,500**
Total Weight (lb)	**61,900**	**936**	**6,500**

Note: Numbers of expended materials are estimates; NA = Not applicable

Under Alternative 2, 1,587 sonobuoys would be used each year during training exercises. Assuming an expended materials deposition area of 20 percent of the TMAA, the deposition rate of expended sonobuoys would be approximately 0.2 sonobuoy per nm^2 (0.05 sonobuoys per km^2) of ocean per year. Expended materials from sonobuoys would weigh approximately 61,900 lb (27,900 kg) per year, with a deposition rate (by weight) of 7.35 lb per nm^2 (0.96 kg per km^2) of ocean per year.

About 4,680 lb (2,100 kg) of hazardous materials would be deposited annually on the ocean floor from ASW exercises using sonobuoys, which would deposit approximately 0.56 lb per year of hazardous material per nm^2 (0.07 kg per km^2) of ocean. Section 3.3.4.1 discusses the potential impact on water resources of sonobuoy batteries and explosive components. Given the conclusions in that section, sonobuoy use under Alternative 2 would only affect water and sediment quality in the immediate vicinity of expended sonobuoys. Ocean currents would quickly disperse leached substances to concentrations below harmful levels. Thus, the proposed increase in sonobuoy use under Alternative 2 would have no measurable impact on water resources.

Portable Undersea Training Range

Under Alternative 2, PUTR would require the same number of anchors (seven) to be placed on the ocean floor as under Alternative 1. Anchors would be made of concrete or sand, and would not contain any hazardous materials. Any effects on the marine environment would be the same as under Alternative 1.

SINKEX

Alternative 2 would include two SINKEX events (one each summertime training exercise). Table 3.3-15 provides a list of the types and numbers of training materials that could be expended annually during SINKEX.

Table 3.3-15: Training Materials Expended During a SINKEX

Type of Training Material	Number of Items
Missiles	
AGM-65 Maverick	6
AGM-84 Harpoon	10
AGM-88 high-speed anti-radiation missile (HARM)	4
AGM-114 Hellfire	2
AGM-119 Penguin	2
Standard Missile-1	2
Standard Missile-2	2
Bombs	
MK-82 (inert)	6
MK-82 (live)	14
MK-83	8
Naval Gun Shells	
5-in gun shells	800
Torpedoes	
MK-48 ADCAP torpedo	2
Targets	
Surface Ship Hulk	2
Total	**858**
Total Expended Weight (lb)	**67,800[1]**

Notes: Numbers are cumulative for two separate SINKEX events; (1) Due to the variability in weight of available ship hulks, the total expended weight does not include ship hulk weights.

Ordnance use during SINKEX would vary, based on training requirements and training conditions. For example, a MK-48 ADCAP torpedo would only be used at the conclusion of SINKEX if the target vessel was still afloat. This analysis assumes that the greatest number of ordnance would be used during SINKEX under Alternative 2. Therefore, 858 ordnance items per year would be expended during two SINKEX events under Alternative 2. This would result in approximately 67,800 lb (30,500 kg) per year of expended materials, which would increase the ocean floor density of such materials by approximately 8.0 lb per nm^2 (1.0 kg per km^2) per year. Most of these materials would be relatively inert, with approximately 650 lb (290 kg) per year of hazardous material (e.g., residual explosives, propellant, and heavy metals such as lead). These materials would be in solid forms, and would leach slowly because of their low solubility. This amount of hazardous materials would not have an effect on the marine environment.

Alternative 2 would expend two surface vessels per year during two SINKEX events. For SINKEX, the vessels used as targets are selected from a list of U.S. Navy-approved vessels that have been cleaned in accordance with USEPA guidelines. By rule, SINKEX would be conducted at least 50 nm (93 km) offshore and in water at least 6,000 feet deep (1,830 m) (40 CFR §229.2). USEPA considers the contaminant levels that would be released during the sinking of a target vessel to be within the standards of the Marine Protection, Research, and Sanctuaries Act (16 USC 1341, et seq.). As with other inert materials, the vessel would become encrusted by chemical processes and biological organisms. Therefore, vessels used as targets would not pose a hazard to ocean water resources.

Summary of Impacts – Alternative 2 (Preferred Alternative)

Training materials expended under Alternative 2 are summarized in Table 3.3-11. Under Alternative 2, 41,298 items would be expended each year, a 160-percent increase over the No Action Alternative. This would result in approximately 4.90 items per nm^2 (1.42 items per km^2). The weight of expended materials would increase 360 percent to 352,000 lb (160,000 kg) per year. Assuming expended materials would be deposited on 20 percent of the TMAA, the deposition rate of expended materials would be approximately 41 lb per nm^2 (5.4 kg per km^2) of ocean per year. Assuming Navy training under Alternative 2 would remain consistent for the next 20 years, the Navy would expend approximately 3,520 tons of materials, with a total concentration of approximately 835 lb per nm^2 (110 kg per km^2) of ocean.

Under Alternative 2, approximately 10,300 lb (4,680 kg) per year of hazardous material would be expended. Assuming deposition of expended materials on 20 percent of the TMAA, the ocean floor density of hazardous materials would increase by approximately 1.2 lb per nm^2 (0.2 kg per km^2) per year. Alternative 2 would also include two decommissioned surface vessels expended during two SINKEX events. Vessels would be cleaned according to USEPA standards, and would be considered relatively inert in the marine environment.

Most expended materials would relatively inert, and hazardous materials would either be consumed upon detonation or would be present in insoluble forms. Most expended materials would be relatively inert and would settle to the sea bottom, becoming encrusted by chemical processes and marine organisms. This would slow chemical leaching below harmful concentrations, and pose no hazard to ocean water resources. Expended materials under Alternative 2 would not substantially impact water resources because the distribution density of hazardous materials would be low and most expended training materials would consist of relatively inert substances that degrade slowly in the marine environment.

3.3.3 Mitigation

Impacts on water resources under the alternatives would be below thresholds that could result in long-term degradation of water resources or affect water quality. Possible impacts on water quality during normal operating conditions would continue to be mitigated by measures identified in Section 3.3.1.2. No additional mitigation measures would be implemented because there would be no substantial impact on water quality.

3.3.4 Summary of Effects

None of the proposed alternatives would have long-term or substantial impacts on water resources in the TMAA. Short-term effects on water resources would be related to ordnance use and expended materials, and would not be anticipated to be measurable, given the large area over which activities occur and the dynamic nature of the marine environment. Table 3.3-16 summarizes the effects of the No Action Alternative, Alternative 1, and Alternative 2 on water resources under both NEPA and EO 12114.

Table 3.3-16: Summary of Effects by Alternative

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
No Action Alternative	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1997, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts on water resources would occur. • Aircraft overflights would not involve expenditures of training materials, and thus would not affect water quality.	• Ordnance constituents and other materials (batteries, fuel, and propellant) from training devices have minimal effect or are below standards. • No long-term degradation of marine water quality.
Alternative 1	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1997, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts on water resources would occur. • Aircraft overflights would not involve expenditures of training materials, and thus would not affect water quality.	• An estimated 26-percent increase in expended training materials would occur, compared to the No Action Alternative. • Deposition of hazardous materials (i.e., batteries, fuel, and propellant) from expended materials would be minimal (less than ½ lb per nm^2). • No long-term degradation of marine water quality would occur.
Alternative 2 (Preferred Alternative)	• Under Alternative 2, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1997, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts on water resources would occur. • Aircraft overflights would not involve expenditures of training materials, and thus would not affect water quality.	• An estimated 160 percent increase in expended training materials would occur, compared to the No Action Alternative. • Impacts from the increase in expended materials would be minimal because most expended materials (97 percent) would be inert in the marine environment. • Assuming deposition over 20% of the TMAA, the amount of hazardous materials from expended materials would be low, approximately 1.2 lb per nm^2 per year.

3.4 ACOUSTIC ENVIRONMENT (AIRBORNE)

3.4.1 Affected Environment

For purposes of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the region of influence (ROI) for the acoustic environment includes the Temporary Maritime Activities Area (TMAA). Activities involving use of airspace inland from the coastline, including United States (U.S.) Air Force (Air Force) air ranges and U.S. Army (Army) training lands, are addressed in the *Alaska Military Operations Areas EIS* (USAF 1995), *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999), and the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

Aircraft overflights occurring above 15,000 feet (ft) in altitude will take place in airspace over the U.S. territorial seas (0-12 nautical miles [nm]) to the TMAA. Given the altitude of these subsonic flights, they will have no effect on the acoustic environment and are, therefore, dismissed from further analysis.

3.4.1.1 Introduction to Sound

Sound is a physical phenomenon and a form of energy that can be described, measured, and represented with mathematical expressions. Noise, on the other hand, is not a physical process, but rather an implicit social value, defined generally as unwanted sound. Recognition of sound is based on the receptor's objective and reproducible response to sound's primary physical attributes: intensity (perceived by the receptor as loudness), frequency (perceived as pitch), frequency distribution and variation over time, and duration (whether continuous, sporadic, or impulse). Perception of sound, however, is subjective and circumstantial. Sounds that are soothing to some are annoying to others, and sounds barely noticed and generally ignored in one circumstance may be considered highly objectionable in another circumstance.

Beyond subjective effects, however, sound at higher intensities or power levels can have physical consequences. The range of such impacts have been defined for humans as falling into three categories as sound pressure levels increase: subjective effects (e.g., annoyance, nuisance, dissatisfaction), interferences with activities (e.g. communication, sleep, learning, behavioral changes), and physiological effects (e.g., anxiety, hearing impacts, loss of hearing).

3.4.1.2 Sound Characteristics

Sound Fundamentals

Sound is typically described by its magnitude (otherwise referred to as amplitude), intensity, and frequency and the changes in those values over time (e.g., sudden impulse vs. continuous vs. repetitive). The physical phenomenon of sound is generated by mechanical vibrations traveling through an elastic medium (i.e., air or water), resulting in a rapid change in pressure (high and low pressure fluctuations or waves) in the medium.

Sound waves are characterized by parameters such as amplitude, intensity, wavelength, frequency, and velocity. The amount of energy contained in a sound pressure wave is referred to as its amplitude, while the amount of energy passing through a unit area per unit of time is the sound wave's intensity. The units of sound intensity are watts per square meter (energy per unit of time per unit of area). Amplitude and intensity are directly and linearly related. Higher amplitude sounds are perceived to be louder than lower amplitude sounds. Sound pressures are usually represented in micropascals (μPa). A pascal is equal to one newton of force distributed over 1 square meter. The maximum sound pressure level of a noise event is referred to as the "peak noise level."

The frequency of sound represents the rate at which the source produces sound waves (a complete cycle of high and low pressure waves) or the rate at which the sound-producing body completes one vibration cycle. Frequency is a precisely measurable quantity representative of a particular sound. Sounds are produced throughout a wide range of frequencies, including frequencies beyond the audible range of a given receptor. Most of the sounds we hear in the environment do not consist of a single frequency, but rather a broad band of frequencies differing in sound level. The intensities of each frequency add to generate the sound we hear.

The speed of sound is not affected by its intensity, amplitude, or frequency, but rather depends wholly on the characteristics of the medium through which it is passing. Sound generally travels faster as the density of the medium increases. Speeds of sound through air are primarily influenced by air temperature, and negligibly by the air's relative humidity and pressure, averaging about 1,115 feet/second (ft/sec) (340 meters/second [m/sec]) at standard barometric pressure. Sound speeds in air increase as air temperature increases. Speed of sounds in liquid is similarly influenced primarily by the liquid's density and temperature. Thus, the speed of sound in 32 degrees Fahrenheit (°F) (0 degrees Celsius [°C]) water is 4,600 ft/sec (1,402 m/sec) and in 68°F (20°C) water is 4,862 ft/sec (1,482 m/sec). The speed of sounds in solids is a more complex matter, with longitudinal and transverse waves traveling at different speeds depending on the density of the material as well as its geometry and molecular structure.

The mathematical relationship between sound stimulus and sound perception by a human receptor is logarithmic. This logarithmic relationship between magnitude and perception is the basis for the decibel (dB) scale used to express sound intensity. The decibel scale measures relative sound intensities rather than absolute intensities; specifically, it measures the ratio of a given intensity (of sound) to the threshold sound intensity of human hearing (by definition 0 dB). For most human individuals, a sound wave pressure of 20 μPa represents the hearing threshold. As sound stimuli increases geometrically (i.e., multiplied by a fixed factor), the corresponding perception changes arithmetically (i.e., additive by constant amounts). Thus, a tenfold increase in sound stimulus over the threshold of hearing is assigned a value of 10 dB but is perceived as a doubling of loudness; a hundredfold increase to 20 dB is perceived as sound that is four times louder, and so forth (Figure 3.4-1).

Although sound is a physical phenomenon that can be represented by mathematical expressions and measured with precision, perception of sound pressure level is the result of physiological responses as well as subjective factors, each influenced by current circumstances and past exposures. The sound pressure level is the perception of a sound wave's pressure by a single receptor at a specified distance and direction from the sound source.

Sound pressure levels are measured by sound level meters, which typically contain filters that reduce the meter's sensitivity to frequencies of little or no relevance to the human receptor. The method commonly used to quantify environmental sounds consists of determining all of the frequencies according to a weighting system that reflects the nonlinear response characteristics of the human ear. Filtering the very low and very high frequency sounds thus acts as a general approximation of the human ear's response to sounds of medium intensity. This is called "A" weighting, and the decibel level measured is called the A-weighted sound level (dBA). In practice, the level of a noise source is conveniently measured using a sound level meter that includes a filter corresponding to the dBA curve.

A common method of describing sound pressure levels is by comparing commonly experienced sounds. Typical sound sources and their corresponding environments are presented in Figure 3.4-1. Sound levels indicated are for single events. Such events are discrete, and two or more events cannot simply be added together. Integrating varying noise levels and sources over a given period requires complex calculations or modeling.

The sound measure employed by federal agencies is known as the day-night average sound level (DNL). The DNL is defined as the A-weighted average sound level for a 24-hour day. It is a calculated noise metric derived from measurements but includes a 10-dB penalty for late-night (i.e., 10:00 p.m. to 7:00 a.m.) sound levels. This penalty accounts for the increased sensitivity of humans to noise at night.

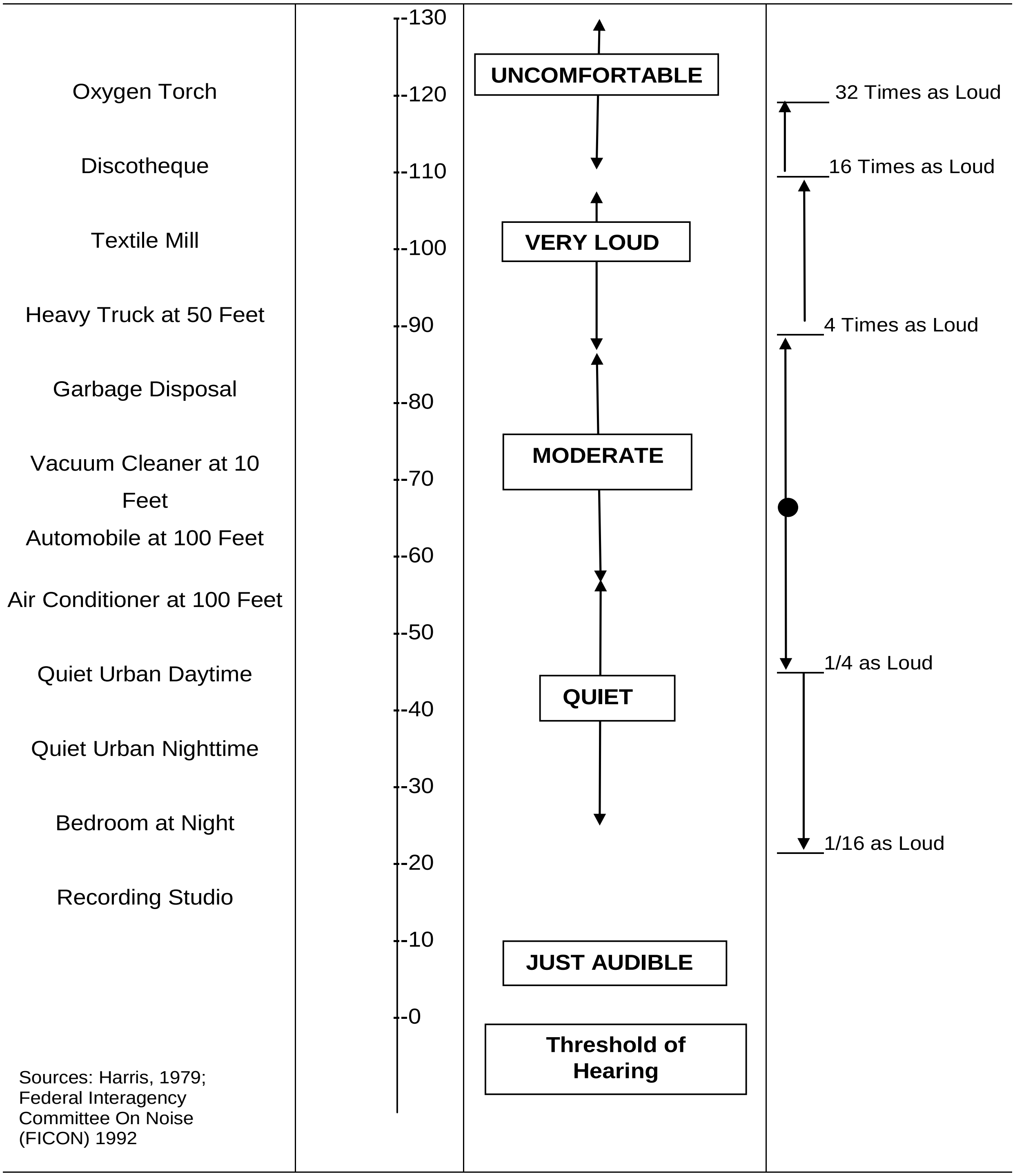

Figure 3.4-1: Sound Levels of Typical Airborne Noise Sources and Environments

Sound Propagation

Understanding the impact of sound on a receptor requires a basic understanding of how sound propagates from its source. Sound propagation follows the inverse square law: the intensity of a sound wave decreases inversely with the square of the distance between the source and the receptor. Thus, doubling the distance between the receptor and a sound source results in a reduction in the intensity of the sound of one fourth of its initial value; tripling the distance results in one ninth of the original intensity, and so on.

Sound propagates through gases and liquids primarily as longitudinal waves, causing displacements of the molecules comprising the gas or liquid in directions generally parallel to the direction of the sound wave. While the concept of a longitudinal or transverse sound wave traveling from its source to a receptor is relatively simple, sound propagation in fact is quite complex due to the simultaneous presence of numerous sound waves of different frequencies and other phenomena such as reflections of sound waves and subsequent constructive or destructive interferences between reflected and incident waves.

Interferences between two waves with different frequencies result in the production of "beats." Depending on whether the interferences between these waves are constructive (where their amplitudes are additive) or destructive (where their amplitudes cancel each other), the sound perceived by the receptor is alternately loud and soft, with the rate at which such amplitude changes occur generally reflecting the difference between the frequencies of the two interacting waves. Perception of interfering sound waves is complex, and in some frequency ranges the receptor perceives ("hears") neither of the frequencies of the interacting waves, but rather a third frequency known as a "subjective tone" or "difference tone."

3.4.2 Existing Conditions

3.4.2.1 Ambient Sound

Airborne noise sources at sea include those from manmade sources such as sounds produced from commercial, fishing, research, and recreational vessels, and general and commercial aviation. Navy training events may also add to these sounds intermittently and at widely separate locations in the TMAA during an exercise period (an exercise lasting a maximum of 21 days in the April to October timeframe occurring once or twice a year depending on the alternative).

Issues with regard to airborne noise as transmitted underwater are discussed in Sections 3.5 (Marine Plants and Invertebrates), 3.6 (Fish), 3.7 (Sea Turtles), 3.8 (Marine Mammals), and 3.9 (Birds).

3.4.2.2 Sound from Military Sources

Airborne noise attributable to military activities in the TMAA emanates from multiple sources including naval ship power plants, military aircraft, target engine noise, bombs, missiles, and gunfire. The boundaries of the TMAA form a roughly rectangular area oriented from northwest to southeast, approximately 300 nautical miles (nm) (556 kilometers [km]) long by 150 nm (278 km) wide, situated south of Prince William Sound and east of Kodiak Island. The TMAA is an area 42,146 square nautical miles (nm^2) (144,556 square kilometers [km^2]) in size. With the exception of Cape Cleare on Montague Island located over 12 nm (22 km) from the northern point of the TMAA, the nearest shoreline (Kenai Peninsula) is located approximately 24 nm (44 km) north of the TMAA's northern boundary. The approximate middle of the TMAA is located 140 nm (259.3 km) offshore. Therefore, sound in the TMAA from military sources will originate no closer than approximately 12 nm (22 km) from the nearest shoreline, and these will be sounds generally dominated by high aircraft overflight noise.

Military Aircraft

Flying aircraft contribute sound to the environment. As with most manmade sounds, most aircraft sounds involve low frequencies. Aircraft sound entering the water at an angle of incidence of 13 degrees from the vertical or less will lose some of the sound energy as sound is transmitted under the water's surface. At greater angles of incidence, the water surface acts as an effective reflector of the sound wave, allowing the sound energy to remain largely unchanged in the above-water environment (Urick 1972, Eller and Cavanagh 2000). Navy training activities involving aircraft in the TMAA are generally dispersed over large expanses of the open ocean. Representative sound levels associated with military aircraft and ordnance use are depicted in Table 3.4-1.

Table 3.4-1: Representative Aircraft and Ordnance Sound Sources in the TMAA

Noise Source	Sound Level (dBA)
Jet Aircraft Takeoff	115 @ 1,000 ft
SH-60 Helicopter Hovering	90 @ 50 ft
ASW Target Drop	90 @ 50 ft
Chaff (packet rupture at high altitude) Aircraft ALE-37	90 @ 50 ft
Aircraft Defensive Flares	65 @ 50 ft
Practice Bombs, 25 lb inert, spotting charge	60 @ 50 ft
Inert Bombs, 500 lb (at impact)	105 @ 50 ft
Inert Bombs, 1,000 lb (at impact)	108 @ 50 ft
Live Bombs, 500 lb (at impact)	110 @ 50 ft
Live Bombs, 1,000 lb (at impact)	125 @ 50 ft
Naval Gun Ammunition 5"/54	110 @ 50 ft
Cannon Shells, 20mm (at source)	105 @ 50 ft
Cannon Shells, 25mm (at source)	110 @ 50 ft
7.62mm M60 Machine Gun	90 @ 50 ft
0.50-caliber Machine Gun	98 @ 50 ft

Notes: 50 ft and 1,000 ft are standard reference distances. ASW - Anti-Submarine Warfare; dBA - decibels, A-weighted; ft - feet; lb - pound; TMAA – Temporary Maritime Activities Area; mm - millimeters
Source: Investigative Science and Engineering (ISE), 1997; Naval Air Station Whidbey Island, 1993; Ewbank, 1977

Sonic Boom Noise

Supersonic aircraft flights can occur from time to time in the TMAA. Such flights are usually limited to altitudes above 30,000 ft (9,144 m) and/or locations more than 30 nm (55.6 km) from shore. Several factors influence sonic booms: weight, size, shape of aircraft or vehicle; altitude; flight paths; and atmospheric conditions. A larger and heavier aircraft must displace more air and create more lift to sustain flight compared with small, light aircraft. Therefore, larger aircraft create sonic booms that are stronger and louder than those of smaller, lighter aircraft. Consequently, the larger and heavier the aircraft, the stronger the sonic boom shock waves will be (Department of Navy [DoN] 2007).

Of all the factors influencing sonic booms, increasing altitude is the most effective method of reducing sonic boom intensity. The width of the boom "carpet" or area exposed to sonic boom beneath an aircraft is about 1 mile (mi) (1.6 km) for each 1,000 ft (305 m) of altitude. For example, an aircraft flying supersonic straight and level at 50,000 ft (15,240 km) can produce a sonic boom carpet about 50 mi (80 km) wide. The sonic boom, however, will not be uniform. Maximum intensity is directly beneath the aircraft, and decreases as the lateral distance from the flight path increases until shock waves refract away from the ground and the sonic boom attenuates. The lateral spreading of the sonic boom depends only on altitude, speed, and the atmosphere, and is independent of the vehicle's shape, size, and weight. The ratio of the aircraft length to maximum cross-sectional area also influences the intensity of the sonic boom. The longer and more slender the aircraft, the weaker the shock waves will be. The wider and more blunt the vehicle, the stronger the shock wave can be (DoN 2007). Sonic booms are generated as aircraft reach Mach 1.0 (speed of sound) and increase in intensity as the Mach number increases.

Ordnance Use

Impulsive sound results from ordnance use in the TMAA. Some representative ordnance sound levels are depicted in Table 3.4-1.

Missile and Target Launch

Sound associated with missile and target launches occurs in the TMAA infrequently, and then only during scheduled events. Due to safety concerns over launch activities, a buffer zone of several square miles is always instituted and enforced. Sound due to missile and target launches is typically at a maximum at the point of initiation of the booster rocket, and rapidly fades as (1) the missile or target reaches optimal thrust conditions, and (2) the missile or target reaches a downrange distance where the booster burns out and a sustainer engine continues. For example, data for the BQM-34 show that its booster Jet Assisted Take-Off (JATO) bottles generate 113 dBA at the source at launch. Sound levels decrease to 99 dBA at 2,400 ft (731.5 m) (DoN 1998). The BQM-34 may be used in the TMAA (though much less frequently than the smaller BQM-74).

In the TMAA, the BQM-74 is likely to be the typical target drone. It can be launched from surface vessels as shown in Figure 3.4-2, as well as aircraft. The BQM-74s will be used during Surface-to-Air (S-A) Missile Exercise (MISSILEX) training proposed to occur under Alternatives 1 and 2. They are proposed to occur very infrequently. The events take place at high altitude (between 10,000 ft and 20,000 ft [3,048 m and 6,096 m) and over 12 nm (22.2 km) from shore.

Figure 3.4-2: Target Drone Launch

Nonexplosive Impact Noise

Nonexplosive impact sound in the TMAA is generally from high-velocity "dummy" projectiles and inert training bombs. Sounds of this type are produced by the kinetic energy transfer of the object with the target or earth's surface, and are highly localized to the area of disturbance. Sound associated with the impact event is typically of low frequency (less than 250 Hertz [Hz]) and of a short enough duration (i.e., impulse sound) that it produces negligible amounts of acoustic energy. These events occur far out to sea in connection with events such as an Air-to-Surface (A-S) Bombing Exercise (BOMBEX) that are restricted from the public, so they often go unobserved. The impacts may be scored by remote observers—participants in the exercise who are at a safe distance from the source.

Ordnance Detonations

Ordnance detonated at the water surface can introduce loud, impulsive, broadband sounds into the marine environment. The potential impacts of explosive detonations on wildlife are considered in Sections 3.5 (Marine Plants and Invertebrates), 3.6 (Fish), 3.7 (Sea Turtles), 3.8 (Marine Mammals), and 3.9 (Birds). The airborne noise associated with underwater explosions is minimal. A characteristic phenomenon of the difference in acoustic impedance between air and water is that the air/water interface will act as a very good reflector, the so-called Lloyd mirror. Therefore, very little energy will pass this reflector, meaning that sound generated in the water will not pass over to the air and vice versa.

Three source parameters influence the effect of an explosive: the weight of the explosive warhead, the type of explosive material, and the detonation depth. The net explosive weight (NEW) accounts for the first two parameters. The NEW of an explosive is the weight of the explosive material in a given round, referenced to the explosive power of trinitrotoluene (TNT) or C4. Table 3.4-2 sets forth the explosive weight of various explosive ordnance items used in the TMAA. The ordnance used is shown with the particular training event using that ordnance. All events will occur in the open ocean far from shore.

Table 3.4-2: Training Events Utilizing Explosives in the TMAA

Training Event	Ordnance Involved (Net Explosive Weight per Item)
Air-to-Air MISSILEX	AIM 7 Sparrow (85 lb), AIM 9 Sidewinder (20.8 lb), AIM-120 AMRAAM (48 lb)
Surface-to-Air MISSILEX	Standard missile (223 lb)
Air-to-Surface BOMBEX, SINKEX	MK-82 (192.2 lb), MK-83 (415.8 lb) and MK-84 (944.7 lb)
Gunnery Exercise (GUNEX, SINKEX)	5-inch naval gunfire (8.8 lb), 76mm gun rounds (1.3 lb)
ASW Tracking Exercise (TRACKEX)-Maritime Patrol Aircraft (MPA)	IEER sonobuoys (two 4 lb charges per sonobuoy)
SINKEX (Surface to Surface, Air to Surface, Torpedo)	HARM (41.6 lb), Harpoon (265 lb), Maverick (78.5 lb), Hellfire (16.4 lb), Penguin (123 lb), Standard Missile 1 (223 lb), MK-48 (851 lb)

The detonation depth of an explosive in the water is important due to a propagation effect known as surface-image interference. For sources located near the sea surface, a distinct interference pattern arises from the coherent sum of the two paths that differ only by a single reflection from the pressure-release surface. As the source depth and/or the source frequency decreases, the destructive interference of these two paths increases and reaches total cancellation at the surface (barring surface reflection scattering loss). Since all explosive sources used in military activities in the TMAA (with two exceptions) are munitions that detonate essentially on impact, the effective source depths are quite shallow, and therefore the surface-image interference effect can be pronounced. The exceptions are the SSQ-110 (Improved Extended Echo Ranging [IEER]) sonobuoy, which is a small underwater detonation producing no airborne noise and the MK-48 torpedo (associated with SINKEX).

3.4.2.3 Current Requirements and Practices

In accordance with aircraft standard operating procedures, each aircrew will be familiar with the noise profiles of their aircraft and shall be committed to minimizing noise impacts without compromising operational and safety requirements. Flights of naval aircraft shall be conducted so that a minimum of annoyance is experienced by persons that may be below. It is not enough for the pilot to be satisfied that no person is actually endangered. Definite and particular effort shall be taken to fly in such a manner that individuals do not believe they or their property are endangered.

3.4.3 Environmental Consequences

As noted in Section 3.4.1, the ROI for the acoustic environment includes the TMAA. Navy training activities that occur within the Air Force inland Special Use Airspace (SUA) and the Army inland training lands were evaluated under previous National Environmental Policy Act (NEPA) documentation (USAF 1995, USAF 2007, Army 1999, and Army 2004). These documents are incorporated by reference. Environmental effects in the open ocean beyond the U.S. territorial seas (outside of 12 nm [22 km]) in the TMAA are analyzed in this EIS/OEIS pursuant to Executive Order (EO) 12114.

3.4.3.1 Previous Analysis

Impacts related to the acoustic environment were previously evaluated in Sections 3.3, 4.3, and Appendix F of the *Alaska Military Operations Areas EIS* (USAF 1995); Sections 3.2.5 and 4.0 of the *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007); Sections 3.22 and 4.22 of the *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999); and Sections 3.16 and 4.16 of the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

3.4.3.2 Approach to Analysis

A description of noise-related environmental stressors, data sources, and methodology related to assessing airborne-noise related environmental consequences follows.

Noise-Related Environmental Stressors

Navy GOA training activities will involve fixed-wing aircraft, helicopters, ships, missiles, gunfire, and explosive ordnance that are all potential sources of airborne noise. Airborne noises generated through implementation of the proposed action generally consist of either (1) noise that would be experienced over the course of an aircraft overflight or (2) impulse noise such as would be experienced during gunfire or ordnance detonation. The discussion of noise associated with Navy training events focuses on airborne sound above the water's surface and its potential impacts to human receptors. In the ocean area of the TMAA, the potential receptors could be merchant seamen, fishermen, and boaters (personnel participating in training are not considered to be sensitive receptors[1] of airborne noise for purposes of

[1] For analysis of impacts on the acoustic environment, a "sensitive receptor" is a location of a human activity where the introduction of sound as noise would have an adverse impact on the activity associated with that location. Examples of typical types of locations (sensitive receptors) include residences, places of worship, schools, hospitals, some businesses (e.g., cinema, concert hall), or the outdoors (e.g., parks, natural areas). Examples of potential impacts to these locations can involve the effects to occupancy, re-sale, purpose, or enjoyment of the environment (natural quiet).

environmental impact analysis). Given the distance from shore for the majority of the TMAA, Notices to Mariners (NOTMARs), and the inability to safely conduct most training activities in the vicinity of non-training participants, these potential human receptors should not be present and therefore will not be exposed to high levels of sound resulting from training activities.

Noise impacts on humans depend on a variety of factors, including the duration of the noise event, the decibel level of the noise event, and the context of the noise within the ambient noise environment. Table 3.4-3 illustrates the various training events that occur associated with the proposed training activities, the noise stressors associated with each training event, and the general location where the events occur. As shown in the table, potential noise stressors can emanate from aircraft engine noise, surface vessel engine noise, and ordnance noise. Most training event types occur far out in the open ocean, given the approximate center of the TMAA is located 140 mi from the coast with the closest boundary 24 nm from shore and thus beyond the hearing of any human receptors on shore.

Table 3.4-3: Warfare Areas and Noise-Related Environmental Stressors

		Stressors			Location		
Primary Warfare Area and Activity	Training Area(s)	Surface Vessel Engine Noise	Aircraft Engine Noise	Explosive or Gunfire Noise	Over land	0-12 nm from shore	Beyond 12 nm
Anti-Air Warfare (AAW)							
Air Combat Maneuver (ACM)	TMAA, Air Force SUA		✓		✓	✓	✓
Air Defense Exercise (ADEX)	TMAA	✓	✓			✓	✓
Missile Exercise (Surface-to-Air) (MISSILEX [S-A])	TMAA	✓	✓	✓			✓
Gunnery Exercise (Surface-to-Air) (GUNEX [S-A])	TMAA	✓	✓	✓		✓	✓
Missile Exercise (Air-to-Air) (MISSILEX [A-A])	TMAA, Air Force SUA		✓	✓	✓	✓	✓
Surface Warfare (SUW)							
Visit Board Search and Seizure (VBSS)	ATA	✓	✓				✓
Missile Exercise (Air-to-Surface) (MISSILEX [A-S])	TMAA	✓	✓				✓
Bombing Exercise (Air-to-Surface) (BOMBEX [A-S])	TMAA		✓	✓			✓
Gunnery Exercise (Air-to-Surface) (GUNEX [A-S])	TMAA		✓	✓			✓
Gunnery Exercise (Surface-to-Surface) (GUNEX [S-S])	TMAA	✓		✓			✓
Maritime Interdiction	ATA	✓	✓			✓	✓
Sea Surface Control (SSC)	ATA	✓	✓				✓
Sinking Exercise (SINKEX)	TMAA	✓	✓	✓		✓	✓

Table 3.4-3: Warfare Areas and Noise-Related Environmental Stressors (continued)

		Stressors			Location		
Primary Warfare Area and Activity	**Training Area(s)**	**Surface Vessel Engine Noise**	**Aircraft Engine Noise**	**Explosive or Gunfire Noise**	**Over land**	**0-12 nm from shore[1]**	**Beyond 12 nm**
Anti-Submarine Warfare (ASW)							
Anti-Submarine Warfare Tracking Exercise – Helicopter (ASW TRACKEX-Helo)	TMAA		✓				✓
Anti-Submarine Warfare Tracking Exercise – Maritime Patrol Aircraft (ASW TRACKEX-MPA)	TMAA		✓			✓	✓
Anti-Submarine Warfare Tracking Exercise – Extended/ Improved/ Advanced Echo Ranging (EER / IEER / AEER)	TMAA		✓				✓
Anti-Submarine Warfare Tracking Exercise-Surface Ship (ASW TRACKEX-Surface)	TMAA	✓					✓
Anti-Submarine Warfare Tracking Exercise – Submarine (ASW TRACKEX-Sub)	TMAA		✓				✓
Electronic Combat (EC)							
Electronic Combat (EC) Exercises	TMAA, Air Force SUA	✓	✓			✓	✓
Chaff Exercise (CHAFFEX)	TMAA, Air Force SUA	✓	✓			✓	✓
Counter Targeting Exercise	TMAA	✓	✓				✓
Naval Special Warfare (NSW)							
Insertion/Extraction	ATA		✓		✓		
Strike Warfare (STW)							
Bombing Exercise (Air-to-Ground) (BOMBEX [A-G])	Air Force SUA, Army ranges		✓	✓	✓	✓	
Personnel Recovery (PR)	TMAA, Air Force SUA, Army ranges	✓	✓		✓		✓
Other Activities							
Deck Landing Qualifications (DLQs)	ATA		✓				✓

Note: ATA- Alaska Training Areas; TMAA – Temporary Maritime Activities Area; SUA – Special Use Airspace

1 - The only activities that occur within 0-12 nm are aircraft overflights above 15,000 feet.

Data Sources

A review of relevant literature and data has been conducted to complete this analysis for airborne noise in the TMAA. Of the available scientific literature (both published and unpublished), the following types of documents were utilized in the assessment: journals, books, periodicals, bulletins, Department of Defense (DoD) operations reports, theses, dissertations, and other technical reports published by government agencies, private businesses, or consulting firms.

Methods

The method used in this EIS/OEIS to assess the airborne noise environment impacts associated with existing and proposed Navy training and testing within the TMAA includes the following steps:

- Analyze existing federal noise management regulations applicable to the proposed action;
- Consider existing Navy policies affecting noise production levels (e.g., standard operating procedures [SOPs]);
- Analyze the natural ambient or background noise levels in the TMAA;
- Analyze the various types of noise sources associated with training and testing within the TMAA (e.g., continuous versus impulsive noises); and
- Determine the overall noise environment impacts associated with existing Navy training and testing within the TMAA given the regulatory/procedural framework.

The analysis presented in this section is limited to impacts of airborne sound on humans. Impacts of military-generated sound on natural resources are addressed in Sections 3.6 (Fish), 3.7 (Sea Turtles), 3.8 (Marine Mammals), and 3.9 (Birds).

3.4.3.3 No Action Alternative

Under the No Action Alternative, noise levels would remain at current levels. Navy training in the TMAA, especially live firing of weapons and aircraft activities, is a source of intrusive noise in the immediate vicinity, but the only receptors of that noise should be personnel engaged in the training. Area clearance procedures and the issuance of NOTMARs are undertaken to prevent exposure of non-military personnel in ocean areas (such as fishermen in the TMAA). Training activities, such as launch and recovery of aircraft from a CVN and firing of weapons, would not take place if civilian vessels are present in the vicinity.

Personnel engaged in the training events who might be exposed to noise from these activities are required to take precautions, such as the wearing of protective equipment, to reduce or eliminate potential harmful effects of such exposure (personnel engaged in the training are not considered sensitive receptors for purposes of impacts analysis). The center of the TMAA is located approximately 140 nm (259.3 km) from shore, and at its closest is over 12 nm (22.2 km) from shore. Activities in the TMAA are likely to be beyond the hearing of any human receptors other than personnel who are part of the training event.

Because sound-generating events in the TMAA are intermittent, occur in remote areas or off-limits areas, and do not expose the public to high noise levels, no sensitive receptors are likely to be exposed to sound from military activities under the No Action Alternative.

3.4.3.4 Alternative 1

Under Alternative 1, in addition to training activities currently conducted, the Navy would increase the number of training activities above baseline levels for some activities and would conduct training associated with the introduction of new weapon systems, vessels, and aircraft into the Fleet. This alternative would include conducting Anti-Submarine Warfare (ASW) activities and the use of active sonar sources during ASW activities. Some of those ASW activities introduce the use of additional helicopters in low-level flight over the water and the use of the P-3 for the detection and tracking of submarines.

The replacement of the EA-6B with the EA-18G would decrease the contribution to the noise environment from these activities over the foreseeable future. Slight decreases in noise levels from past

Navy training activities throughout the TMAA airspace would be expected given the projected decreases in noise levels from the EA-18G aircraft. Also planned is the use (beginning in 2013) of the P-8A Poseidon (Multimission Maritime Aircraft [MMA]) as the Navy's replacement for the aging P-3 Orion turbo-prop aircraft. MPA is a term used to describe both the P-3 Orion aircraft and the P-8A Poseidon. The P-8A is a modified Boeing 737-800ERX that brings together a highly reliable airframe and high-bypass turbo fan jet engine. It will be equipped with modern ASW, Anti-Surface Warfare (ASUW), and intelligence, surveillance, and reconnaissance (ISR) sensors. In short, the P-8A MMA is a long-range ASW, ASUW, ISR aircraft that is capable of broad-area, maritime, and littoral activities. Average sound levels for the P-3 and P-8A are similar (for example, the P-8A is approximately 1 dB louder than the P-3 during takeoff; DoN 2008) so the minimal difference resulting from the proposed replacement of this aircraft should not result in any noticeable changes in sound levels in the TMAA.

Under Alternative 1, the majority of activities involving or potentially involving explosive ordnance in the TMAA would increase above current levels, as discussed in Chapter 2. As noted previously, precautions are taken to eliminate exposure of non-military personnel to unwanted sound from military activities. As with the No Action Alternative, sound-generating events under Alternative 1 are intermittent during the exercise period and would occur in remote areas or off-limits areas. The center of the TMAA is located approximately 140 nm (259.3 km) from shore and at its closest is over 12 nm (22 km) from shore. Activities in the TMAA are likely to be beyond the hearing of any human receptors.

3.4.3.5 Alternative 2

Under Alternative 2, the majority of Navy training activities would increase approximately twofold, as discussed in Chapter 2. Activities that include or would include aircraft make up a large portion of Alternative 2 activities. Although a small proportion of flights would be at altitudes as low as 300 ft, the preponderance of these air activities would take place at high altitudes far out to sea and out of range of human receptors.

Under Alternative 2, activities involving or potentially involving explosive ordnance would double. The types of sound generated by military activities under Alternative 2 would be identical to those under the No Action Alternative and Alternative 1. As with the No Action Alternative and Alternative 1, sound generating events under Alternative 2 are intermittent and would occur in remote ocean areas or off-limits areas. The center of the TMAA is located approximately 140 nm (259.3 km) from shore, and at its closest is over 12 nm (22 km) from shore. Activities in the TMAA are likely to be beyond the hearing of any human receptors. Precautions are taken pursuant to safety exclusion zone SOPs would prevent noise generating activities from occurring in the proximity to non-exercise personnel in ocean areas (such as fishermen in the TMAA). Members of the public at-sea in the TMAA, therefore, would not likely be exposed to high noise levels (such as may be generated by aircraft engine noise or explosive-related events).

Because sound-generating events in the TMAA are intermittent, occur in remote areas or off-limits areas, and do not expose the public to high noise levels, no sensitive receptors are likely to be exposed to sound from military activities under Alternative 2.

3.4.4 Mitigation

In the TMAA, most Navy training takes place far out to sea, and airborne noise levels will primarily affect military personnel operating the equipment/weapon systems producing the noise. Personnel engaged in the exercise wear personal protective equipment and are not considered sensitive receptors as that term is used in this EIS/OEIS analysis. No additional noise-specific mitigation measures are required.

3.4.5 Summary of Effects

Table 3.4-4 summarizes the effects for the No Action Alternative, Alternative 1, and Alternative 2 on airborne noise under both NEPA and EO 12114.

Table 3.4-4: Summary of Effects by Alternative

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, >12 nm)
No Action Alternative	• Current Navy activities involving aircraft overflight were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to Airborne Noise would occur. • Aircraft overflights (> 15,000 ft) over the U.S. territorial seas (0-12 nm) to the TMAA would have no effect on the acoustic environment.	*Surface Ship Noise* • No change from current conditions. Minor at-sea noise. No sensitive receptors present. *Aircraft Noise* • No change from current conditions. Short-term noise impacts, including sonic booms. No sensitive receptors present at sea. *Weapon and Target Noise* • No change from current conditions. Very short-term noise impacts. No sensitive receptors present at sea.
Alternative 1	• Current Navy activities involving aircraft overflight were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to Airborne Noise would occur. • Aircraft overflights (> 15,000 ft) over the U.S. territorial seas (0-12 nm) to the TMAA would have no effect on the acoustic environment.	*Surface Ship Noise* • Minor localized engine noise. No sensitive receptors present. *Aircraft Noise* • Short-term noise impacts, including sonic booms. No sensitive receptors present at sea. *Weapon and Target Noise* • Very short-term noise impacts. No sensitive receptors present at sea.
Alternative 2 (Preferred Alternative)	• Current Navy activities involving aircraft overflight were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to Airborne Noise would occur. • Aircraft overflights (> 15,000 ft) over the U.S. territorial seas (0-12 nm) to the TMAA would have no effect on the acoustic environment.	*Surface Ship Noise* • Minor localized engine noise. No sensitive receptors present. *Aircraft Noise* • Short-term noise impacts, including sonic booms. No sensitive receptors present at sea. *Weapon and Target Noise* • Very short-term noise impacts. No sensitive receptors present at sea.

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3.5 MARINE PLANTS AND INVERTEBRATES

3.5.1 Affected Environment

For purposes of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the Region of Influence (ROI) for marine plants and invertebrates includes the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA). The TMAA is more than 12 nautical miles (nm) (22 kilometers [km]) from land and is therefore outside of United States (U.S.) territorial seas.

3.5.1.1 Existing Conditions

The GOA forms a large, semicircular bight opening southward into the North Pacific Ocean (Royer and Muench 1977, Stabeno et al. 2004; Figure 3.5-1). The region is bounded by the mountainous coast of Alaska to the west, north, and east and encompasses watersheds of the Alaskan Peninsula from 176º west (W) to the Canadian mainland on Queen Charlotte Sound (127.5ºW) (Mundy and Olsson 2005). The GOA is characterized by a broad and deep continental shelf containing numerous troughs and ridges, and the region receives high amounts of freshwater input, experiences numerous storms, and undergoes intense variability in waters overlying the continental shelf (Whitney et al. 2005).

The GOA is one of the world's most productive ocean regions and the habitats associated with these cold and turbulent waters contain identifiable collections of macrohabitats that sustain resident and migratory species including seabirds, marine mammals, invertebrates, and fishes (e.g., salmon and groundfish; Mundy and Cooney 2005, Mundy and Spies 2005); these habitats support some of the largest fisheries in the United States. (Heifetz et al. 2003).

Important ecosystem functions provided by marine plants and invertebrates within the GOA include the following:

- Phytoplankton form the basis of the ocean food chain.
- Zooplankton serves as an important food source for other organisms, including fishes and whales.
- Benthic invertebrates, which range from microscopic crustaceans to clams and crabs, also provide valuable links in the food chain and perform ecosystem functions such as nutrient processing.
- For humans, marine plants and invertebrates contribute to economic, cultural, and recreational activities in the GOA.

The TMAA is more than 12 nm (22 km) from the closest point of land and includes primarily offshore habitats including continental shelf, slope, and abyssal plain regions, which are influenced by both the Alaska Coastal Current and the Alaska Gyre (Figure 3.5-1). The TMAA consists of open ocean, and the following discussion is divided into two distinct habitat types:

- Pelagic, or open ocean habitat, and
- Benthic, or bottom dwelling habitat.

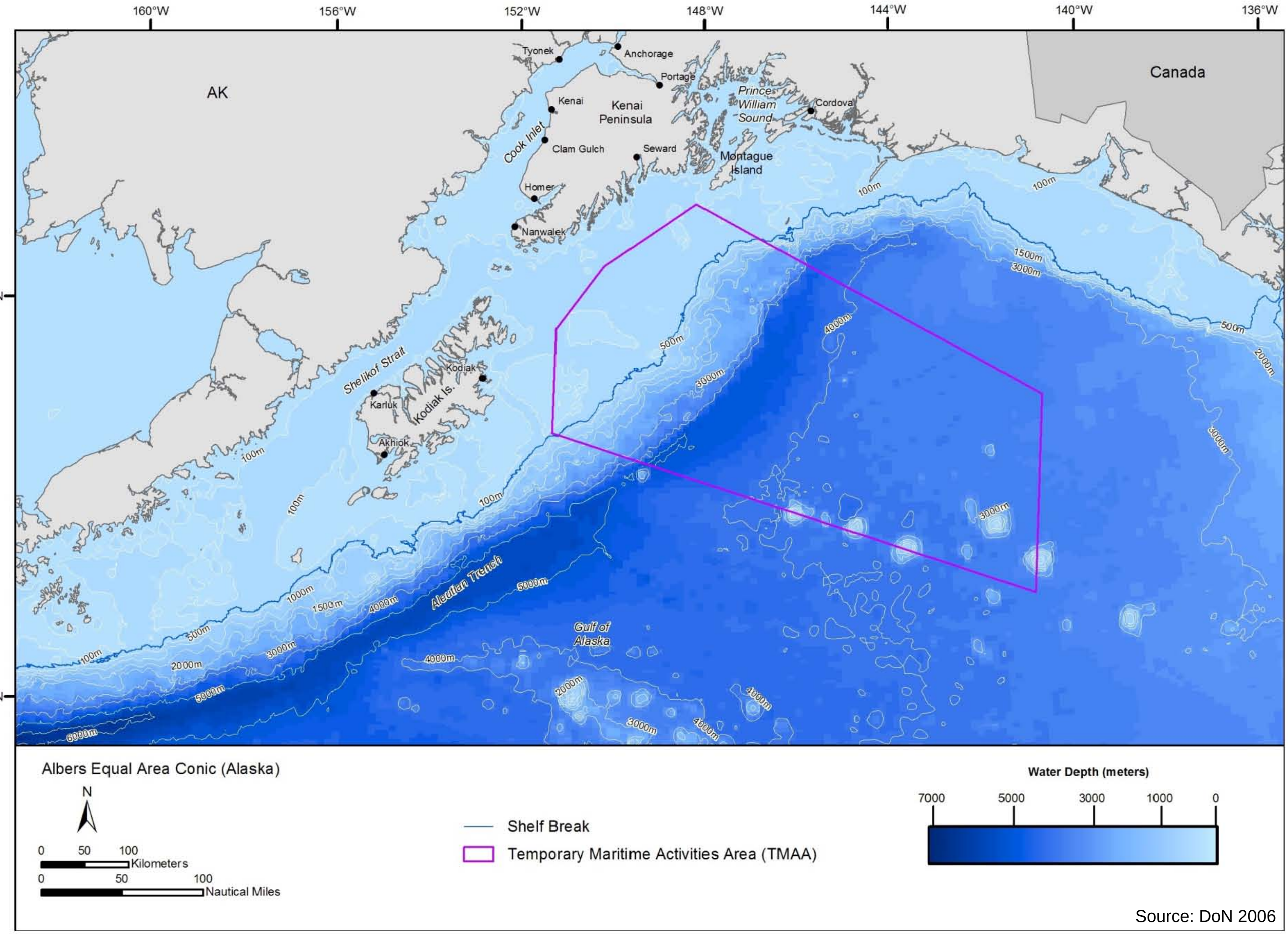


Figure 3.5-1: 2D Bathymetry of the TMAA and surrounding Vicinity

Open Ocean Pelagic Habitats

All areas except those near the coast and the sea floor are called the pelagic or oceanic zone; this zone is further divided into light and depth-dependent zones (Figure 3.5-2). The photic zone (with light) of the open ocean consists of the epipelagic and mesopelagic zones. The aphotic zone (without light) of the open ocean consists of all the zones lower in the ocean. The epipelagic zone stretches from the surface down to 660 feet (ft) (200 meters [m]) and is home to the greatest biodiversity in the sea, largely because of the availability of sunlight that enables photosynthetic organisms to thrive (Department of Navy [DoN] 2006). Both marine plants and animals are present in the epipelagic zone.

From 660 to 3,300 ft (200 to 1,000 m) is the mesopelagic zone, a twilight zone where some light filters through, but does not reach a level of brightness necessary for photosynthesis to occur.

The bathypelagic zone is from 3,300 to 13,200 ft (1,000 to 4,000 m) and completely dark. Plants are non-existent in the bathypelagic zone. Animals that can live here survive on the dead material, or detrius, that falls from surface zones or on other animals that live in the deep sea. Most animals in the abyssalpelagic zone, located from 13,200 ft (4,000 m) down, are blind and colorless due to the complete lack of light.

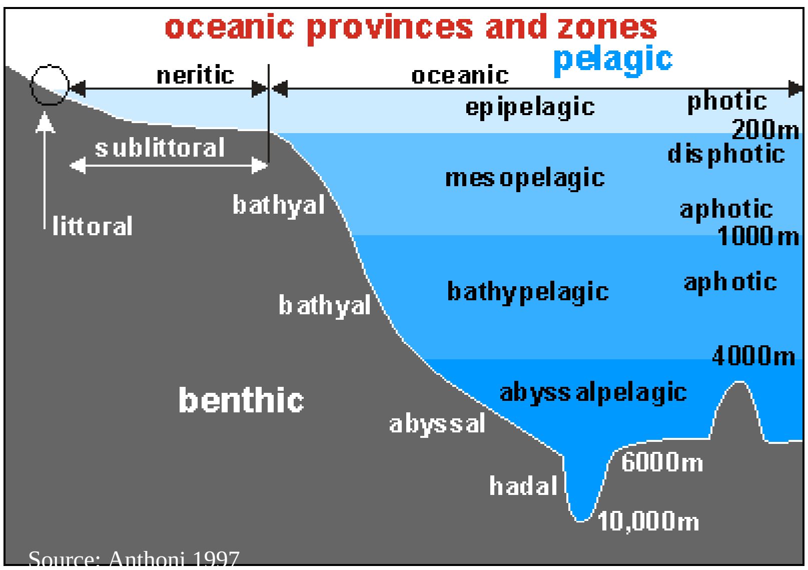


Figure 3.5-2: Oceanic Zones

Microscopic Communities

Plankton are organisms that float or drift in the water column and are unable to maintain their position against the movement of water masses (Parsons et al. 1984); they are at the mercy of the currents in the local aquatic environment. Planktonic assemblages include bacterioplankton (bacteria), zooplankton (animals) including ichthyoplankton (larval fish), and phytoplankton (plant-like). In general, plankton are very small or microscopic although there are exceptions. For example, jellyfish (even though some jellyfish can grow to 10 ft [3 m] in diameter) and pelagic *Sargassum* are considered part of the plankton group due to their inability to move against surrounding currents.

Phytoplankton

Phytoplankton make up most of the marine plant life in the GOA. These organisms photosynthesize to convert light energy into chemical energy; thereby, in the oceans, they comprise the lowest level of the food web and can be considered the most important group of organisms in the ocean. A vast majority of organisms in the oceans depend either directly or indirectly on phytoplankton for survival. Growth and distribution of phytoplankton are influenced by several factors including temperature (Eppley 1972), light (Yentsch and Lee 1966), nutrient concentration (Goldman et al. 1979), alkalinity (pH), and salinity (Parsons et al. 1984). In general, the distribution of phytoplankton is patchy, occurring in regions with the optimal conditions for growth. The concentration of chlorophyll measured in the water column or at the sea surface can be used as a proxy for phytoplankton; regions of enhanced chlorophyll (chl a) concentrations are indicative of high phytoplankton abundance (Figure 3.5-3). In general, the concentration of phytoplankton decreases with increased distance from the shore and water depth.

Continental Shelf and Nearshore Waters

Although the predominance of downwelling conditions in the GOA limits the supply of nutrients to the shelf, it remains a highly productive region (Ladd et al. 2005b). Frequent storms, high tidal energy, persistent storms, and localized upwelling appear to be the primary mechanisms that enhance vertical mixing along the coastal shelf (Hood 1986, Sambrotto and Lorenzen 1986, Mundy and Spies 2005). Shelf and coastal waters host a traditional phytoplankton community composed of nanoplankton (2 to 20 microns [µm]) and microplankton (20 to 200 µm); large and small diatoms and dinoflagellates tend to dominate the region (Cooney 1986b, Sambrotto and Lorenzen 1986, Sherr et al. 2005). When production is high, diatoms commonly account for more than 80 percent of the phytoplankton (Whitney et al. 2005).

In the GOA, the annual production cycle is characterized by well-defined spring (and sometimes fall) blooms of large diatom species (most are larger than 50 µm; Cooney 2005). These blooms typically begin in late March and early April in response to a seasonal stabilization of the winter-conditioned deep mixed layer, and increased ambient light (Stabeno et al. 2004, Cooney 2005, Mundy and Cooney 2005).

These blooms and their associated high rates of photosynthesis typically last only 4 to 6 weeks before being controlled by nutrient depletion, sinking, and zooplankton grazing (Goering et al. 1973, Mundy and Cooney 2005). The timing, duration, and intensity of blooms are controlled largely by the physical structure of the water column. Depending on the variable conditions of any given spring, the plant bloom may be early or late by as much as 3 weeks; strong periods of wind, tidal mixing, or both during the bloom can prolong bloom events (Cooney 2005, Mundy and Cooney 2005, Weingartner 2005). When the phytoplankton bloom is prolonged in this way, its intensity is lessened.

In the late spring and early summer, large diatom-dominated spring blooms decline as nutrient supplies are diminished; dinoflagellates and other smaller forms are the dominant taxa under these conditions (Cooney 2005). In Prince William Sound, dominance in the phytoplankton bloom was shared by the large chain-forming diatoms including *Skeletonema*, *Thalassiosira*, and *Chaetoceros*. Later in June, when nutrients become more restrictive to growth, phytoplankton are dominated by smaller diatoms (e.g., *Rhizosolenia*) and tiny flagellates. Regions southeast of Kodiak Island have higher standing stocks during the summer than shelf regions to the northeast where fewer submarine canyons and troughs are located. It is believed that intrusion of nutrient-rich waters in these troughs and the subsequent mixing of these nutrients into the euphotic zone support this phytoplankton assemblage (Ladd et al. 2005a).

In some years, a nearshore or inshore fall bloom of diatoms occurs in September and October in response to a deepening wind-mixed layer and enhanced nutrient levels (Cooney 2005). A fall phytoplankton bloom occasionally can be detected in Prince William Sound. The ecological importance of this late-season production and the physical forces responsible are not yet understood (Mundy and Cooney 2005).

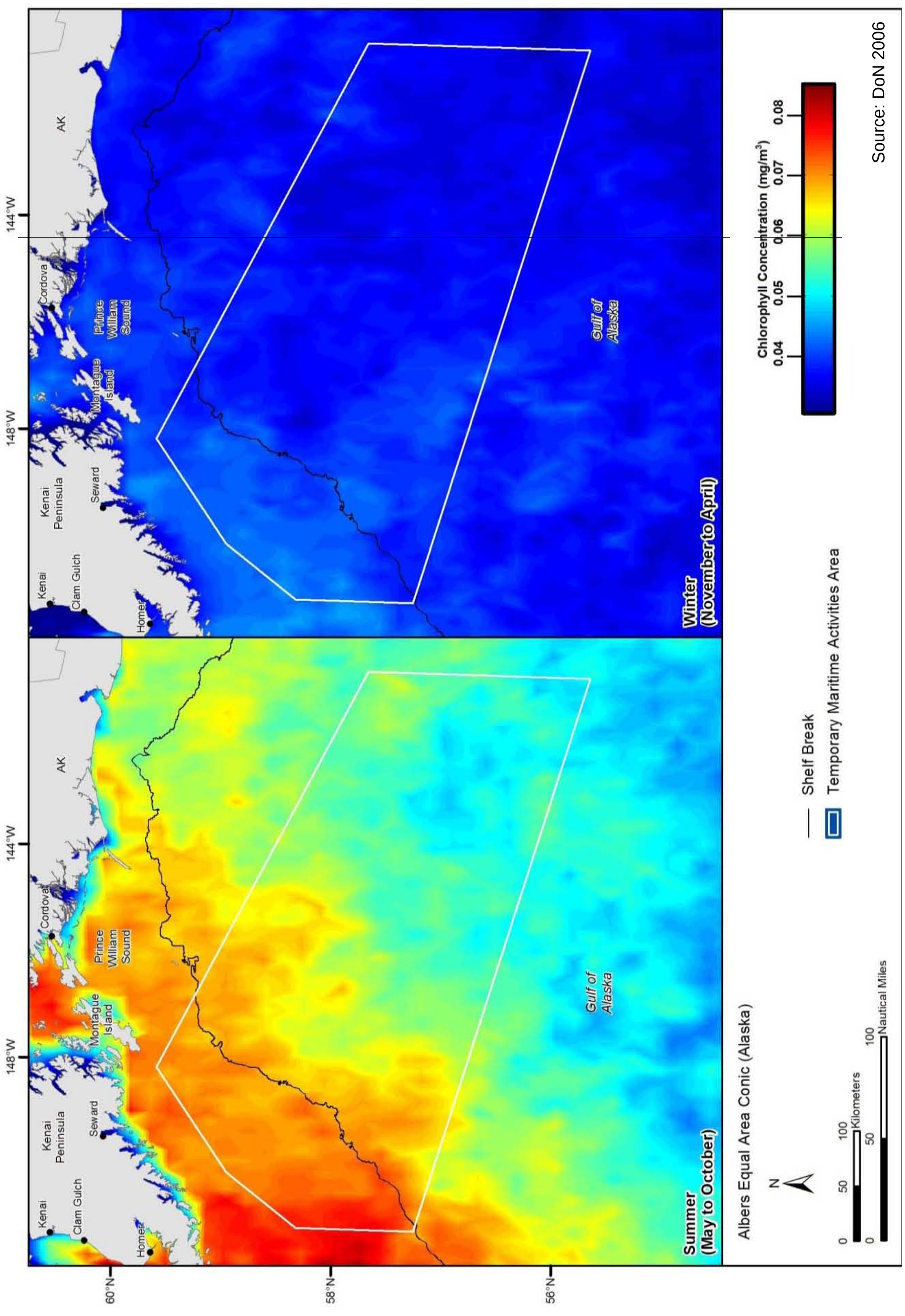


Figure 3.5-3: Seasonal Distribution of Chlorophyll throughout the TMAA and surrounding Vicinity during Summer (May through October) and Winter (November through April)

Offshore and the Alaskan Gyre

The basin of the GOA is a high-nutrient, low-chlorophyll environment (Ladd et al. 2005b). As a result of winter mixing combined with advection, phytoplankton in the center of the basin are supplied with sufficient nutrients for growth (Wheeler 1993). However, due to iron limitation, concentrations of chlorophyll remain low (approximately 0.3 milligrams [mg] chl/cubic meter [m^3]) throughout the year and production does not reach the levels seen in coastal regions (Sambrotto and Lorenzen 1986, Martin et al. 1989, Boyd et al. 1995). The phytoplankton community comprising the oceanic euphotic zone is dominated year-round by very small phytoplankton including small diatoms, naked flagellates, and cyanobacteria (Sambrotto and Lorenzen 1986, Booth 1988). Most of these organisms are smaller than 10 µm in size. The smallest of these phytoplankton include phototrophic bacteria, coccoid cyanobacteria, and picoplankton (<1 to 3 µm); these classes are considered to be the most important phytoplankton in open ocean gyres (Sherr et al. 2005). Unlike the coastal regions of the GOA, the outer shelf and deep ocean regions do not undergo seasonal blooms in phytoplankton abundance (Cooney 2005, Mundy and Cooney 2005).

Zooplankton

Zooplankton is a term for microscopic (< 2 µm) to small animals (2 to 20 cm) that live in the open ocean. Examples include ciliates; a wide variety of crustaceans such as copepods and krill (euphausiids); and the eggs, larvae, and juvenile stages of organisms ranging in complexity from jellyfish to fish (Kideys 2002).

Most zooplankton feed on phytoplankton. The zooplankton, in turn, serves as an important food source for other organisms, including fishes and whales. Copepods and krill are the two most important food sources for adult pelagic fish and baleen whales. Krill usually live at depths beyond the range of surface-feeding animals, but during swarming, large numbers may migrate to the surface within reach of flocks of birds (Sheard 1953, Boden et al. 1955).

Shelf waters in the GOA host a traditional plankton community in which large phytoplankton (diatoms and dinoflagellates) are grazed upon by copepods (Cooney 1986b, Sambrotto and Lorenzen 1986, Incze et al. 1997, Coyle and Pinchuk 2003, Cooney 2005, Coyle and Pinchuk 2005). The dominant zooplankton that inhabit the GOA are copepods and cnidarians, and abundance and species composition is largely driven by local salinity (Coyle and Pinchuk 2003). In addition to copepods, larger micronektonic species (e.g., euphausiids, amphipods, and some shrimp species) can be important zooplankton components in the diets of local fish and large predators (Coyle and Paul 1992, Incze et al. 1997, Boldt and Haldorson 2003). Highest levels of biomass tend to occur in the summer months of May (copepods) and August (cnidarians); lowest values tend to occur in February (Coyle and Pinchuk 2003, Zamon and Welch 2005). Cross-shelf distribution of zooplankton is influenced by their depth preferences, migration behavior, salinity and temperature preferences, and water movement. A mid-shelf transition region also can be identified where the zooplankton community is composed of a mixture of neritic and oceanic species (Coyle and Pinchuk 2005).

Grazing by the larger mesozooplankton (i.e., copepods) accounts for only a small percentage of phytoplankton mortality in the Alaska Gyre (Mackas and Tsuda 1999). Rather, production of phytoplankton in the oceanic regions of the GOA is thought to be controlled by an assemblage of microzooplankters and microconsumers, represented by abundant ciliate protozoans and small flagellates, rather than by large copepods (Miller et al. 1991a, Miller et al. 1991b, Booth et al. 1993, Dagg 1993, Frost 1993). Because the growth rates of these grazers are higher than those of the phytoplankton, it is hypothesized that these consumers are capable of efficiently tracking and limiting the overall oceanic productivity by eating the primary producers (Banse 1982, Taniguchi 1999). Oceanic zooplankton in the upper layers of the water column exhibit marked seasonality. In the late winter, biomass of zooplankton in the region increased 5-fold to 100-fold (values increase from 5 to 20 mg/m^3 in the winter to 100 to 500 mg/m^3 in the mid-summer). During this increase, copepods dominate the zooplankton community (Cooney 1986a, 1986b; Hood 1986; Landry and Lorenzen 1989; Cooney 2005).

Many of the zooplankton inhabiting the GOA migrate diurnally over 330 ft (100 m) or more. These migrations may interact with vertical or horizontal currents in ways that create localized swarms and patches of plankton in the region (Mundy and Cooney 2005, Weingartner 2005).

El Niño events have little effect on the phytoplankton composition within the shelf waters of the GOA (Coyle and Pinchuk 2003, Zamon and Welch 2005). Horizontal expansion of zooplankton stocks occur during warm periods of the Pacific Decadal Oscillation (PDO) along the coast. Both El Niño and the PDO affect the phytoplankton assemblage in the oceanic regions. Following the shift to a positive (warm) PDO regime in the late 1970s, zooplankton biomass doubled in the offshore regions of the GOA (Brodeur and Ware 1992, McFarlane and Beamish 1992, Brodeur et al. 1996, Francis and Hare 1997). During an El Niño event, a shallower mixed layer restricts the supply of nutrients to the ocean surface. In turn, the entire GOA experiences extreme nitrate depletion and decreased levels of primary production. Zooplankton become depleted as their food source is not as abundant (Freeland 2000).

Pelagic Invertebrates

Open-ocean or pelagic invertebrates consist of "jellies"—jellyfish (cnidarians), comb jellyfish (ctenophorans), and salps (chordates)—plus a wide variety of other animals, including shrimp (decapods), gastropods, and polychaete marine worms. Most of these animals filter the sea water for plankton. Salps are more abundant in phytoplankton-rich surface waters, but have been found at depths to 3,300 ft (1,000 m). Many of these soft-bodied invertebrates are important sources of food for sea turtles.

Open Ocean Deepwater Benthic Habitats

The variety of bottom substrates and the complicated system of water circulation and bathymetry in the GOA results in a complex benthos (Chikuni 1985). The distribution of the benthos in the GOA is primarily a function of depth (i.e., light penetration, temperature, and wave action) and substrate (i.e., availability and type of substrate and movement and accumulation of sediments; Maragos 2000).

In addition, the distribution, diversity, and abundance of the benthos of the GOA are strongly influenced by the Alaska Coastal Current in conjunction with heavy sediment loads that originate from glacial meltwater. The GOA has a relatively wide shelf (up to 54 nm [100 km]) with several banks bisected by submarine canyons. Most regions of the GOA shelf experience high sedimentation rates of clayey silt that results in poorly consolidated sediments; however, in some relatively shallow areas, few sediments accumulate because of scouring by strong bottom currents and frequent winter storm waves. The megahabitats (delineated by water depth) of the GOA include the continental shelf (<660 ft [<200 m]), upper slope (~660 to 9,900 ft [200 to 3,000 m]), submarine canyons (660 to 1,320 ft [200 to 400 m]), and abyssal plain (~9,900 to 16,500 ft [3,000 to 5,000 m]). Over 400 infaunal invertebrate taxa, representing 11 phyla, and approximately 180 epifaunal species, representing 10 phyla, have been described along the continental shelf. Over the entire shelf of the GOA, the mean diversity and species richness was highest on banks and at the shelf break (Feder and Jewett 1986). The more offshore areas of the GOA, the continental slope and abyssal plain, are characterized as having substrata with large grain sizes (e.g., boulders, cobble) that provide macrohabitats to support a diversity of organisms including groundfish and rich epifaunal communities (e.g., coral, sponges, anemones, bryozoans). Since many deepwater areas are characterized by stable environments dominated by long-lived species, the potential impacts of fishing on these areas can be substantial (National Marine Fisheries Service – Alaska Region [NMFS-AKR] 2005). The following are summaries of each megahabitat.

Continental Shelf

Much of the continental shelf is covered with sand, mud, silt, bits of broken shell, and other fine materials that are often inhabited by organisms living within the upper layers of the seafloor (infauna) or on the surface of these seafloor substrates (epifauna). The benthic invertebrate fauna of the GOA differs markedly as a function of bottom type. Epifauna live attached to or rove over the sediment surface wherever suitable substrate occurs. For example, sponges, barnacles, anthozoans, soft corals, ascidians, sea whips, sea pens, mussels, and bryozoans are distributed throughout the continental shelf of the GOA, many of which provide important structure to the soft sediment seafloor. Infaunal invertebrates such as polychaetes, clams, nematodes, and amphipods burrow into sand and mud bottoms and stabilize the sediments. These benthic invertebrates serve as prey for mobile epibenthic invertebrates and for demersal fishes. In the GOA, common predatory invertebrates include sea stars (e.g., leather [*Dermasterias imbricate*] and sunflower star [*Pycnopodia helianthoides*]), crabs (e.g., helmet, Dungeness, king, snow, and Tanner crabs), shrimp (*Carangon* and *Pandalus* shrimps), gastropods, and some scavenging invertebrates (AMCC [Alaska Marine Conservation Council] and ASG [Alaska Sea Grant] 2003, Peterson 2005).

The shelf of the GOA is a complex and dynamic geologic environment characterized by banks, patchy rocky substrate, and patchy bottom sediments. Banks are exposed to both wave and current action (particularly during winter storms) that continually resuspend bottom sediments. Bottom material such as sand, gravel, boulders, and broken shells are most characteristic of the banks while finer sediment accumulates in the depressions and the troughs of the region. Sessile suspension feeders are most abundant at the shelf edge with the biomass exceeding 9.9 ounces/ square foot (ft^2) (3,000 grams [g]/square meter [m^2]) in some regions. Mobile suspension feeders occur mainly in two areas: 1) on the plateau-like surfaces of the shelf in areas with smooth relief and predominance of sand sediments and 2) on the sides of troughs and canyons. Selective deposit-feeders comprise 15 percent of the total biomass of the shelf and are most common between 172 and 521 ft (52 and 158 m) on bottoms covered with fine-grained sand or muddy sediments that are characterized by a smooth relief (Feder and Jewett 1986).

In the TMAA, the benthos of Portlock Bank was surveyed in water depths from about 165 to 2,475 ft (50 to 750 m). The seafloor is generally flat and covered with small boulders, cobble, and gravel. The most common epifauna were crinoids, small nonburrowing sea anemones, glass sponges, stylasterid corals, and brittlestars. The glass sponges and stylasterid corals found attached to the boulders were larger than those observed on the surrounding seafloor (Heifetz et al. 2003).

Sponges - The distribution of sponges (Phylum Porifera) in the GOA is patchy. However, there are four common sponges found in the GOA. The barrel sponge (*Halichondria panicea*) is a large, thick-walled colony. Although highly variable in shape, the barrel sponge can reach a maximum height of 12 inches (in) (30 cm). The cloud sponge (*Aphrocallistes vastus*) is an upright sponge that grows to 12 in (30 cm) in height. The hermit sponge (*Suberites ficus*) is a small sponge (less than 6 in [15 cm] in height) that grows over snail shells. The tree sponge (*Mycale loveni*) forms a hard, tree-like skeleton surrounded by soft sponge and attains a maximum height of 10 in (25 cm) (National Marine Fisheries Service–Alaska Region [NMFS-AKR] 2005). Sponges provide prime habitat for red king crab (*Paralithodes camtschaticus*), rockfish, and Atka mackerel (*Pleurogrammus monopterygius*) (AMCC and ASG 2003).

Bryozoans - Bryozoans are small colonial animals that are common on hard substrates (i.e., rock, live and dead bivalve and gastropod shells, and crab shells). Roughly two-thirds of the known species in the region are low-profile encrusting forms. In the GOA, the bryozoans, *Flustrella* sp. and *Dendrobeania* spp., have been associated with the largest catches of juvenile red king crab, suggesting that bryozoans provide prime habitat for these crabs (NMFS-AKR 2005).

Hydroids - Hydroids are small, mostly colonial, cnidarians; in the GOA, approximately 200 species have been identified. Most hydroids are erect, tree-like, and grow no taller than 6 in (15 cm); other hydroids encrust on mollusk shells, rock, and other hard surfaces. In the GOA, hydroids are considered to be the main food source of juvenile red king crab (NMFS-AKR 2005).

Ascidians - Ascidians, small sedentary marine invertebrates with a saclike body, include members of the genus *Boltenia* (sea onions), *Styela* (sea potato), and *Halocynthia* (sea peach). In the GOA, sea onions, sea potatoes, anemones, and sponges typically cover the sandy seafloor at depths of 83 to 330 ft (25 to100 m) (AMCC and ASG 2003, NMFS-AKR 2005). Sea onions are stalked, solitary ascidians with a white or pinkish bulb-like body that floats in the water column and is tethered to the bottom by a stalk; the entire animal reaches up to 30 cm or more in length. Two species of sea onions, *Boltenia ovifera* and *B. villosa*, are commonly found in the GOA. Compound ascidians, bryozoans, and hydroids frequently attach to the stems and holdfasts of sea onions. Sea onions and associated attached invertebrates are known to provide habitat to small juvenile red king crab. Sea potatoes are dark brown and have a potato-shaped body that can reach a maximum size of 4 in (10 cm). They grow in clumps that permanently attach to snail, clam, or other invertebrate shells. The sea peach, *Halocynthia aurantium*, is a large (up to 7 in [18 cm]), ascidian that is often found in groups. It has a smooth or wrinkled red-orange outer covering with a barrel-shaped body that attaches directly to the substrate (NMFS-AKR 2005).

Anthozoans - Anthozoans are a large taxonomic group that include sea raspberries (*Gersemia* sp.), a soft coral whose groups of small polyps, when inflated, form thick, soft, red lobes in colonies that can reach a height of 10 in (25 cm). When contracted, the colony has a "brain-like" appearance and is considerably smaller. Two species of sea raspberries that are found in the GOA, *G. rubiformis* and *G. fruticosa*, have the widest temperature and substrate preference range of all Alaskan soft corals (AMCC and ASG 2003). Anthozoans also include sea anemones, sea pens, sea whips, and corals, all of which can form dense concentrations in the GOA (NMFS-AKR 2005).

Sea whips and sea pens - Some of the most distinctive groups of long-lived, habitat-forming organisms are the sea whips and sea pens (order Pennatulacea). Sea whips and sea pens can reach a length of 1.5 m or more and can be found on soft substrates at depths greater than 26 ft (8 m) but are more common at greater depths and have been found in depths as great as 300 ft (91 m) (NMFS-AKR 2005). However, several genera are typically collected most frequently at depths exceeding 3,300 ft (1,000 m) worldwide and are known from 1,650 to 3,300 ft (500 to 1,000 m) in the GOA, e.g. *Anthoptilium* spp. (DoN 2006). In the TMAA, the sea whips, *Protoptilum* sp. and *Halipteris willemoesi*, have been found in densities as high as 10 individuals per m^2 and sea pens, such as *Ptilosarcus gurneyi*, have been found in dense aggregations at depths less than 99 ft (30 m) (NMFS-AKR 2005).

Stands of sea whips and sea pens provide vertical relief to otherwise flat habitats and shelter for many organisms including gadids (e.g., pollock), rockfish, crab, and the Pacific ocean perch, *Sebastes alutus* (AMCC and ASG 2003; NMFS-AKR 2005). A clear relationship exists between sea whip and sea pen abundance and the diversity of marine life. For example, worms, bivalves, sea cucumbers, basket stars, shrimps, several species of flatfishes, small octopuses, and squids are often found in sea whip and sea pen habitats (AMCC and ASG 2003).

Coral communities - Etnoyer and Morgan (2003, 2005) synthesized data on the occurrence of habitat-forming deep-sea corals in the Northeast Pacific Ocean. Deep-sea corals are typically found from the edge of the continental shelf to the continental rise, on banks, and on seamounts (Freiwald et al. 2004). While the mean depth range of deep-sea corals in the Northeast Pacific Ocean is 875 to 4,165 ft (265 to 1,262 m), deep-sea corals are known to occur in the GOA from the shoreline to the upper slope (3.3 to 2,789 ft [1 to 845 m]) water depth range; Heifetz 2002, Marine Conservation Biology Institute [MCBI] 2003, Etnoyer and Morgan 2005).

True deep-sea coral communities live in complete darkness, in temperatures as low as 39 degrees Fahrenheit (°F) (4 degrees Celsius [°C]) and in waters as deep as 19,800 ft (6,000 m); therefore, they are also known as “cold-water coral reefs” (Freiwald et al. 2004). Deep-sea corals lack the symbiotic zooxanthellae found in tropical reef-building corals. Thus, deep-sea corals do not benefit from a carbon supply provided by symbiotic algae but rather survive solely on suspension feeding. The biological diversity of deep-sea corals communities is high; from an economic perspective, this diversity creates valuable habitat for several commercially fished species (Witherell et al. 2000, Gass 2003).

Deep-sea coral communities usually consist of sessile stony corals (Order Scleractinia), soft corals (Sub Class Octocorallia), black corals (Order Antipatharia), and lace corals (Order Stylasterina, Freiwald et al. 2004, Hain and Corcoran 2004, Roberts and Hirshfield 2004). These corals can build very large 3D structures in deep-sea environments that are comparable in size and complexity with coral reefs that occur in shallow tropical waters. Deep-sea coral assemblages provide habitat to thousands of species including sponges, polychaetes (or bristle worms), crustaceans (crabs and lobsters), mollusks (clams, snails, octopuses), echinoderms (starfish, sea urchins, brittle stars, feather stars), bryozoans (sea moss), and fish (Freiwald et al. 2004). Yet, much like shallow-water corals, deep-sea corals are fragile and slow growing: thus, they are vulnerable to human-induced physical impacts (Andrews et al. 2002, Roberts and Hirshfield 2003, Freiwald et al. 2004, Roberts and Hirshfield 2004).

The overall size of deep-sea coral communities can range from patches of small solitary corals to massive reef structures (mounds, banks, and forests) several meters to tens of kilometers across and a meter to tens of meters high (Tucker and Wright 1990, Cairns 1994). The red tree coral, *Primnoa pacifica*, found in the GOA (33 to 2,640 ft [10 to 800 m] water depth), can reach 9.9 ft (3 m) in height and 23.1 ft (7 m) in width and achieve over 100 years of age (Heifetz 2000, Andrews et al. 2002, Heifetz 2002, Cairns and Bayer 2005). Bamboo corals (Family Isididae), found at 2,310 ft (700 m) water depth in the GOA, Warwick Seamount (48°3’ north [N], 132°44’W), were 75 to 208 years old and their growth rates ranged from 0.05 to 0.16 millimeters (mm)/year (yr) (Roark et al. 2005).

Trawls and heavy fishing gear used by commercial fishing have caused severe damage to deep-sea coral communities in many areas of the world including the GOA (Freese et al. 1999, Roberts and Hirshfield 2004). Deep-sea coral communities are also susceptible to physical impacts caused by oil- and gas-related activities, cable laying, seabed aggregate extraction, shipping activities, the disposal of waste in deep waters, coral exploitation, mineral exploration, and increased atmospheric carbon dioxide (CO_2) (Gass 2003, Freiwald et al. 2004, Roberts and Hirshfield 2004). It may take decades to centuries for physically damaged deep-sea coral communities to recover (Freiwald et al. 2004, Roberts and Hirshfield 2004). The recovery of the deep-sea corals is particularly slow not only because of slow growth rates but also because larvae production is positively related to the size of the parent coral colony. Further, some damaged colonies will first devote energy to making repairs before sexual reproduction takes place (Andrews et al. 2002).

Corals in Alaskan waters are found in the GOA, the Aleutian Islands, and the Bering Sea (Heifetz 2002, MCBI 2003). The known distribution of deep-sea corals is contained to water depths that are shallower than 2,970 ft (900 m); however, given the general distribution of deep-sea corals in the Northeast Pacific Ocean it is likely that deep-sea corals occur at greater depths and over a broader geographical extent. In the GOA, the distribution of corals may extend beyond the 2,970 ft (900 m) isobath (Freiwald et al. 2004, Hoff and Stevens 2005). In a recent survey of seamounts in the Kodiak-Bowie Seamount Chain (Kodiak Seamounts), diverse deep-sea coral communities (including new coral species; tentatively belonging to the Primonidae, Isididae, and Antipathidae coral families) and associated invertebrates and fishes were documented in the deep-sea coral distribution database; however, these recent discoveries have yet to be reported in the peer-reviewed literature (Tsao and Morgan 2005).

There are a total of 105 known coral species in Alaskan waters including soft corals, gorgonians, sea pens, sea whips, cup corals, black corals, and hydrocorals (Wing and Barnard 2004). The locations of 14 coral taxa mapped in the GOA include antipatharians (Family Antipathidae), gorgonians (Families Corallidae, Isididae, Paragorgidae, Primnoidae), and hydrozoans (Family Stylasteriidae; Heifetz 2002, MCBI 2003; Figure 3.5-4). Yet the most common coral taxa encountered in the GOA are cup corals (unidentified scleractinians; 31 percent of coral records) and gorgonians (mostly *Callogorgia* and *Primonoa*; ~45 percent of coral records; Heifetz 2002). For comparison, there are 43 coral taxa known for the Aleutian Islands and 8 coral taxa for the Bering Sea. The cup corals found in the GOA are probably of the genera *Balanophyllia* (occurring in waters depth ranging from 0 to 40 ft [12 m]) and *Caryophyllia* (40 to 13,200 ft [12 to 4,000 m]; NMFS-AKR 2005). Black corals (antipatharians) are found throughout the GOA in water depths ranging from 1,320 to 3,300 ft (400 to 1,000 m) (NMFS-AKR 2005). Gorgonians are the most abundant coral taxa in the Aleutian Islands, and soft corals are the most abundant in the Bering Sea (Heifetz 2002). Gorgonians and cup corals occur throughout the Aleutian Islands but have a patchy distribution in the GOA, including substantial patches located off the Kenai Peninsula. Hydrocorals (Order Stylasterina) and soft corals (Order Alcyonacea) are found in a few small patches in the GOA (Heifetz 2002).

Because of their abundance, size, and longevity, red tree corals form essential habitat for fishes and invertebrates. Krieger and Wing (2002) observed colonies of *Primnoa* spp. in the southeast GOA (531 to 1,205 ft [161 to 365 m] water depth) that were used as habitat by rockfish (e.g., rougheye [*Sebastes aleutianus*], redbanded [*S. babcocki*], shortraker [*S. borealis*], sharpchin [*S. zacentrus*], dusky [*S. ciliatus*], and yelloweye [*S. ruberrimus*]), sea stars (e.g., *Hippasteria heathi*), nudibranchs (e.g., *Tritonia exulans*), crinoids (e.g., *Florometra* sp.), basket stars (e.g., *Gorgonocepahlaus eucnemis*), golden king crab (*Lithodes aquaspina*), shrimps, snails, anemones (e.g., *Cribinopsis* spp., *Stomphia* spp., and *Tealia* spp.), and sponges. Seastars, nudibranchs, and snails found on the *Primnoa* colonies were feeding upon and damaging coral polyps. Crinoids, basket stars, anemones, and sponges used *Primnoa* as a substrate for attachment in an effort to filter feed while suspended off the surrounding seafloor. Rockfish, shrimp, and crabs sought refuge within the branches of the *Primnoa* colonies (Krieger and Wing 2002). In the GOA, *Primnoa* colonies have been harvested for jewelry (200 kilograms [kg]/yr) from 1997 to 2001 (Krieger and Wing 2002). Deep-sea corals, including colonies of *Primnoa*, were accidentally but indiscriminately destroyed by commercial bottom trawling (Krieger and Wing 2002, Etnoyer and Morgan 2005). Increased use and geographic expansion of bottom-impacting fishing gear are likely to negatively impact deep-sea coral habitats and associated species. The regulation of fisheries by regional fishery management councils can protect deep-sea coral ecosystems that are currently impacted and prevent the destruction of unexploited areas by using science-based information (surveys and mapping) to implement an ecosystem-based approach (Freese et al. 1999, Witherell et al. 2000, Andrews et al. 2002, Frame and Gillelan 2005).

Corals in the TMAA are known in water depths ranging from 3 to 2,789 ft (1 to 845 m) (MCBI 2003; Figure 3.5-4). As noted earlier they occur in deeper water and over a broader expanse potentially including Dall Seamount found within the TMAA. Known corals in the TMAA include antipatharians (Family Antipathidae), gorgonians (Families Corallidae, Isididae, Paragorgidae, and Primnoidae), and hydrozoans (Family Sytlasteriidae; MCBI 2003). However, this area has not been fully sampled and deep-sea corals are likely to occur in deeper water and over a broader expanse within the TMAA (MCBI 2003).

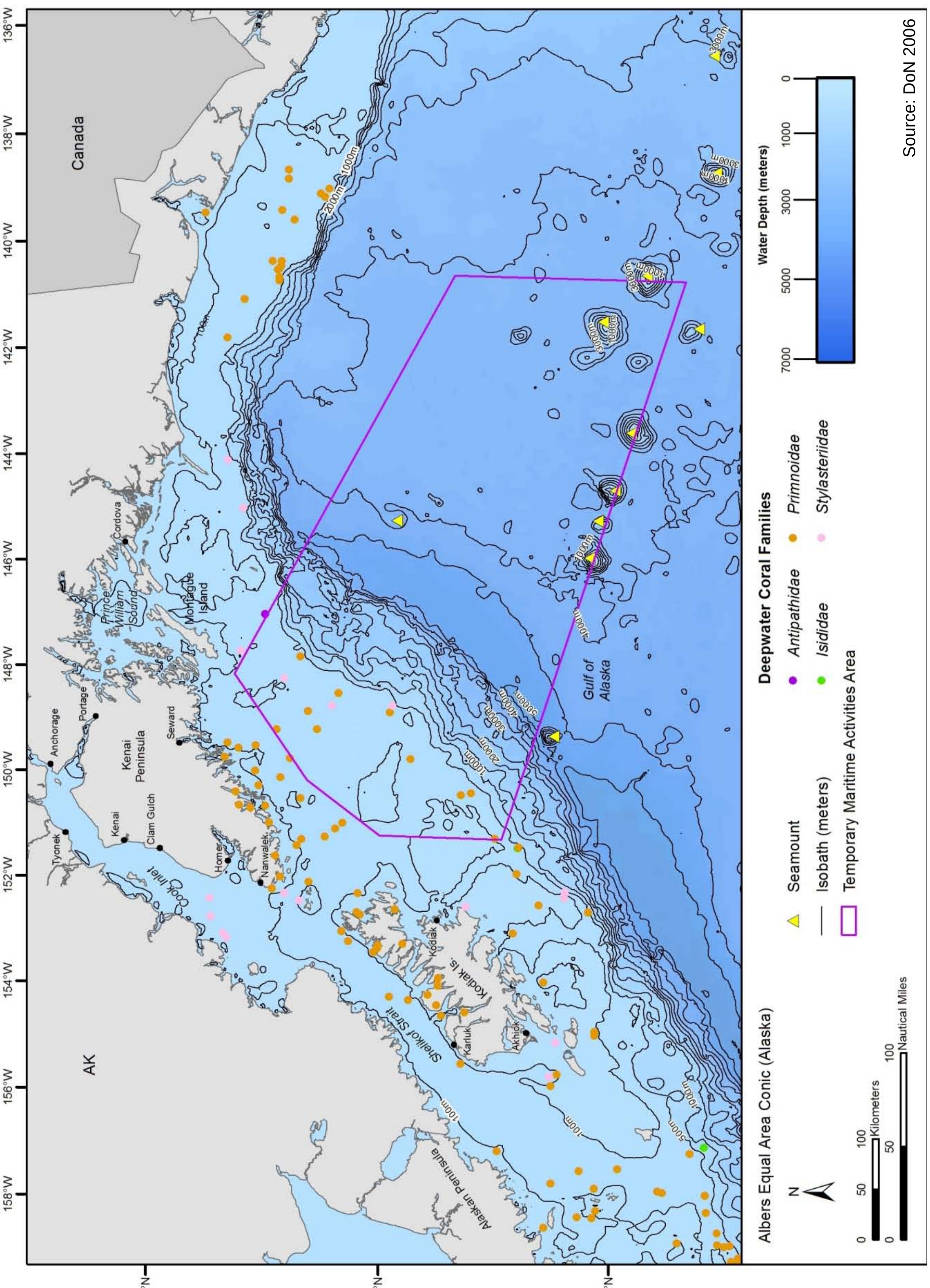


Figure 3.5-4: Coral Communities (hydrozoans & anthozoans) of the TMAA & Surrounding Vicinity

Continental Slope

In addition to substrate, the species composition of the benthos in the GOA changes significantly with water depth. The bottom substrate of the continental slope is typically covered with silts, clays, and fine sediments; however, there is the occasional hardbottom substratum (e.g., rocky outcroppings, rubble, talus, vertical wall, and seamounts) that supports a diverse assemblage of deep-sea invertebrates and fishes. Bottom substrate type governs the abundance and diversity of deep-sea organisms. Abundance and diversity are generally higher on hard, irregular substrates than on smooth, hard surfaces (Lissner 1988). Although there have been many descriptive studies detailing the community assemblages on the continental shelf, habitats on the continental slope and deeper are challenging to study because they usually lie beyond the range of self-contained underwater breathing apparatus (SCUBA) and mechanical sampling is difficult (Airamé et al. 2003). Therefore, the outer continental shelf and the continental slope are not well studied in the GOA system. There has been some description of the mobile epibenthic communities and the demersal fish communities (Feder and Jewett 1986); however, most sampling of the continental slope habitats involves trawling and focuses on the commercial fisheries of crabs, shrimps, and demersal fishes. The continental shelf represents key fishing areas in the GOA and has correspondingly high value to humans. Because trawling can dramatically modify and damage the community structure of benthic biogenic habitats such as sponges and soft corals from equipment dragging along the sea floor, this human fishing activity is an object of concern (Peterson 2005).

Submarine Canyon Communities

The GOA continental shelf and slope is highly dissected by numerous submarine canyons. Submarine canyons contain various habitats, including vertical cliffs, ledges, talus, cobble and boulder fields, and soft mud. Generally, rocky substrate lines steep canyon walls, whereas the bottom of the canyon is formed of a gently sloping bottom that accumulates sediments to form the soft substrate (e.g., silt and mud). The organisms that live in submarine canyon habitats must be able to withstand extreme conditions—depths in excess of 1,650 ft (500 m), little or no light, cold water temperature, and tremendous pressure (up to 318 atmospheres; Airamé et al. 2003).

Some of the production associated with submarine canyons is introduced via adjacent habitats. Drift macroalgae and other organic matter produced in shallow or surface waters may settle and accumulate at the mouth and along the slopes of submarine canyons. This detritus may be washed down into the canyon during storms, contributing to productivity in the deep sea. In addition, the soft substrate at the base of the canyons supports a diverse invertebrate community. The complex structure of rocky substrate in submarine canyons provides cover for numerous fish species (e.g., groundfish) and can help to protect these species from overfishing because they tend to be difficult to locate and target. However, submarine canyons are vulnerable to human activities; they extend across a range of depths and may be heavily influenced by the deposition of sediments and pollutants that is associated with coastal development (Airamé et al. 2003).

Abyssal Plain

In the GOA, the abyssal plain extends from the bordering continental rises to the south and the mid-oceanic ridge to the west; it is a relatively flat expanse of sea floor that is 9,900 to 16,500 ft (3,000 to 5,000 m) below sea level. In the GOA, there is abyssal plain habitat that occurs at the base of the continental slope and extends eastward into the GOA basin with a deepest depth of approximately 16,500 ft (5,000 m). Abyssal plains are covered with fine particles that constantly rain down from the overlying water column. These particles, fine, clay-sized sediments and the remains of marine life, drift slowly downward filling in depressions on the irregular rocky ocean floor. They have accumulated to make up the 16,500 ft (5,000 m) thick sediment bed that constitutes the largest portion of the ocean basin (Airamé et al. 2003). Because of this thick layer of sediment, abyssal plains are among the smoothest surfaces on the planet, with less than 5 ft (1.5 m) of vertical variation for every mile. In a few places, extinct volcanoes or seamounts disrupt the monotony of the abyssal plain (Wilson 1976; Beaulieu 2001a, 2001b; Cunha and Wilson 2003; O'Dor 2003). The abyssal plain is regarded as the true ocean floor and is characterized by extremely cold water, no light, and extremely diverse marine inhabitants (e.g., deep sea isopods, polychaetes, worms, sponges, crustaceans, and sea stars) that are adapted to near freezing temperatures and immense pressure (Smith 1991). The deep sea is one of the largest and least explored ecosystems on Earth and is a major reservoir of biodiversity and evolutionary novelty.

Significant physical, chemical, and biological interactions occur between the upper ocean and the deep benthos on time scales of days to millennia (Airamé et al. 2003). Benthic communities that live within, upon, or associated with the ocean bottom rely upon the input of detritus (e.g., marine snow) from the surface waters; this sinking detritus provides the primary source of nutrients for bathypelagic and deep-sea communities. On average, less than 3 percent of primary production sinks through the water column to the deep sea; however, in the northeastern Pacific Ocean, where production is particularly high, approximately 5 to 15 percent of the surface production eventually reaches the deep sea. Deep benthic fauna living on or in the benthos grow more slowly, live longer, have smaller broods than animals living in shallow waters, and although consumption is slow, once organic matter reaches the sea floor, it is almost entirely consumed; a very small portion of the organic matter may dissolve or become buried in sediments (Grassle 1991).

In spite of these extreme conditions, the deep sea supports a remarkable diversity of organisms (Airamé et al. 2003). Due to the unpredictable and patchy supply of food, organisms in the deep sea use a variety of foraging strategies. Many deep-sea animals are “sit-and-wait” predators, while others are active scavengers that break down carcasses on the sea floor, attracting slower-moving animals, such as mollusks, sea stars, brittlestars (ophiuroids), and sea cucumbers. In many areas of the deep sea, ophiuroids are the dominant megafauna; they are often found around sea pen (Pennatulacea) beds and are so abundant that their feeding behavior and high activity levels can alter the ecology of benthic softbottom communities.

Seamounts

Seamounts are isolated mountains rising from 2,970 to 9,900 ft (900 to 3,000 m) above the surrounding bottom. Seamounts are found in all oceans but are more numerous in the Pacific Ocean, with over 2,000 having been identified (Thompson et al. 1993). Very little research has been conducted on seamounts; they are among the least understood habitats in the ocean basins (Rogers 1994). Seamounts provide a unique habitat for both deep-sea and shallow-water organisms due to the large ranges of depth, hard substrate, steep vertical gradients, cryptic topography, variable currents, clear oceanic waters, and geographic isolation that characterize seamount habitats (Rogers 1994). Thus, seamounts are capable of supporting a wide range of organisms (Wilson and Kaufmann 1987). The most common invertebrates found on seamounts worldwide are cnidarians and the most common fishes are scorpaenids and morids (Wilson and Kaufmann 1987). The abundant and diverse benthic fauna consists of a wide array of sponges (including large brilliant-yellow barrel sponges that have been known to support intrinsic communities), coral (including large gorgonians and huge golden coral sea fans), brittlestars, crinoids, clams, seastars, polychaetes, crabs, tunicates, sea urchins, sea cucumbers, and octopi (Rogers 1994). Seamounts attract various predators, including fishes and marine mammals as a result of this relatively high biomass.

A total of 597 invertebrate species have been recorded from seamounts in studies that have been conducted worldwide (Wilson and Kaufmann 1987). A rich and diverse benthic fauna with a high degree of endemism exists on seamounts. In one study, levels of endemism among 850 macro- and megafaunal species (including fish) were as high as 29 to 34 percent (Richer de Forges et al. 2000). Thus, seamounts can function ecologically as island groups or chains, leading to localized species distributions with apparent speciation. Dispersal of organisms from the seamounts is likely an active and a passive process;

seamounts appear to provide “stepping stones” for transoceanic dispersal of animals in both the Atlantic and Pacific Oceans (Richer de Forges et al. 2000; Johnston and Santillo 2004). Few studies have investigated the interaction between seamount-inhabiting organisms and the surrounding abyssal plain, nearshore area, and other seamount habitats.

Seamount communities are extremely vulnerable to the impacts of fishing. Some seamount fish and benthos are already known to have been seriously impacted by fishing activities (Johnston and Santillo 2004); their recovery is complicated by the limited fixed habitat, the extreme longevity of many species (on the order of 100 years and more), and the slow or limited recruitment between seamounts (Richer de Forges et al. 2000). The global status of seamount benthic communities is unknown; however, the limited distribution of seamount biota greatly increases the threat of extinction. The conservation and protection of seamount communities is necessary and requires action to be taken on a local scale (O'Dor 2003).

There are several seamounts located in the TMAA (Figure 3.5-5). The coral and rocky relief that are associated with the Dall seamount are known to provide shelter for adult and juvenile rockfish, greenlings, and ling cod and attachment substrates for hydrocorals and red tree corals. With further explorations some undiscovered pinnacles and seamounts will undoubtedly be identified; this exploration will help to unveil their ecological value to the surrounding ocean habitats. For example, deep-sea explorers of seamounts in the GOA have discovered that lingcod spawn in very deep water at the base of pinnacles and seamounts and giant spider crabs have been discovered that span over 7 feet across. Some pinnacles, such as the Albatross Pinnacle south of Kodiak Island, come close to the surface and provide a substrate for kelp that in turn provide essential rearing habitat for juvenile fish. These pinnacles are known to be covered with sponges, anemones, hydroids, tunicates, barnacles, crabs, worms, snails, chitons, and other invertebrates and algae (AMCC and ASG 2003).

Chemosynthetic Ecosystem

In a normal marine ecosystem, the primary producers (e.g., phytoplankton and seagrasses) produce energy through photosynthesis (a photosynthetic ecosystem). In methane- and sulfide-rich environments, chemolithoautotrophic bacteria (i.e., sulfur-oxidizing bacteria, methane-oxidizing bacteria, and sulfide-reducing bacteria) create the energy that can be used by the organisms in the environment (a chemosynthetic ecosystem; Hessler and Lonsdale 1991, Hashimoto et al. 1995, Galkin 1997). Some of the benthic fauna associated with chemosynthetic ecosystems contain symbiotic chemosynthetic bacteria inside their bodies to obtain essential nutrients (Nybakken 2001). Chemosynthetic communities are a significant source of biological productivity on the deep-sea floor. In some locations, vast fields of hydrothermal vents can support benthic communities (Fisher et al. 2000, Lanoil et al. 2001, Reed et al. 2002). In other locations, gas hydrates in the sediments support extensive chemosynthetic communities (Fujikura et al. 2002).

Chemosynthetic habitats are formed by a variety of geological and biological processes on continental margins, and despite their location in the deep sea, have high biomasses maintained by chemosynthetic bacterial production (Hessler and Lonsdale 1991, Hashimoto et al. 1995, Galkin 1997, Smith et al. 2003) Cold seeps, natural whale falls, hydrothermal vents, and wood falls provide specific habitat duration and each of these chemosynthetic habitats appears to foster a characteristic fauna (Fujikura et al. 2002, Smith et al. 2003). In general, chemosynthetic communities in the GOA are characterized by tubeworms, giant white clams, mussels, gastropods, and sponges (Anderson et al. 1993).

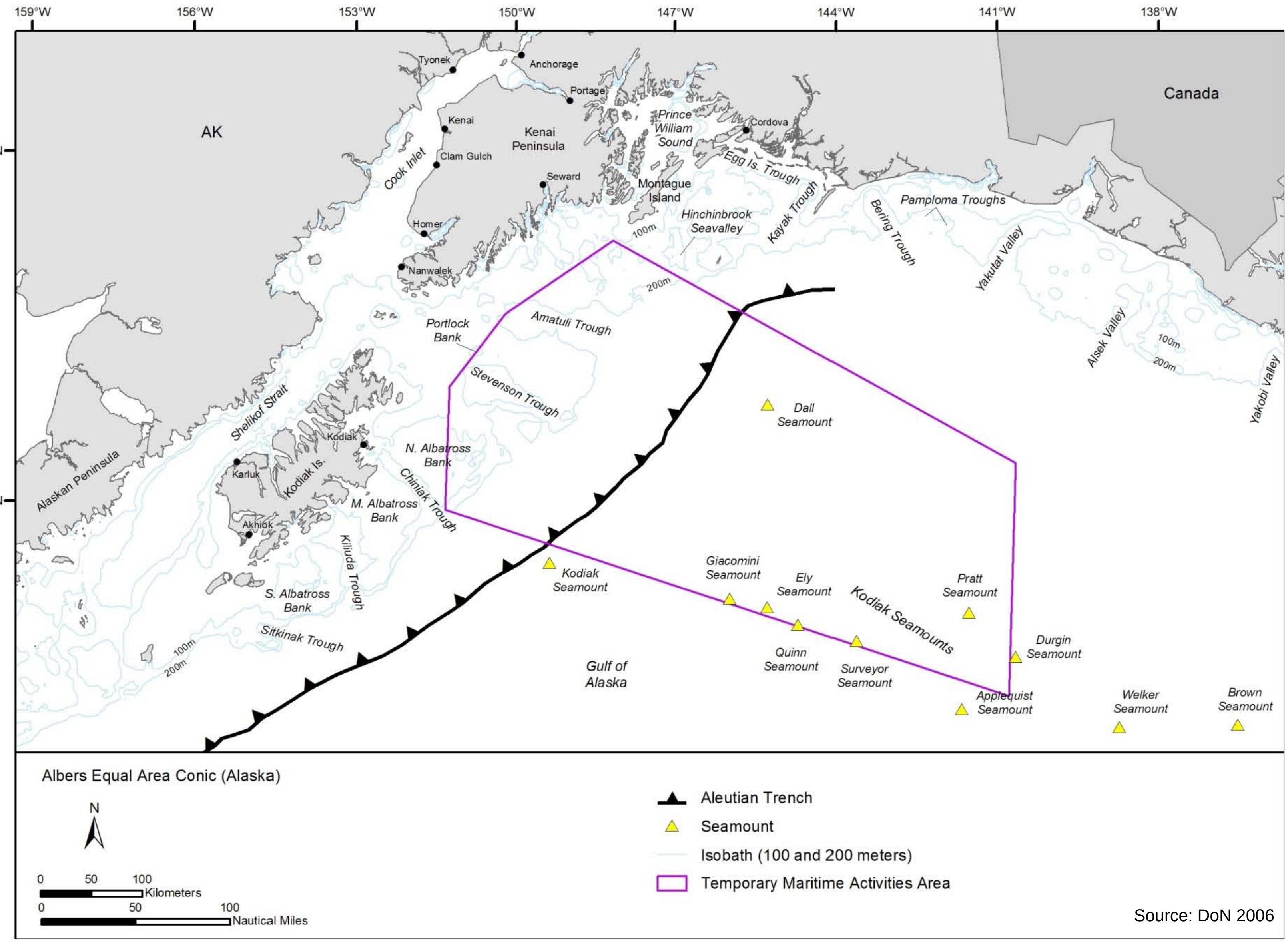


Figure 3.5-5: Major Geological Features of the TMAA and Surrounding Vicinity

Cold Seeps

A cold seep (sometimes referred to as a cold vent) is a region of the seafloor that releases hydrogen sulfide, methane, and other hydrocarbon-rich fluids (Hashimoto et al. 1989, Kvenvolden 1993). Cold seep communities depend upon chemolithoautotrophic production associated with the emission of reducing chemicals from "cold" hypersaline brines or other hydrocarbon seeps such as methane hydrates (Airamé et al. 2003).

Chemolithoautotrophic bacteria oxidize the reduced chemicals to form organic matter from carbon dioxide. Typically, cold seeps originate from relatively young sediments and are common along basin margins (Kvenvolden 1993). However, in recent years many seep communities have been reported in tectonically passive margins, active regions of plate collision, and along marginal basins (Schmidt 2004).

Cold seeps have formed along much of the GOA where the water is cold and the pressure is sufficient to support formation; although they are not known to occur in the TMAA, in the GOA region, two seep microhabitats were observed at 14,563 to 14,662 ft (4,413 to 4,443 m). These seep areas were populated by dense aggregations of *Calyptogena phaseoliformis* (clams), *Siboglinidae* (pogonophorans), and galatheid crabs (Levin and Michener 2002).

Whale Falls

Whale carcasses on the seafloor support a high abundance of organisms commonly found near seeps, vents, and other deep-sea hard substrates (Smith and Baco 2003). It has been estimated that at any given time there may be in excess of 500,000 sulfide-rich whale skeletons on the deep-sea floor (Smith et al. 2003). Whale falls promote high species diversity by providing hard substrates for settling, organic enrichment, and free sulfides on a typically organic-poor, sediment-covered sea floor (Smith et al. 2003); these whale falls can support productive communities of chemosynthetic organisms for decades. The falls of large whales yield massive pulses of organic matter to the deep-sea floor (Smith et al. 2003). The chemosynthetic communities associated with whale falls are probably the least known of the chemosynthetic ecosystems. Studies of whale falls have revealed that chemolithoautotrophic bacteria reside in, on, and around whale falls (Smith and Baco 2003). Sulfide diffuses out of the bone and provides the energy source for the chemolithoautotrophic bacteria (Bennett et al. 1994, Butman et al. 1995, Smith and Baco 2003).

Although whales have been much reduced throughout the world's oceans, Smith (1992) estimates that such sulfide-rich whale falls may have an average spacing of one per 14 nm (25 km) in the North Pacific and may give credence to the hypothesis that such falls may be the stepping stones that permit the sulfide-based communities to disperse over vast distances between the vent systems.

Artificial Habitat

Artificial habitats (shipwrecks, artificial reefs, jetties, pontoons, docks, and other man-made structures) are physical alterations to the naturally occurring marine environment. In addition to artificial structures intentionally or accidentally placed on the seafloor, fish aggregating devices are suspended in the water column and anchored on the seafloor to attract fish (Fager 1971, Bohnsack et al. 1991). Artificial structures provide a substrate upon which a marine community can develop (Ritter et al. 1999). Navigational, meteorological, and oceanographic buoys suspended in the water column potentially function like artificial habitats.

When solid, hard objects with numerous and varied surfaces are introduced to the seafloor, artificial substrates are provided for the settlement and colonization of epibenthic organisms (e.g., algae, sponges, barnacles, mussels, amphipods, soft corals, sea anemones, and hydroids; Ambrose and Swarbrick 1989, DeMartini et al. 1994). The initial colonization of artificial habitats works to build communities that increase marine production by providing an attachment substrate and a biotope suitable for larger motile organisms (e.g., starfish, lobster, crabs, fishes; Ritter et al. 1999).

Artificial habitat sites are often important nearshore locations for human activities including commerce, navigation, aquaculture, and recreation (Baine 2001). Fishermen often target these artificial habitats as they tend to provide food, shelter, and nurseries for a variety of demersal and pelagic fishes (including sport fishes) and many invertebrates (Seaman and Jensen 2000). Under optimal conditions, artificial habitats benefit benthic communities and offshore/onshore economies. The benefits experienced by marine biological communities increase with time (Ambrose and Swarbrick 1989, DeMartini et al. 1994). There are a significant number of artificial habitats available for the marine communities in the GOA including shipwrecks, buoys, and moorings (Figure 3.5-6); however, in the TMAA, moorings and buoys are the only artificial habitats.

Buoys and Moorings

A buoy is a floating platform used for navigational purposes or for supporting scientific instruments that measure environmental conditions. Moorings are floating blocks used for scientific study of a particular area; instruments are usually fastened along the line, which is fixed firmly to the seafloor. Both buoys and moorings can act as a substrate for attachment and aggregation locations for pelagic fish. Currently, two buoys and twelve moorings are located in the TMAA, none of which are owned by the Navy (DoN 2006, Figure 3.5-6).

Federally Protected Areas

Marine Protected Areas

Marine Protected Area (MPA) is a general term for natural and cultural marine resources that are protected by federal, state, tribal, or local governments. There are many different kinds of MPAs, including national parks, wildlife refuges, monuments and marine sanctuaries, critical habitat for species of concern, state parks, and estuarine reserves. MPAs complement other management measures such as fishery regulations and pollution controls. Each of these areas is afforded varying degrees of protection under law. Washington, Oregon, and California also have several protected natural areas along their coasts.

Marine Management Areas (MMAs) are similar to MPAs, but encompass a wider range of management intents, including geological, cultural, or recreational resources, plus security zones, shellfish closures, sewage discharge areas, and pipeline and cable corridors. The primary difference between MPAs and MMAs is the duration of the site. MMAs must provide yearly protection for at least 3 months out of each year, and must provide a minimum of 2 years of protection. MPAs must be designated with the intention to become permanent. Seven sites are located within the TMAA and vicinity. Examples include the Alaska Maritime National Wildlife Refuge, Steller Sea Lion Protection Areas, Kachemak Bay Research Reserve, Katmai National Park and Preserve, and the Kodiak Island Wildlife Refuge (DoN 2006).

National Marine Sanctuaries

The National Marine Sanctuary (NMS) system is administered by National Oceanic and Atmospheric Administration (NOAA) and protects special natural and cultural resources. There are 14 sites in the NMS program, creating a system that protects over 113,123 square nm (nm^2) (388,000 square km [km^2]) of U.S. ocean waters and habitats. Each NMS has an established management plan that guides the activities and sanctuary programs, sets priorities, and contains relevant regulations. There are no NMSs located within the boundaries of the TMAA.

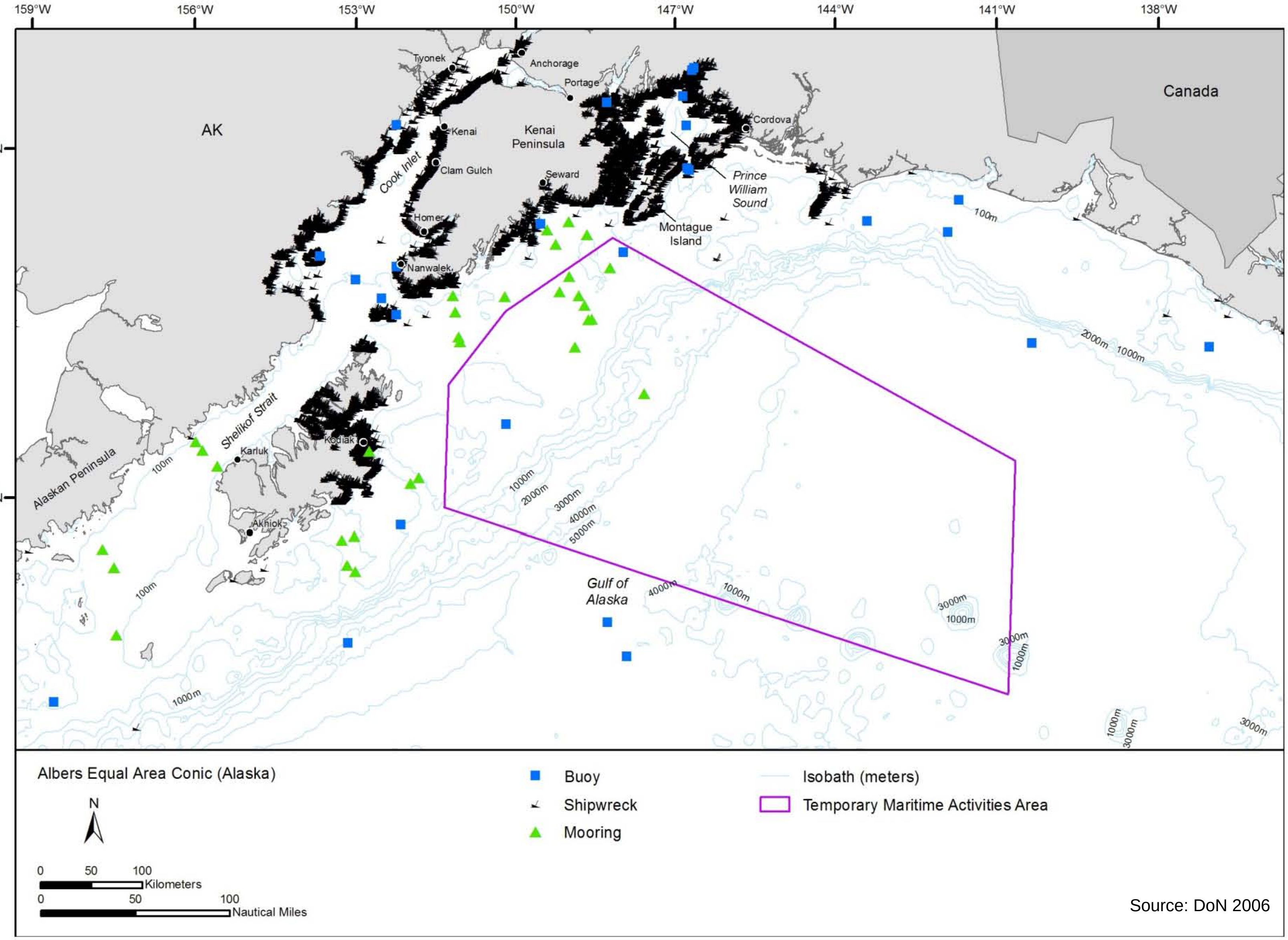


Figure 3.5-6: Artificial Habitat (e.g., buoys & moorings) within the TMAA & Surrounding Vicinity

Protected Habitats

Protected areas (Conservation Areas) throughout the GOA restrict groundfish harvest to minimize harmful impacts of fishing methodology and equipment to ocean bottom habitat (Figure 3.5-7). A widespread Atka mackerel closure established in 2002 under Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) extends from the coastline to the EEZ boundary (200 nm) throughout the GOA (DoN 2006). Fishing restrictions also reduce food resource competition by increasing Steller sea lion prey abundance (NMFS 1997). Protected areas are located around Steller sea lion haulout and rookery sites with coverage varying from 3 to 20 nm (5.6 to 37 km). Access, harvest, and fishing restrictions are modified for all 79 sites. Restriction enforcement and fishery management are controlled by NOAA, North Pacific Fishery Management Council (NPFMC), and United States Coast Guard (USCG).

Current Requirements and Practices

The Navy has no existing protective measures in place specifically for marine plants and invertebrates. However, marine plants and invertebrates benefit from measures in place to protect marine mammals and sea turtles. For a complete description of these measures, see Chapter 5.

3.5.2 Environmental Consequences

As noted in Section 3.5.1, the ROI for consideration of impacts on marine plants and invertebrates is the GOA TMAA. Aircraft overflight and training activities are assumed to have no impacts to marine communities because impacts of sound on plants and invertebrates are unknown and difficult to quantify.

3.5.2.1 Regulatory Framework

Federal

Impacts to wetlands, estuarine mud flats, and marine vegetated shallows are regulated under Section 404 of the Clean Water Act (CWA; 33 U.S.C. 1251, et seq.) and Executive Order (EO) 11990, *Protection of Wetlands*. Dredge and fill activities are permitted by the U.S. Army Corps of Engineers (USACE) and the U.S. Environmental Protection Agency (EPA). Other provisions of the CWA are intended to address water quality, such as excess nutrient that can affect the health of estuarine habitat like seagrass beds. The EO directs federal agencies to minimize wetland loss and degradation resulting from federal projects and land management activities.

The federal Coastal Zone Management Act (CZMA; 16 U.S.C. 1451, et seq.) is a voluntary federal-state partnership that encourages states to adopt programs that meet federal goals of protecting and restoring coastal zone resources, including protecting coastal waters from nonpoint source pollution (16 U.S.C. 1455[b]). The program is administered by NOAA. The act requires participating coastal states to develop management programs that demonstrate how states will carry out their obligations and responsibilities in managing their coastal areas. Upon federal approval of a state's coastal zone management program, the state benefits by becoming eligible for federal coastal zone grants and by gaining review authority over certain federal activities in the coastal zone and the consistency of those activities with the coastal zone management plan. CZMA specifically excludes federal lands from state designation. However, federal consistency requirements in the act (Section 307) require that federal activities be consistent with the management program to the "maximum extent practicable."

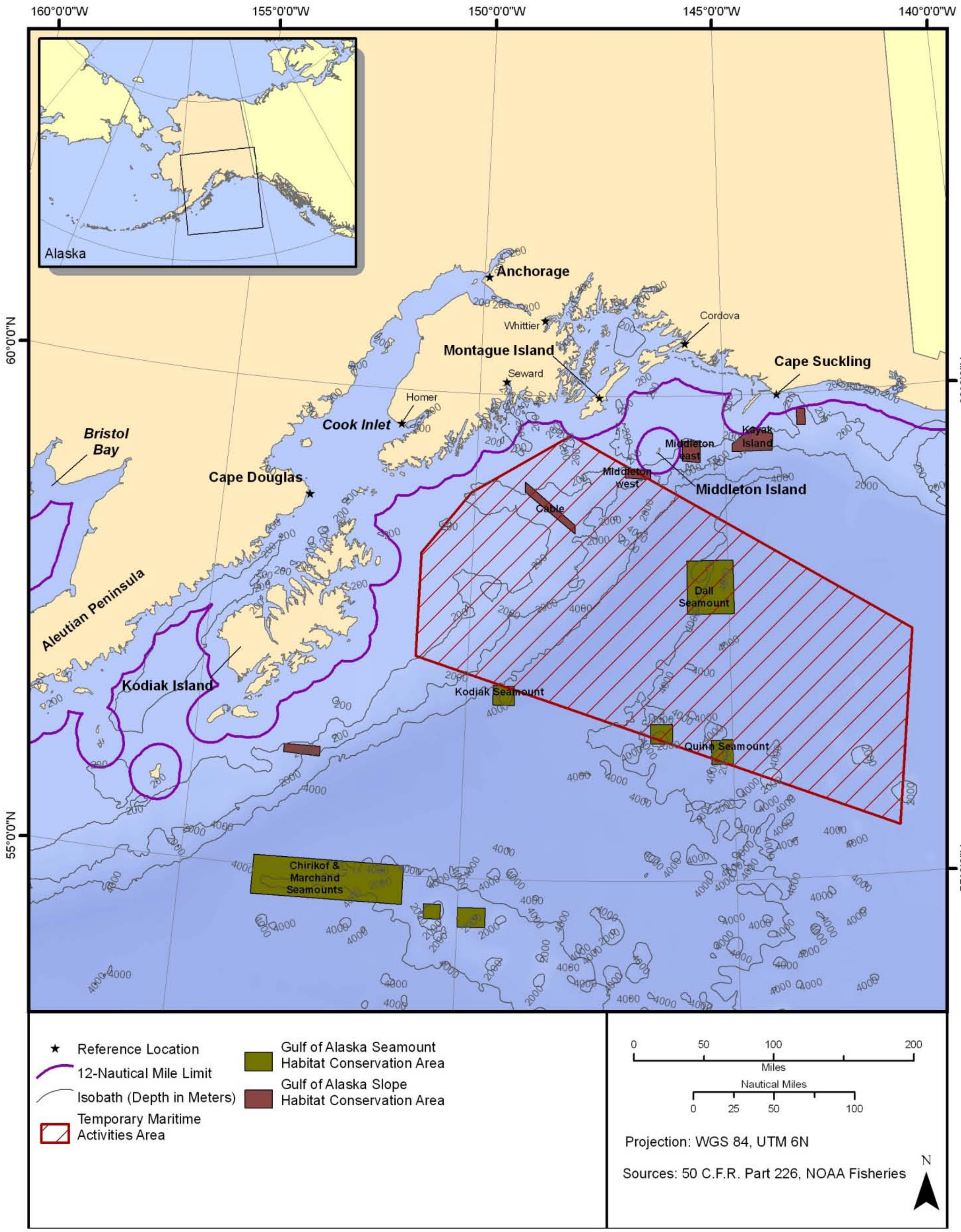


Figure 3.5-7: Conservation Areas in Vicinity of the TMAA

State and Local Governments

Alaska has several protected areas, such as state parks and significant biological areas along its coast. However, ocean training activities under the Proposed Action would occur at least 20 nm (37 km) offshore. Therefore, the materials expended during training, and the explosions and impacts anticipated, will not affect these areas. More details regarding state programs related to CZMA may be found in Section 3.3, Water Resources.

3.5.2.2 Approach to Analysis

Sources of Information

A systematic review of relevant literature and data was conducted to complete this analysis for marine plants and invertebrates in the GOA. Sources included journals, books, Internet sites, natural resource management plans, previous NEPA documents for facilities and activities in the GOA, Department of Defense (DoD) operations reports, and other technical reports published by government agencies, private businesses, and consulting firms. The literature and other information sources cited are identified in Chapter 8, References.

Methods

Potential stressors to marine communities in the TMAA that would result from changes in activities between the No Action Alternative and the other alternatives are limited to 1) direct impacts to bottom-dwelling communities from materials expended during training, or the accumulation of those materials; and 2) explosions on or below the sea surface. Impacts to pelagic and benthic marine communities could include localized disturbance of water column habitat, alteration or destruction of benthic habitat, or detrimental effects to federal and state species of concern or their habitats. Some of the metals and other materials used during training are hazardous, such as lead ballast and battery components. The impact of these materials on marine water and sediment quality is discussed in Sections 3.2 and 3.3, Expended Materials and Water Resources, respectively.

Materials Expended during Training

Impacts on marine communities that may arise from materials expended during training were evaluated based on the estimated amount of debris under each alternative, the geographic dispersion of the proposed activities, the resulting density of the debris, and timing of and duration of training exercises.

Explosions

Alternatives were evaluated for long-term effects on marine communities that would result from explosions, based on their force, location, and proximity to the bottom. Short-term effects, including increases in local turbidity, were not considered because they dissipate relatively quickly under the influence of ocean and tidal currents, wind-generated currents, and the natural sediment transport processes that operate continuously in the open ocean.

3.5.2.3 No Action Alternative

Activities under the No Action Alternative that may affect marine communities include materials expended during training as well as explosions and impacts. This analysis reviews the circumstances under which those expended materials and explosions may harm or substantially degrade the pelagic marine communities or benthic communities in the TMAA.

Expended Materials

Materials expended during training include sonobuoys; parachutes and nylon cord; some towed, stationary, and remote-controlled targets; inert munitions; and exploded and unexploded munitions, including missiles, bombs, and shells. These materials arise from 1) missiles and bombs used during Missile Exercises (MISSILEX) and Bombing Exercises (BOMBEX), respectively; and 2) shells fired during Gunnery Exercises (GUNEX) and BOMBEX. BOMBEX mostly involves the use of inert training munitions, but explosives are occasionally used.

Materials from these sources include a variety of plastics, metals, and batteries. Unless otherwise noted in the discussion or the table, targets are not recovered. Most of these materials are inert and dense, and will settle deep in bottom sediments, become covered by sediments, or encrusted by physical or biological processes. However, some of the metals and other materials such as lead, lithium, and batteries, are hazardous.

Additional materials expended during training include illuminating flares, marine markers, and chaff. These materials were dismissed from further analysis because, for both canisters and markers, the majority of the constituents are consumed by heat and smoke, both of which dissipate in the air. Any remaining materials from marine markers would sink into bottom sediments or become encrusted by chemical processes or by marine animals. Phosphorus contained in the markers reacts with seawater to produce phosphoric acid, a variable, but normal, component of seawater. Chaff consists of aluminum-coated polymer fibers inside of a launching mechanism, and are widely dispersed on deployment. Chaff settling on the ocean surface may temporarily raise turbidity, but will quickly disperse with particles eventually settling to the ocean floor.

The impact of these materials on marine water and sediment quality is discussed in Sections 3.2 and 3.3, Expended Materials and Water Resources, respectively.

Open Ocean Habitats

The effect of materials expended during training in the TMAA is assessed by the number of expended items per unit area. Under the No Action Alternative, an estimated 15,982 items would be expended in this area (Table 3.5-1). Based on a TMAA size of 42,146 nm^2 (144,557 km^2) and conservatively assuming that activities occur across 20 percent of the TMAA, 1.9 items per nm^2 (0.5 per km^2) per year would be deposited in the ocean. More than 97 percent of these items would be from gunshells and small caliber rounds.

Table 3.5-1: Expended Training Materials in the TMAA – All Alternatives

Training Material	No Action Alternative	Alternative 1		Alternative 2	
	Number	Number	% Increase from No Action	Number	% Increase from No Action
Bombs	120	180	50%	360	200%
Missiles	22	33	50%	66	200%
Targets and Pyrotechnics	252	322	28%	644	160%
Naval Gunshells	10,564	13,188	25%	26,376	150%
Small Caliber Rounds	5,000	5,700	14%	11,400	130%
Sonobuoys	24	793	3,200%	1,587	6,500%
PUTR	0	7	NA	7	NA
SINKEX	0	0	NA	858	NA
Total	**15,982**	**20,223**	**26%**	**41,298**	**160%**

Notes: Numbers of training items are estimates.

Pelagic Communities

Pelagic species, whether plankton or large invertebrates, are most common in the surface and near-surface layers of the open ocean. Therefore, any expended materials have the potential to kill or harm individual animals and plants in the immediate vicinity. In situations where expended materials are deposited in an area with a high concentration of individuals, the extent of death or harm would be greater than in a more barren area. However, pelagic species are abundant, have high rates of reproduction, are widely distributed, both across the ocean surface and vertically in the water column, and their distribution tends to be patchy rather than uniform. Because of these factors and the very low density of expended materials that would be associated with the No Action Alternative, negligible impacts are anticipated.

Deepwater Benthic Habitats

The shelf of the TMAA is a complex and dynamic geologic environment characterized by banks, patchy rocky substrate, and patchy bottom sediments (DoN 2006). Banks are exposed to both wave and current action (particularly during winter storms) that continually resuspend bottom sediments. Bottom material such as sand, gravel, boulders, and broken shells are most characteristic of the banks while finer sediment accumulates in the depressions and the troughs of the region. The bottom substrate of the continental slope is typically covered with silts, clays, and fine sediments; however, there is the occasional hard bottom substratum (e.g., rocky outcroppings, rubble, talus, vertical wall, and seamounts) that supports a diverse assemblage of deep-sea invertebrates and fishes.

Most expended materials are inert and dense and readily sink deep into existing sediments or become covered with sediment over time. These materials would also become encrusted by chemical processes or by marine organisms that further isolates them from the environment. Once deposited, the materials would not pose a hazard to benthic communities. Because high quality habitat occupies only a small portion of the benthic environment, there is a small potential for the communities to be affected by initial impact of expended materials. However, injury or death could occur to bottom-dwelling organisms if struck.

The deposition of training materials on the ocean bottom under the No Action Alternative is judged to have negligible impacts because 1) expended materials are distributed widely enough that less than two items would be deposited on the bottom per nm^2; and 2) the majority of those items are small caliber rounds that would have little impact. However, if sensitive habitats were struck by larger objects, localized impacts could occur. These communities usually have slow rates of recovery; however, over the long term, such objects could also provide new, hard substrate for benthic communities to utilize.

<u>Explosions</u>

Under the No Action Alternative, activities involving explosive munitions occur at or just below the surface in the TMAA. These include sea surface explosions from missiles and bombs used during BOMBEX and SINKEX; and shells fired during GUNEX and BOMBEX. Additional subsurface explosions involve the use of explosive sonobuoys used during Tracking Exercises (TRACKEX).

Open Ocean Habitats

The effect of explosions in the TMAA is based on the number and force of explosive munitions in proximity to pelagic and deepwater benthic habitats. Under the No Action Alternative an estimated 88 explosive munitions would be used in the open ocean of the TMAA (Table 3.5-2). Based on a TMAA size of 42,146 nm^2 (144,557 km^2) and conservatively assuming that activities occur across 20 percent of the TMAA, 0.01 explosions would occur per nm^2 (0.003 per km^2) per year.

Table 3.5-2: Explosive Munitions Used in the TMAA – All Alternatives

Training Material	No Action Alternative	Alternative 1		Alternative 2	
	Number	Number	% Increase from No Action	Number	% Increase from No Action
Bombs	48	72	50%	166	246%
Naval Gunshells (5-inch / 76 mm)	40	56	40%	112	180%
IEER Sonobuoys	0	40	NA	80	NA
SINKEX	0	0	NA	858	NA
Total	**88**	**168**	**91%**	**1,194**	**1,257%**

Notes: Numbers of training items are estimates.

Pelagic Communities

Pelagic species, whether plankton or large invertebrates, are most common in the surface and near-surface layers of the open ocean. Therefore, any surface or near-surface explosions or impacts have the potential to kill or harm individual animals and plants in the immediate vicinity. However, the shock waves from such explosions attenuate quickly (within a period of milliseconds). In situations where an explosion or impact occurred in an area with a high concentration of individuals, the extent of death or harm would be greater than in a more barren area. However, pelagic species are abundant, have high rates of reproduction, are widely distributed, both across the ocean surface and vertically in the water column, and their distribution tends to be patchy rather than uniform. Because of these factors and the very low density of explosions that would be associated with the No Action Alternative, negligible impacts are anticipated.

Deepwater Benthic Habitats

All of the explosions listed in Table 3.5-2 would occur at or near the surface of waters that generally exceed 1,650 ft in depth (500 m) over the continental shelf, and several thousand feet deep over the slope and abyssal plain. In such settings, the shock waves from explosions and impacts at or near the surface would largely attenuate well before reaching bottom-dwelling habitats. Thus, adverse impacts are not considered likely under the No Action Alternative.

3.5.2.4 Alternative 1

Alternative 1 is a proposal designed to meet Navy and DoD current and near-term operational training requirements. If Alternative 1 were to be selected, in addition to training activities currently conducted, the ATA would support an increase in training activities to include conducting ASW activities and the use of MFA sonar during ASW activities, as well as increases in training activities due to force structure changes associated with the introduction of new weapon systems, vessels, aircraft, and training instrumentation into the Fleet. Under Alternative 1, baseline-training activities would be increased for some activities. In addition, training activities associated with force structure changes would be implemented for the EA-18G Growler, Guided Missile Submarine (SSGN), P-8 Multimission Maritime Aircraft (MMA), Guided Missile Destroyer [DDG] 1000 [Zumwalt Class] destroyer, and unmanned aerial systems (UASs). Force structure changes associated with new weapons systems would include new sonobuoys. Force structure changes associated with new training instrumentation include the Portable Undersea Training Range (PUTR).

Activities under Alternative 1 that may affect marine communities include materials expended during training as well as explosions and impacts. This analysis reviews the circumstances under which those expended materials and explosions may harm or substantially degrade the pelagic marine communities or benthic communities in the TMAA.

Materials Expended during Training

Open Ocean Habitats

Under Alternative 1, an estimated 20,223 items would be expended in the open ocean of the TMAA, a 26 percent increase over the No Action Alternative (see Table 3.5-1). Based on an open ocean area of 42,146 nm^2 (144,557 km^2) and conservatively assuming that activities occur across 20 percent of the TMAA, 2.4 items per nm^2 (0.7 per km^2) per year would be deposited in the ocean. More than 93 percent of these items would be from gunshells and small caliber rounds**.**

Pelagic Communities

Pelagic species are abundant, have high rates of reproduction and are widely distributed, both across the ocean surface and vertically in the water column. Because of these factors and the low density of materials expended during training, Alternative 1 would have negligible impacts on pelagic communities.

Deepwater Benthic Habitats

Similar to the No Action Alternative, the deposition of training materials on the ocean bottom under Alternative 1 is judged to have negligible impacts because 1) using conservative estimates expended materials are distributed widely enough that less than three items would be deposited on the bottom per nm^2; and 2) the majority of those items are small caliber rounds that would have little impact. However, if sensitive habitats were struck by larger objects, localized impacts could occur. These communities usually have slow rates of recovery; however, over the long term, such objects could also provide new, hard substrate for benthic communities to utilize.

Explosions

Open Ocean Habitats

As shown in Table 3.5-2, an estimated 168 explosions would occur in the TMAA under Alternative 1, an increase of 91 percent over the No Action Alternative. Based on an open ocean area of 42,146 nm^2 (144,557 km^2) and conservatively assuming that activities occur across 20 percent of the TMAA, there would be about 0.02 explosions per nm^2 (0.006 per km^2) per year.

Pelagic Communities

Based on the abundance and wide-spread distribution of pelagic species, the effects of explosions under Alternative 1 would be negligible.

Deepwater Benthic Habitats

Because all explosions in the open ocean would occur at or near the surface, the impacts to deepwater benthic habitats under Alternative 1 would be negligible.

Portable Undersea Tracking Range

The PUTR is a self-contained, portable, undersea tracking capability that employs modern technologies to support coordinated undersea warfare training for Forward Deployed Naval Forces (FDNF). PUTR will be available in two variants to support both shallow and deep water remote activities in keeping with Navy requirements to exercise and evaluate weapons systems and crews in the environments that replicate the potential combat area. The system will be capable of tracking submarines, surface ships, weapons, targets, and Unmanned Underwater Vehicles (UUVs) and distribute the data to a data processing and display system, either aboard ship, or at a shore site.

No area supporting a PUTR system has been identified; however, potential impacts to marine habitats that support plants and invertebrates can be assessed based on several assumptions. Assuming that transponders are deployed on soft-bottom habitats, impacts would be similar to those discussed for expended materials. There would be direct impact to soft bottom habitat where the clump weight contacted the bottom, which may result in localized mortality to epifauna and infauna within the footprint, although it is anticipated that recolonization would occur within a relatively short period of time. Upon completion of the exercise, the transponders, which have an acoustic link, are sent a signal that breaks the link and the transponders float to the surface for recovery. This design feature eliminates any potential impacts associated with hazardous materials such as batteries and electronic components. The clump weights are not recovered, and since they are composed of inert material, they are not a potential source of contaminants, and could provide a substrate for benthic fauna. There may also be indirect effects associated with increased turbidity due to resuspension of sediments from the clump weights contacting the bottom. The turbidity plume is expected to be localized and temporary, as sediment would eventually settle to the ocean floor or be dispersed by ocean currents. Therefore, localized and temporary impacts to benthic fauna may occur from the PUTR, but no long-term impact is anticipated.

3.5.2.5 Alternative 2

Implementation of Alternative 2 would include all elements of Alternative 1 (accommodating training activities currently conducted, increasing specific training activities to include the use of active sonar, and accommodating force structure changes). In addition, under Alternative 2 the following activities would occur:

- Conduct one additional separate summertime CSG exercise lasting up to 21 days within the ATA.
- Conduct a SINKEX in each summertime exercise (a maximum of 2) in the TMAA.

Activities under Alternative 2 that may affect marine communities include materials expended during training as well as explosions. This analysis reviews the circumstances under which those expended materials and explosions may harm or substantially degrade the pelagic marine communities or benthic communities in the TMAA.

Materials Expended During Training

Open Ocean Habitats

Under Alternative 2, an estimated 41,298 items would be expended in the TMAA, an increase of 160 percent over the No Action Alternative (see Table 3.5-1). Based on an open ocean area of 42,146 nm^2 (144,557 km^2) and conservatively assuming that activities occur across 20 percent of the TMAA, 4.9 items per nm^2 (1.4 per km^2) per year would be deposited in the ocean. More than 91 percent of these items would be from gunshells and small caliber rounds.

Pelagic Communities

Pelagic species are abundant, have high rates of reproduction, and are widely distributed, both across the ocean surface and vertically in the water column. Because of these factors and the low density of materials expended during training, negligible impacts are anticipated under Alternative 2 (same as the No Action Alternative).

Deepwater Benthic Habitats

Similar to the No Action Alternative, the deposition of training materials on the ocean bottom under the Alternative 2 is judged to have negligible impacts because 1) using conservative estimates expended materials are distributed widely enough that less than five items would be deposited on the bottom per nm^2; and 2) the majority of those items are small caliber rounds that would have little impact. However, if sensitive habitats were struck by larger objects, localized impacts could occur. These communities usually have slow rates of recovery; however, over the long term, such objects could also provide new, hard substrate for benthic communities to utilize.

Explosions

Open Ocean Habitats

Under Alternative 2, an estimated 1,194 explosions would occur in the open ocean of the TMAA, an increase of 1,257 percent over the No Action Alternative (see Table 3.5-2). Based on an open ocean area of 42,146 nm^2 (144,557 km^2) and conservatively assuming that activities occur across 20 percent of the TMAA, there would be 0.14 explosions per nm^2 (0.04 km^2) per year.

Pelagic Communities

Based on the abundance and wide-spread distribution of pelagic species, the effects of explosions under Alternative 2 would be negligible.

Deepwater Benthic Habitats

Because all explosions in the open ocean of the TMAA would occur at or near the surface, the impacts to deepwater benthic habitats under Alternative 2 would be negligible.

Portable Undersea Tracking Range

Under Alternative 2, impacts from the PUTR would be the same as those described for Alternative 1, with localized and temporary impacts to benthic fauna, but no long-term impacts are anticipated.

SINKEX

A SINKEX is conducted under the auspices of an overarching permit from the USEPA (40 CFR § 229.2, Transport of Target Vessels, and the August 1999 Navy/USEPA agreement that details vessel preparation requirements to address PCBs under the SINKEX permit). Operations involve the use of missiles, bombs, and torpedoes, which contain missile propellants, fuel, engine oil, hydraulic fluid, and batteries, all of which may affect marine water quality and biota. The detailed analysis of Sections 3.2 (Expended Materials) and 3.3 (Water Resources) indicates that the concentration of potential contaminants associated with bombs, missiles, and torpedoes is below criteria established for the protection of aquatic life. Although localized and temporary impacts to the pelagic environment would occur, the relatively small quantities of materials expended, dispersed as they are over a very large area, would have no adverse physical effects on marine biological resources. In addition, SINKEX operations occur in the open ocean (at least 1,000 fathoms [6,000 ft] deep). However, the sunken vessel may alter soft-bottom habitats, but may provide a beneficial use by providing habitat in the deep water environment. Given these reasons, impacts to open ocean habitats from SINKEX are negligible.

3.5.3 Mitigation

As summarized in Section 3.5.2, the actions proposed under the alternatives described in this EIS/OEIS would have minimal impacts on the marine plant and invertebrate communities of the TMAA. Therefore, no resource-specific mitigation measures would be required. See Chapter 5 for additional discussion of mitigation measures.

3.5.4 Summary of Effects

The Proposed Action alternatives would have negligible impacts on marine plant or invertebrate resources in the TMAA. These effects would be related to ordnance use and expended materials, and would not be anticipated to be measurable, given the large area over which activities occur and the dynamic nature of the marine environment of the TMAA. Table 3.5-3 summarizes the effects of the No Action Alternative,

Alternative 1, and Alternative 2 on marine plants and invertebrates under both the National Environmental Policy Act (NEPA) and EO 12114.

Table 3.5-3: Summary of Effects by Alternative

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
No Action Alternative	• Overflights would not affect marine plants and invertebrates.	• Expended materials and the release of munitions constituents and other materials would be distributed widely over the TMAA (1.9 items per nm^2 [0.5 per km^2]) and have minimal effects on pelagic and benthic communities. More than 97 percent of these items would be from gunshells and small caliber rounds. • Surface or near-surface explosions have the potential to kill or harm individual animals and plants in the immediate vicinity resulting in localized impacts. Given the TMAA size and using conservative estimates, 0.01 explosions would occur per nm^2 (0.003 per km^2) per year resulting in minimal effects. Benthic communities would not be affected by explosions due to water depth.
Alternative 1	• Overflights would not affect marine plants and invertebrates.	• Expended materials and the release of munitions constituents and other materials would be distributed widely over the TMAA (2.4 items per nm^2 [0.7 per km^2]) and have minimal effects on pelagic and benthic communities. More than 93 percent of these items would be from gunshells and small caliber rounds. • Surface or near-surface explosions have the potential to kill or harm individual animals and plants in the immediate vicinity resulting in localized impacts. Given the TMAA size and using conservative estimates, 0.02 explosions would occur per nm^2 (0.006 per km^2) per year resulting in minimal effects. Benthic communities would not be affected by explosions due to water depth. • Localized and temporary impacts to benthic fauna may occur from the PUTR, but no long-term impact is anticipated.

Table 3.5-3: Summary of Effects by Alternative (continued)

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
Alternative 2 (Preferred Alternative)	• Overflights would not affect marine plants and invertebrates.	• Expended materials and the release of munitions constituents and other materials would be distributed widely over the TMAA (4.9 items per nm^2 [1.4 per km^2]) and have minimal effects on pelagic and benthic communities. More than 91 percent of these items would be from gunshells and small caliber rounds. • Surface or near-surface explosions have the potential to kill or harm individual animals and plants in the immediate vicinity resulting in localized impacts. Given the TMAA size and using conservative estimates, 0.14 explosions would occur per nm^2 (0.04 per km^2) per year resulting in minimal effects. Benthic communities would not be affected by explosions due to water depth. • Although localized and temporary impacts to the pelagic environment would occur from a SINKEX, the relatively small quantities of materials expended, dispersed as they are over a very large area, would have no adverse physical effects on marine biological resources.

Note: Quantitative estimates conservatively assumed that activities occurred across 20 percent of the TMAA.

3.6 FISH

3.6.1 Affected Environment

For purposes of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the Region of Influence (ROI) for fish is the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA). The TMAA is more than 12 nautical miles (nm) (22 kilometers [km]) from the closest point of land and is therefore outside of United States (U.S.) territorial seas. Thus, this section provides an overview of the species, distribution, and occurrence of fishes that are either resident or migratory through the GOA TMAA. A brief discussion of Essential Fish Habitat (EFH) is provided in Section 3.6.1.2 of this EIS/OEIS and a brief discussion of federally listed threatened and endangered fish species protected under the Endangered Species Act (ESA) in the TMAA is provided in Section 3.6.1.3. The Navy will consult, as appropriate, with the National Marine Fisheries Service (NMFS) as part of the EIS/OEIS process.

In the GOA, the majority of the fishery resources are found along the broad continental shelf ecosystem (Richardson and Erickson 2005). Important marine species include salmonids (Chinook, coho, chum, pink and sockeye salmon, and steelhead), Pacific halibut, shelf and slope groundfish (walleye pollock, Pacific, sablefish, rockfishes, rex sole, Dover sole, arrowtooth flounder), dungeness crab, and scallops (NMFS-AKR [Alaska Region] 2005, Richardson and Erickson 2005). The Pacific high seas salmon are arguably the most important living marine resource within the GOA. Currently the GOA supports habitats of “endangered” and “threatened” populations of high seas salmon (Chinook, coho, chum, and sockeye salmon, and steelhead) (See Table 3.6-2, Section 3.6.1.3) (NMFS 2005b, 2005d).

The TMAA falls within the Alaska Current (AC) and the Alaska Coastal Current (ACC) systems. Both currents flow in a northerly direction off southeastern Alaska and then turn southwestward along the Alaska coast. Beyond Kodiak Island, the AC intensifies and becomes the Alaskan Stream as it flows along Alaskan Peninsula and the Aleutian Archipelago (Reed and Schumacher 1986). The AC system is rich in microscopic organisms (i.e., large-celled diatoms, small cyanobacteria, microflagellates, micro-/meso-zooplankton) which form the base of the food chain in the GOA. Grazers like forage species and small pelagic fish depend on this planktonic food supply, and in turn are forage for larger species, such as highly migratory species (e.g., high seas salmon) (Parsons 1986).

The TMAA and vicinity is a highly productive region for various marine fish and shellfish populations and supports some of the most productive fisheries in the United States. (Lanksbury et al. 2005). It is also an important spawning area for many fishes, supporting a diverse array of larval fish species influenced by bathymetric features (i.e., shelf, slope, etc.) in the spring and bathymetry/circulation features in the autumn (Doyle et al. 2002, Matarese et al. 2003, Doyle et al. 2005, Lanksbury et al. 2005). At least 383 species belonging to 84 families of marine and anadromous fishes have been reported from the predominant ecosystems found in the GOA TMAA: nearshore, continental shelf/slope, and offshore areas (Mecklenburg et al. 2002). Bony fishes (e.g., sculpins, snailfish, rockfish, and flatfish) dominate the number of species in the GOA with less than 10 percent of species being cartilaginous fishes (e.g., sharks, skates) (Mundy and Hollowed 2005). Shellfish (arthropods [e.g., crabs/shrimps] and mollusks (e.g., scallops, squids, and octopuses]) along with other benthic invertebrates comprise the bottom assemblage on the shelf/slope and nearshore areas in number of species and biomass (Feder and Jewett 1986; Outer Continental Shelf Environmental Assessment program [OCSEAP] 1986).

The fish fauna of the GOA consists of a mix of temperate and subarctic species, resulting in a large gradient in species composition along the shelf from the eastern to the western GOA (Hart 1973). Nearshore areas (e.g., Kodiak Island, lower Cook Inlet, and Prince William Sound) consisting of habitats such as rocky/kelp, epipelagic, intertidal beaches, subtidal shelves, and deeper bottom of bays serve as important spawning and nursery grounds for juveniles of numerous demersal and pelagic species (Rogers

1986, Rogers et al. 1986). These species include high seas salmon, walleye pollock, Pacific cod, crab, flatfish, and various forage species (Mueter 2004). The life history of many of these species is closely tied to the cyclonic boundary currents (e.g., subarctic), which transport eggs and larvae, and serve as important migratory pathways for juvenile salmon (Beamish et al. 2005).

Offshore areas are dominated by large epipelagic species that are capable of moving independently of currents (i.e., nekton), such as high seas salmon throughout the year with Pacific pomfret (*Brama japonica*), Pacific saury (*Cololabis saira*), and albacore tuna being common in the summer. These offshore areas in the GOA provide the principal feeding habitat for many species, particularly high seas salmon (Brodeur et al. 1999). All of these various species display a strong latitudinal gradient with their distribution correlating with sea surface temperature (Mueter 2004).

3.6.1.1 Existing Conditions

The following discussion provides an overview of the predominant fish species and habitat types known to occur in the TMAA. Two fish categories are described: salmonids and groundfish. As discussed in Section 3.5, Marine Plants and Invertebrates, the TMAA is over 12 nm (22.2 km) offshore and includes primarily offshore open ocean habitats including pelagic, continental shelf, slope, and abyssal plain regions, which are influenced by both the ACC and the Alaska Gyre.

Salmonids

There are six dominant species of salmon that occur in the GOA and have the potential of occurring in the TMAA: Chinook (*O. tshawytscha*), coho (*O. kisutch*), chum (*O. keta*), pink (*O. gorbuscha*), sockeye (*O. nerka*), and steelhead (*O. mykiss*). Salmonids found in the GOA are anadromous fish species that spend at least part of their adult life in the ocean but return to freshwater environments to spawn.

Pacific salmon (genus *Oncorhynchus*) range from San Francisco Bay, California, northward around the Pacific Rim through Alaska and southward along the coasts of Russia, Japan, and Korea (Myers et al. 1998). There are seven species of Pacific salmon; two species, masu (*Oncorhynchus masou*) and amago (*O. rhodurus*) only occur in Asia, and five species, Chinook, coho, chum, pink, and sockeye reproduce in North America and Asia (Groot and Margolis 1991, DFO 2002, NMFS-AKR 2005).

Until 1988, steelhead (the anadromous form of rainbow trout) was classified in the genus *Salmo* along with Atlantic salmon, brown trout, and several western trout species. With additional osteology and biochemistry data, biologists have now reclassified steelhead as members of the genus *Oncorhynchus*. The reason for this is that new information suggested that steelhead are more closely related to Pacific salmon than to brown trout and Atlantic salmon. As such, the American Fisheries Society - American Society of Ichthyologists Committee on Names of Fishes voted unanimously to accept *Oncorhynchus* as the proper generic name. For full scientific details, see Smith and Stearley 1989. As such, the scientific name of steelhead was changed from *Salmo gairdneri* to *Oncorhynchus mykiss*.

In general, the life history of Pacific salmon and steelhead includes incubation, hatching and emergence in freshwater, migration to the ocean, and subsequent initiation of maturation and return to freshwater for completion of maturation and spawning (Eggers 2004). Salmon are anadromous, meaning that they migrate up rivers and streams from the sea to spawn in freshwater. Pacific salmon spawn in gravel beds in rivers, streams and along lake-shores where females lay their eggs in nests or "redd" (Groot and Margolis 1991, Eggers 2004). Depending on the species, they spend between 1 to 7 years at sea, with most making extensive and complicated migrations (Quinn 2005). Generally, Pacific salmon return to their natal rivers to spawn and, with few exceptions, die soon after (Quinn 2005). The death of these salmon returns much-needed nutrients from the ocean to the otherwise nutrient-poor streams (Groot and Margolis 1991). Anadromy and the strong fidelity of homing to their natal streams have resulted in the development of many reproductively isolated subpopulations (little inbreeding occurs between salmon from one river and another) referred to as stocks (Quinn 2005). These subpopulations are exposed to different physical and biotic factors such as temperature, flow, gravel size, predators, prey, competitors, and pathogens (Quinn 2005). These variations between streams have led to the evolution of specializations to help the salmon survive in their home rivers (PFMC 2000). These distinct habitat dynamics require these subpopulations be managed individually rather than as one homogenous species (Duffy et al. 2005).

Groundfish Species

Groundfish species (i.e., flatfish, rockfish, thornyheads, roundfish, skates, sharks and chimeras) support important commercial and recreational fisheries. Many species of groundfish have EFH in the TMAA, and are discussed in more detail in Section 3.6.1.2

The continental shelf/slope supports a large biomass of groundfishes, particularly the wide shelf and banks around Kodiak Island, northwest of the GOA TMAA (Mueter 2004). Typically, the groundfish community in the GOA exhibits strong-depth gradient in species composition and diversity (Mueter and Norcross 2002) found in many other demersal fish communities inhabiting shelf and upper slope regions (Colvocoresses and Musick 1984, Jay 1996, Mahon et al. 1998). Information is lacking about demersal species on the deeper parts of the slope, continental rise, in the deep central basin, and on the numerous seamounts (Mueter 2004). Faunal assemblages collected from GOA seamounts, south of the TMAA, were dominated by giant (*Albatrossia pectoralis*) and Pacific (*Coryphaenoides acrolepis*) grenadiers, rockfish (*Sebastes* spp. and *Sebastolobus* sp.), and sablefish (Hoff and Stevens 2005) and may be representative of other seamounts in the GOA (Maloney 2004, Morato and Pauly 2004).

Flatfish live on the bottom, and are represented by flounders, soles, turbots, and plaice (Mecklenburg et al. 2002).

Rockfish of the Family Scorpaenidae inhabit rocky areas in shallow to moderately deep water or occur farther offshore on silty and sandy, soft bottoms in the marine waters of the TMAA and are represented by the genera *Sebastes* and *Sebastolobus* (Mecklenburg et al. 2002). Approximately 32 of the 36 species of *Sebastes* and two of the three species *Sebastolobus* species have been documented in the TMAA. Rockfish diversity is highest in southern southeast Alaska with the number of species declining markedly west of the central GOA (Enticknap and Sheard 2005). The rockfishes have been divided into three assemblages for management purposes based on species habitat and distribution, as well as commercial composition data: slope, demersal shelf, and pelagic shelf, whereas the thornyheads are managed independently (O'Connell et al. 2003, NMFS-AKR 2005). Rockfish are long-lived and sexual maturity is attained between 5 and 20 years of age. Spawning for most species generally takes place in the early spring (April) or late fall. Once hatched (late winter to mid-summer) the juvenile larvae form part of the pelagic community for up to 3 years and use nearshore habitats. Due to their long lives and late sexual maturity, rockfish are extremely susceptible to over harvest and stock depletion.

Species of sharks and skates that are known to occur in the GOA include salmon shark (*Lamna ditropis*), spiny dogfish (*Squalus acanthias*), big skate (*Raja binoculata*), and longnose skate (*R. rhina*). Sharks and skates form part of the benthic and near-bottom fish communities and are not classified as food fish. These species are often caught as bycatch in groundfish fisheries.

Groundfish range throughout the EEZ and occupy diverse habitats at all stages in their life histories. Some species are broadly dispersed during specific life stages, especially those with pelagic eggs and larvae. The distribution of other species and/or life stages may be relatively limited, as with adults of many nearshore rockfish which show strong affinities to a particular location or substrate type.

Fish Habitat in the Gulf of Alaska TMAA

Habitat characteristics include geomorphic, physical, biological, and chemical parameters. Interactions between environmental parameters make up habitat and determine the biological niche of a species.

Habitat parameters affecting fish distribution throughout the TMAA include both physical (depth, substrate, temperature, salinity, and dissolved oxygen) and biological (competitors, predators, and facilitators) variables (NMFS-Northwest Region [NWR] 2005). Habitat types in the GOA can be separated into two zoogeographic provinces: coastal Aleutian (Aleutian Islands to Sitka, Alaska, Dixon Entrance, or Cape Flattery, Washington) and oceanic Subarctic (GOA to Latitude 43°N). These provinces can further be broken down into the following habitat types utilized by managed fishes within the GOA (Briggs 1974, Feder and Jewett 1986, O'Clair and Zimmerman 1986, Allen and Smith 1988, Malecha et al. 2005, Peterson 2005).

As discussed in Section 3.5, the TMAA is over 12 nm (22.2 km) offshore and does not include nearshore habitat, but primarily consists of offshore open ocean habitats including pelagic, continental shelf, slope, and abyssal plain regions, which are influenced by both the ACC and the Alaska Gyre. However, a brief description of nearshore habitats is provided since some fishes may utilize this habitat throughout their life cycle.

Nearshore Habitats

Embayments

Embayments include bays, fjords, and inlets influenced by both the ocean and river and serve as the transitional zone between fresh and saltwater. Major embayments found north and northwest of the TMAA include Prince William Sound, Resurrection Bay, and lower Cook Inlet.

Islands

Islands include areas separated from the mainland by straits (Kodiak Island by Shelikof Strait) or occurring at mouth of embayments (Montague Island – Prince William Sound or Barrens Island – lower Cook Inlet).

Nearshore Biogenic Habitats

Nearshore biogenic habitats include kelp, seagrass, and epifaunal invertebrates. The biological component (kelp, seagrass, or epifaunal invertebrates) associated with the habitat is generally the feature that makes that habitat suitable for a particular species or life stage (e.g., groundfish).

Nearshore Unconsolidated Bottom (silt, mud, gravel, or mixed)

Composed of small particles (gravel, sand, mud, silt, or mixtures of these particles), these areas contain little to no vegetation due to the lack of stable surfaces for attachment. Contains infaunal invertebrates (i.e., polychaetes, other worms, bivalves) and abundant transient consumers (e.g., fishes, crustaceans, shorebirds).

Nearshore Hardbottom

Nearshore hardbottom is composed of bedrock, boulders, cobble, or gravel/cobble. Nearshore hardbottom is one of the least abundant benthic habitats, but one of the most important for fishes, especially rockfish (e.g., *Sebastes* spp.), lingcod, and sculpins. Most Alaska Pacific herring stocks spawn in intertidal and shallow subtidal hardbottom.

Nearshore Water Column

The nearshore water column, or coastal epipelagic zone, includes egg, juvenile, and larval stages of groundfish commonly associated with macrophyte canopies or drift algae.

Offshore (Shelf and Slope Habitats)

Offshore Biogenic Habitats (corals, sponges, etc.)

Biogenic habitats include structure-forming invertebrates such as corals, basketstars, brittlestars, demosponges, gooseneck barnacles, sea anemones, sea lilies, sea urchins, sea whips, tube worms, and vase sponges.

Offshore Unconsolidated Bottom (silt, mud, sand, gravel, or mixed)

Unconsolidated bottom is composed of cobble, gravel, sand, or silt which contains little to no vegetation due to the lack of stable surfaces for attachment.

Offshore Hardbottom

The hardbottom is composed of bedrock, boulders, cobble, or gravel/cobble. Large, mobile, demersal fishes (e.g., rockfish, sablefish, Pacific hake, spotted ratfish) are typically associated with this habitat.

Offshore Artificial Structures

Artificial structures include artificial reefs utilized by rockfish. Artificial reefs are often composed of concrete, tires, or sunken ships; these features create habitat for sea life.

Offshore Water Column: Pelagic Zone

The pelagic zone is home to the highly migratory species (e.g., high seas salmon), other relatively large pelagics, and early life stages of groundfish inhabiting the epipelagic/mesopelagic area or that are in association with fronts, current systems, and macrophyte canopies or drift algae associated with the TMAA.

3.6.1.2 Essential Fish Habitat

The MSFCMA (16 United States Code [U.S.C.] §1801 et seq.), as amended by the Sustainable Fisheries Act (SFA), mandates identification and conservation of EFH. The MSFCMA defines EFH as those waters and substrates necessary (required to support a sustainable fishery and the managed species) to fish for spawning, breeding, feeding, or growth to maturity (i.e., full life cycle). These waters include aquatic areas and their associated physical, chemical, and biological properties used by fish, and may include areas historically used by fish. Substrate types include sediment, hard bottom, structures underlying the waters, and associated biological communities. Federal agencies are required to consult with NMFS and to prepare an EFH Assessment describing potential adverse affects of their activities on EFH. A detailed EFH Assessment has been prepared for the TMAA.

The NMFS and regional Fishery Management Councils (FMCs) develop EFH descriptions for federally managed fish species and include them in their respective Fishery Management Plans (FMPs). The FMPs identify and describe EFH, describe the EFH impacts (fishing and nonfishing), and suggest measures to conserve and enhance the EFH. The North Pacific Fishery Management Council (NPFMC) developed FMPs for all fisheries occurring within the boundary of the TMAA. The GOA is defined in the FMP as the U.S. EEZ of the North Pacific Ocean, exclusive of the Bering Sea, between the eastern Aleutian Islands at 170°W longitude and Dixon Entrance at 132°40'W longitude and includes the Western, Central, and Eastern regulatory areas (NMFS-AKR 2005).

A total of 68 fish and invertebrate species with designated EFH occur in the TMAA (see Table 3.6-1). They are grouped into the High Seas Salmon (five species), Scallop (four species), and Groundfish Complex (59 species).

Table 3.6-1: The Fish and Invertebrate Species with EFH Designated in the Gulf of Alaska TMAA

NPFMC-Managed Species by Management Plan	
High Seas Salmon FMP Species	
Chinook salmon (*Oncorhynchus tshawytscha*)	Pink salmon (*Oncorhynchus gorbuscha*)
Coho salmon (*Oncorhynchus kisutch*)	Sockeye salmon (*Oncorhynchus nerka*)
Chum salmon (*Oncorhynchus keta*)	
Scallop FMP Species	
Pink or reddish scallop (*Chlamys rubida*)	Spiny scallop (*Chalmys hastata*)
Rock scallop (*Crassadoma gigantea*)	Weathervane scallop (*Patinopectin caurinus*)
Groundfish Complex FMP Species	
Flatfish	
Arrowtooth flounder (*Atheresthes stomias*)	Rex sole (*Glyptocephalus zachirus*)
Flathead sole (*Hippoglossoides elassodon*)	
Flatfish - Shallow-water Assemblage	
Alaska plaice (*Pleuronectes quadrituberculatus*)	Southern rock sole (*Lepidopsetta bilineatus*)
Butter sole (*Isopsetta isopleis*)	Sand sole (*Psettichthys melanostictus*)
English sole (*Parophrys vetulus*)	Starry Flounder (*Platichthys stellatus*)
Northern rock sole (*Lepidopsetta polyxystra*)	Yellowfin sole (*Limanda aspera*)
Flatfish - Deepwater Assemblage	
Deepsea sole (*Embassichthys bathybius*)	Greenland turbot (*Reinhardtius hippoglossoides*)
Dover sole (*Microstomus pacificus*)	
Rockfish - Slope Assemblage	
Bocaccio (*Sebastes paucispinis*)	Redstripe rockfish (*Sebastes proriger*)
Darkblotched rockfish (*Sebastes crameri*)	Rougheye rockfish (*Sebastes aleutianus*)
Greenstriped rockfish (*Sebastes elongatus*)	Sharpchin rockfish (*Sebastes zacentrus*)
Harlequin rockfish (*Sebastes variegatus*)	Shortraker rockfish (*Sebastes borealis*)
Northern rockfish (*Sebastes polyspinis*)	Silvergray rockfish (*Sebastes brevispinis*)
Pacific ocean perch (*Sebastes alutus*)	Splitnose rockfish (*Sebastes diploproa*)
Pygmy rockfish (*Sebastes wilsoni*)	Vermilion rockfish (*Sebastes miniatus*)
Redbanded rockfish (*Sebastes babcocki*)	
Rockfish - Demersal Shelf Assemblage	
Canary rockfish (*Sebastes pinniger*)	Rosethorn rockfish (*Sebastes helvomaculatus*)
China rockfish (*Sebastes nebulosus*)	Tiger rockfish (*Sebastes nigrocinctus*)
Copper rockfish (*Sebastes caurinus*)	Yelloweye rockfish (*Sebastes ruberrimus*)
Quillback rockfish (*Sebastes maliger*)	
Rockfish - Pelagic Shelf Assemblage	
Dark rockfish (*Sebastes ciliatus*)	Widow rockfish (*Sebastes entomelas*)
Dusky rockfish (*Sebastes variabilis*)	Yellowtail rockfish (*Sebastes flavidus*)
Thornyheads	
Longspine thornyhead (*Sebastolobus altivelis*)	Shortspine thornyhead (*Sebastolobus alascanus*)

Table 3.6-1: The Fish and Invertebrate Species with EFH Designated in the Gulf of Alaska TMAA (continued)

NPFMC-Managed Species by Management Plan	
Roundfishes	
Atka mackerel (*Pleurogrammus monopterygius*)	Sablefish (*Anoplopoma fimbria*)
Pacific cod (*Gadus macrocephalus*)	Walleye pollock (*Theragra calcogramma*)
Skates	
Alaska skate (*Bathyraja parmifera*)	Big skate (*Raja binoculata*)
Aleutian skate (*Bathyraja aleutica*)	Longnose skate (*Raja rhina*)
Bering skate (*Bathyraja interrupta*)	
Sculpins	
Bigmouth sculpin (*Hemitripterus bolini*)	Red Irish lord (*Hemilepidotus hemilepidotus*)
Great sculpin (*Myoxocephalus polyacanthocephalus*)	Yellow Irish lord (*Hemilepidotus jordani*)
Plain sculpin (*Myoxocephalus jaok*)	
Sharks	
Salmon shark (*Lamna ditropis*)	Spiny dogfish (*Squalus acanthias*)
Pacific sleeper shark (*Somniosus pacificus*)	
Squids	
Boreal or common clubhook squid (*Onchoteuthis banksii borealjaponicus*)	Red or magistrate armhook squid (*Berryteuthis magister*)
Eastern Pacific bobtail squid (*Rossia pacifica*)	Giant or robust clubhook squid (*Moroteuthis robusta*)
Octopuses	
North Pacific giant octopus (*Enteroctopus doflein*)	Pelagic octopus (*Vampyroteuthis infernalis*)
Forage Fish Species	
Bristlemouths (Gonostomatidae)	Pricklebacks (Stichaeidae)
Deepsea smelts (Bathylagidae)	Sand Lances (Ammodytidae) Pacific sand lance (*Ammodytes hexapterus*)
Gunnels (Pholidae)	Sandfishes (Trichodontidae) Pacific sand fish (*Trichodon trichodon*)
Krill or Euphausiids (Euphausiacea: *Thysanopoda*, *Euphausia*, *Thysanoessa*, and *Stylocheiron*)	Smelts (Osmeridae) Capelin (*Mallotus villosus*) Eulachon (*Thaleichthys pacificus*
Lanternfishes (Myctophidae)	

Source: DoN 2006

The status, distribution, habitat preference (substrate, depth, temperature, and salinity), life history (migration, movements, and spawning), common prey species, and EFH designations of the species complexes and/or individual species are summarized in greater detail in an EFH Assessment prepared by the Navy.

Habitat Areas of Particular Concern (HAPCs) are a subset of EFH. FMCs are encouraged to designate HAPCs under the MSFCMA. HAPCs are identified based on habitat level considerations rather than species life stages as are identified with EFH. EFH guidelines published in federal regulations identify

HAPCs as types or areas of habitat within EFH that are identified based on one or more of the following considerations:

- The importance of the ecological function provided by the habitat.
- The extent to which the habitat is sensitive to human-induced environmental degradation.
- Whether, and to what extent, development activities are or will be stressing the habitat type.
- The rarity of the habitat type (50 Code of Federal Regulations [C.F.R.] 600.815(a)(8))

In addition to the EFH status, some of these species are assigned status categories in conjunction with the ESA and various federal or international agencies. Currently, there are no existing HAPCs in the NPFMC region (Moncada et al. 2004). Several habitat types identified as HAPCs (areas with living substrates in shallow/deep waters and freshwater areas used by anadromous fish) within EFH amendments 55/55/8/5/5 (NPFMC 1999) are currently being revised within EFH amendments 65/65/12/7/8, with the focus centering on specific habitat locations, such as seamounts and hard coral areas (NPFMC 2005b). In addition, the final rule to amendments 7 and 8 to the FMP for salmon fisheries in the EEZ off the coast of Alaska, amendments 7 and 9 to the FMP for the scallop fishery off Alaska, and amendments 73 and 65 to the FMP for groundfish of the GOA have established the following Habitat Conservation Areas (HCAs) and Habitat Protection Areas (HPAs) in the GOA: 10 Gulf of Alaska Slope Habitat Conservation Areas (GOASHCAs), 15 Alaska Seamount Habitat Protection Areas (ASHPAs), and 5 Gulf of Alaska Coral Habitat Protection Areas (GOACHPAs) (NMFS 2006b). Two GOASHCA (Cable and Middleton West) and four ASHPA (Dall, Giacomini, Kodiak, and Quinn Seamounts) occur within or in the vicinity of the TMAA (see Figure 3.5-7).

High Seas Salmon Plan Fishery Management Plan

Description

Five species of Pacific salmon (Chinook, coho, chum, pink, and sockeye salmon) have EFH designated within the TMAA (Duffy et al. 2005). All species are similar in appearance and have an anadromous life history (NMFS-AKR 2005). Anadromous salmon depend on the ecological integrity and connectivity of a suite of habitats extending from the natal freshwater spawning or rearing streams to estuaries and then to coastal, shelf, and offshore waters for their growth (Groot and Margolis 1991). The relative importance of estuarine and coastal marine environments differs within and among the various salmon species due to differences in residence times and utilization of these environments (PICES 2004). All species of salmon spawn in gravel beds in freshwater rivers and streams, or along lake-shores (Thorpe 1994, Anchor Environmental L.L.C. and People for Puget Sound 2002). Coho and Chinook salmon typically migrate to sea after extended periods of rearing as juveniles in freshwaters; whereas pink salmon do not rear long in freshwater and migrate to sea soon after emergence from natal gravel beds (Duffy et al. 2005). Juvenile salmon reside mainly in nearshore intertidal waters, which provide five key functions: migration corridors, food production, physiological refuge, refuge from predators, and high-energy refuge (Good et al. 2005). After achieving some size threshold or after a temporal cue (e.g., a specific residence time), salmon move from shallow nearshore to offshore surface waters in estuarine and marine waters (NMFS 2005b, 2005d; USFWS 2005).

EFH Designations

Salmon EFH includes streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon. The geographic extent of marine EFH for salmon extends from the nearshore and tidal submerged environments within state territorial seas out to the full extent of the Exclusive Economic Zone (EEZ), 200 nm offshore (Pacific Fisheries Management Council [PFMC] 2000, NMFS-AKR 2005).

Freshwater EFH for salmon (streams, lakes, ponds, or wetlands) is not within the TMAA. For more information on freshwater EFH, see NMFS-AKR (2005).

Status

None of these high seas salmon are currently listed on the International Union for Conservation of Nature and Natural Resources (IUCN) red list of threatened species. Those species listed under the ESA are discussed in Section 3.6.1.3.

Groundfish Fishery Management Plan

The GOA Groundfish FMP and its management regime govern all stocks of finfish (including squid and octopus), except salmon, steelhead, halibut, herring, and tuna. The groundfish complex separates the species into five categories: (1) prohibited species – species and/or species of groups whose catch must be returned to the sea with a minimum of injury except when their retention is authorized by other applicable law (e.g., King and Tanner crabs [*Paralithodes*/*Lithodes* spp. and *Chionoecetes* spp.], Pacific halibut, Pacific herring [*Clupea pallasii*], Pacific salmon, steelhead trout); (2) target species – commercially important species generally targeted by groundfish fishery (e.g., walleye pollock, Pacific cod); (3) other species – are not usually targeted, have little current economic value, but may contain significant components of the ecosystem or have economic potential (e.g., sharks, sculpins); (4) forage fish species – critical food source for many marine mammals, seabirds, and fish species (e.g., smelts, euphausiids); and (5) nonspecified species – species and species groups of no current economic value taken by the groundfish fishery only as incidental catch in the target fisheries (e.g., grenadiers, eelpouts, sea urchins, mussels, etc.) (NMFS-AKR 2005, NPFMC 2005a). EFH provisions of the MSFCMA do not apply to prohibited and nonspecified species (unless these species are included in the fishery management unit of another FMP), e.g., Bering Sea/Aleutian Island crab species or salmon fisheries (NMFS-AKR 2005).

Target species consist of the following groups: 13 flatfish species (right-eye flounders) consisting of a single family, 32 rockfish and two thornyheads in the family Scorpaenidae; four roundfish species representing three families; and five skate species in the family Rajidae. Other species consist of six sculpins representing two families, three sharks from three families, four squids consisting of two families, and two octopuses representing two families (see Table 3.6-1) (NPFMC 2005b). The forage fish species comprises nine fish families and one crustacean order Euphausiacea (NPFMC 2005a). EFH designation is based upon the aquatic habitat necessary for groundfish production in supporting a long-term sustainable fisheries and contributing to a healthy ecosystem (NMFS-AKR 2005). According to the Final EIS (FEIS) for EFH Identification and Conservation in Alaska, other species, such as sharks, octopi, and forage fishes are lacking sufficient information to define EFH (NMFS-AKR 2005).

Description

Fifty-nine of the 66 NPFMC managed groundfish species are known to occur in the GOA TMAA (NMFS-AKR 2005). These groundfish species occupy various marine environments including estuaries, tideland marshes, bays, fjords, sandy beaches, unprotected rocky shores, river deltas, and a variety of continental shelf, slope, seamounts, and deep ocean habitats encompassing different physical and biological attributes at various stages in their life histories (Hood and Zimmerman 1986). Research on the life histories and habitats of these species varies in completeness, so while some species are well studied, there is relatively little information on other species. The status, distribution, habitat preference (substrate, depth, temperature, and salinity), life history (migration, movements, and spawning), common prey species, and EFH designations of the species complexes and/or individual species are summarized below, with greater detail provided in an EFH Assessment prepared by the Navy (NPFMC 1990, 2004b, 2005b).

The flatfishes in the GOA have been divided into several categories for management purposes. With the exception of arrowtooth flounder, rex sole, and flathead sole, which are managed as individual species, the remaining flatfishes are managed as "shallow-water" and "deepwater" assemblages (NMFS-AKR 2005). Each of the managed individual species has its own EFH designation (Table 3.6-1). The EFH designation of the Alaska plaice and rock and yellowfin soles best represents the shallow-water assemblage, whereas the Dover sole best represents the deepwater assemblage (NMFS-AKR 2005).

Status

According to NMFS (2005a) and NPFMC (2004a), no groundfish stocks are designated as overfished. The abundances of Pacific cod (*Gadus macrocephalus*), Pacific ocean perch (*Sebaste alutus*), northern rockfish (*S. polyspinis*), dusky rockfish (*S. ciliatus*), thornyheads, flathead sole (*Hippoglossoides elassodon*), Dover sole, and arrowtooth flounder are above target stock size, whereas abundances of walleye pollock are below target stock size (NPFMC 2004a). The relative abundances of other deepwater flatfish, shallow-water flatfish, rex sole, shortraker rockfish (*S. borealis*), rougheye rockfish (*S. aleutianus*), demersal shelf rockfish, other pelagic shelf rockfish, other slope rockfish, Atka mackerel (*Pleurogrammus monopterygius*), and skates are unknown (NMFS 2004a).

Currently, the various individual species comprising the groundfish complex are not listed as threatened or endangered or species of concern (formerly candidate species) under the ESA in the TMAA. Five groundfish species are on the IUCN Red List of Threatened Species. Bocaccio (*S. paucispinis*) is considered critically endangered due to an estimated reduction of at least 80 percent of its population over the last 10 years or three generations. The shortspine thornyhead (*Sebastolobus alascanus*) is considered endangered due to an estimated reduction of at least 50 percent of its population over the last 10 years or three generations. The salmon shark is listed as data deficient, and the big skate is listed as lower risk, but near threatened. The spiny dogfishes' northeast Pacific subpopulation is listed as vulnerable due to the fisheries overexploitation of this species because of its late maturity, low capacity to reproduce, longevity, generation time (25 to 40 years), and a low intrinsic population rate increase of 2 to 7 percent per year. According to the Food and Agriculture Organization (FAO), the salmon shark is listed as category 1 due to a lack of fisheries data (Castro et al. 1999).

3.6.1.3 Threatened and Endangered Species

The Navy is currently conducting consultation with NMFS in accordance with Section 7 of the Endangered Species Act for listed fish species. The results of this consultation process will be incorporated into the Final EIS/OEIS.

Federally listed species of fish are identified by Evolutionarily Significant Units (ESUs) or Distinct Population Segments (DPSs). This policy indicates that one or more naturally reproducing populations will be considered to be distinct population segments and, hence, a species under the ESA, if they represent an ESU or DPS of the biological species. To be considered an ESU, a population must satisfy two criteria: (1) It must be reproductively isolated from other population units of the same species, and (2) it must represent an important component in the evolutionary legacy of the biological species (Good et al. 2005). The first criterion, reproductive isolation, need not be absolute but must have been strong enough to permit evolutionarily important differences to occur in different population units. The second criterion is met if the population contributes substantially to the ecological or genetic diversity of the species as a whole (NMFS 1999). The DPS policy adopts criteria similar to, but somewhat different from, those in the ESU policy for determining when a group of vertebrates constitutes a DPS: the group must be discrete from other populations and it must be significant to its taxon (NMFS 2006a).

Once an ESU or DPS is listed, the ESA requires NOAA and USFWS to designate "critical habitat" for the species. "Critical habitat" is defined as: 1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and 2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation.

Salmonids

Various listed ESUs or DPSs of salmonids (Chinook salmon, coho salmon, chum salmon, sockeye salmon, and steelhead) migrate north to mature in the GOA and may occur in the TMAA. While these listed salmonids have designated critical habitat, none of the critical habitat occurs within the TMAA. Salmon (Chinook and coho, in particular) support important traditional, commercial, and recreational fisheries in the GOA and have long been an integral part of the Native American culture (North Pacific Fisheries Management Council [NPFMC] 1990). Salmon are extremely important to both marine and terrestrial ecosystems (Gende et al. 2002).

Federally listed species that may occur within the TMAA are listed in Table 3.6-2; however, it should be noted that no designated critical habitat occurs within the TMAA.

Table 3.6-2: Pacific Salmonid ESUs and DPSs in the TMAA and Vicinity

Species	ESU	ESA Listing Status	Critical Habitat in TMAA
Chinook Salmon	Sacramento River Winter-run	Endangered	No
	Upper Columbia River Spring-run	Endangered	No
	Snake River Spring/Summer-run	Threatened	No
	Snake River Fall-run	Threatened	No
	Central Valley Spring-run	Threatened	No
	California Coastal	Threatened	No
	Puget Sound	Threatened	No
	Lower Columbia River	Threatened	No
	Upper Willamette River	Threatened	No
Coho Salmon	Central California Coast	Endangered	No
	Southern Oregon / Northern California Coasts	Threatened	No
	Lower Columbia River	Threatened	No
	Oregon Coast	Threatened	No
Chum Salmon	Hood Canal Summer-run	Threatened	No
	Columbia River	Threatened	No
Sockeye Salmon	Snake River	Endangered	No
	Ozette Lake	Threatened	No
Steelhead Trout	Southern California	Endangered	No
	Upper Columbia River	Threatened	No
	Snake River Basin	Threatened	No
	Middle Columbia River	Threatened	No
	Lower Columbia River	Threatened	No
	Upper Willamette River	Threatened	No
	South-Central California Coast	Threatened	No
	Central California Coast	Threatened	No
	Northern California	Threatened	No
	California Central Valley	Threatened	No
	Puget Sound	Threatened	No

Source: NMFS 2009

Chinook Salmon

The Chinook salmon's historical range in North America extended from the Ventura River in California to Point Hope, Alaska (Myers et al. 1998). The natural freshwater range for Chinook salmon extends throughout the Pacific Rim of North America. This species has been identified from the San Joaquin River in California to the Mackenzie River in northern Canada (Healey 1991). The oceanic range encompasses Washington, Oregon, California, throughout the north Pacific Ocean, and as far south as the U.S./Mexico border (PFMC 2000). Offshore ocean distribution is generally more limited (within 200 miles [mi] of the coast) for Chinook than other Pacific salmonids (NPFMC 1990).

Chinook salmon exhibit one of the more diverse and complex life history strategies of all Pacific salmon and are separated into two generalized life-history types: stream-type and ocean-type (Myers et al. 1998, PFMC 2000). Timing of migration to seawater for juveniles is highly variable (PFMC 2000). Ocean-type juveniles may migrate to the ocean immediately after hatching in the late winter or early spring, but most remain in freshwater for 30 to 90 days (NMFS-AKR 2005). Ocean-type juveniles typically inhabit estuaries for several months before migrating to higher salinity waters (PFMC 2000). Stream-type juveniles pass quickly through estuaries, are highly migratory, and may make extensive migrations in the open ocean (NMFS-AKR 2005). Fry enter the upper reaches of estuaries in late winter for the more southern populations or early spring for the more northern populations (PFMC 2000). For a year or more, they reside as fry or parr in freshwater where they exhibit downstream dispersal and utilize a variety of freshwater rearing environments before migrating to sea (Healey 1991). They perform extensive offshore oceanic migrations and return to their natal river during the spring and early summer, several months prior to spawning (Healey 1991). Ocean residency varies but may last from 1 to 6 years (Healey 1991). Stream-type adults often enter freshwater in the spring and summer as immature fish and spawn in upper watersheds in late summer or early fall (PFMC 2000). Stream-type life histories are most common in Alaska, but ocean-type populations are also present in a few watersheds (NMFS-AKR 2005).

Ocean-type Chinook migrate to the ocean within the first year (typically within a few months) after emergence where they spend an average of 4 to 5 years. (Myers et al. 1998, PFMC 2000, Augerot and Foley 2005). Ocean-type Chinook salmon spend most of their ocean life in coastal waters, and return to their natal rivers from spring to winter (Healey 1991). Spawning may range from May/June to December/January depending on location but periods are specific for each run and/or stock (Emmett et al. 1991, Healey 1991, PFMC 2000). Spawning may occur from the tidewater to 1,988 mi (3,200 km) upstream (Healey 1991). Stream-type and ocean-type spawning populations are separated considerably (Healey 1991). In North America there seems to be a sudden shift from stream-type to ocean-type stocks somewhere around Alaska-British Columbia border (Healey 1991). South of approximately 56^{o}N, stream-type Chinook are only found in larger rivers with ocean-type salmon dominating the majority of the runs (Healey 1991).

Chinook salmon may return to their natal streams during any month but there are one to three peaks associated with salmon migratory activity (Healey 1991). These peaks vary between river systems. Northern river systems generally see a single peak in migratory activity around June, although runs can possibly occur from April to August (Healey 1991). As you go farther south, runs occur progressively later (Healey 1991).

Within the TMAA, early life history stages for Chinook occur in freshwater but juveniles and adults utilize marine habitats. Juvenile Chinook prefer coastal areas (less than 34 mi [55 km]) throughout California, Oregon, and Washington, north to the Strait of Georgia and the Inland Passage, Alaska (PFMC 2000). The majority of marine juveniles are found within 17 mi (28 km) of the coast (PFMC 2000). They tend to concentrate around areas of pronounced coastal upwellings (PFMC 2000). Populations originating north of Cape Blanco, Oregon migrate north to the GOA, while populations originating south of Cape Blanco migrate south and west into the waters off California and Oregon

(PFMC 2000). Chinook salmon spawning in rivers south of the Rogue River in Oregon rear in marine waters off California and Oregon, whereas, salmon spawning in rivers north of the Rogue River migrate north and west along the Pacific coast (NMFS-AKR 2005). These migrations are important from a management perspective since fish from Oregon, Washington, British Columbia, and Alaska have the potential of being harvested in the GOA (NMFS-AKR 2005).

Coho Salmon

Coho salmon are found in freshwater drainages from Monterey Bay, California north along the west coast of North America to Alaska, around the Bering Sea south through Russia to Hokkaido, Japan (California Department of Fish and Game [CDFG] 2002). Oceanic lifestages are found from Camalu Bay, Baja California north to Point Hope, Alaska and through the Aleutian Islands (Marine Biological Consultants [MBC] 1987, Sandercock 1991, NMFS-AKR 2005). In the northeastern Pacific, coho can be found south of 40^{o}N, but only in the coastal waters of the California Current (MBC 1987). Tagging studies have shown coho originating from Washington and Oregon as far north as 60^{o}N latitude and coho originating from California as far north as 58^{o}N latitude (PFMC 2000). Oregon coho have been taken in offshore waters near Kodiak Island in the northern Gulf of Alaska. Westward migration of coho salmon appears to extend beyond the EEZ beginning at approximately 45^{o}N latitude off the coast of Oregon (PFMC 2000). In strong upwelling years coho are more dispersed offshore, whereas in weak upwelling years they concentrate near submarine canyons and areas of consistent upwelling.

Adult coho migrate into streams where they deposit their eggs in gravel (Sandercock 1991). Eggs incubate throughout the winter and emerge in the spring as free-swimming fry (Sandercock 1991). Typical freshwater and estuarine residency time in Alaska is one to two years, though coho may spend up to 5 years if their growth is slow (NMFS-AKR 2005). Juveniles spend a minimum of 18 months at sea before returning to their natal streams to repeat the process (NPFMC 1990, Sandercock 1991).

Adult coho salmon migrate to their natal streams from June to February with northern populations beginning their return earlier than southern populations (Emmett et al. 1991, Sandercock 1991). Throughout their range, coho exhibit a variety of return timing patterns (Sandercock 1991). Most juvenile migration occurs from April to August with a peak in May (Emmett et al. 1991). Generally, as you move farther north, estuarine residency time for juveniles increases (PFMC 2000). Upon entering the ocean, coho may spend several weeks or their entire first summer in coastal waters before migrating north (PFMC 2000). In Alaska, coho spend up to 4 months in coastal waters before migrating offshore (NMFS-AKR 2005). Tag, release, and recovery studies suggest that coho salmon of California origin can be found as far north as southeast Alaska and salmon from Oregon and Washington as far north as the northern GOA (PFMC 2000). The extent of coho migrations appears to extend westward along the Aleutian Island chain ending somewhere around Emperor Seamount (believed to be an area of high prey abundance; PFMC 2000). The southern extent of the population expands and contracts annually, with Point Conception, California generally considered the faunal break for the coho and other temperate marine species (PFMC 2000). Offshore, juvenile coho are generally found in waters over the continental shelf, ranging from 23 to 46 mi (37 to 74 km) from shore (NMFS-AKR 2005). Adult coho may enter freshwater as early as July in the Alaska and as late as December or January in California (Sandercock 1991, PFMC 2000). Summer-run coho may enter rivers exceptionally early (spring or early summer; PFMC 2000). Larger rivers have a wider range of entry times than smaller systems (PFMC 2000).

Because of the coho’s extended residency in freshwater environments (streams, ponds, and lakes), they are especially vulnerable to anthropogenic activities such as timber harvesting, mining, and road building (NPFMC 1990). Catch rates for coho in Alaska are at historically high levels and most stocks are rated as stable (NMFS-AKR 2005).

Chum Salmon

Chum salmon have the largest range of natural geographic and spawning distribution of all the Pacific salmon species (Pauley et al. 1988). Historically, in North America, chum salmon occurred from Monterey, California to the Arctic coast of Alaska and east to the Mackenzie River which flows into the Beaufort Sea. Present spawning populations are now found only as far south as Tillamook Bay on the northern Oregon coast (Salo 1991). Juvenile chum occur along the coast of North America and Alaska in a band that extends out to 22 mi (36 km) (Salo 1991).

Chum salmon are an anadromous species distributed throughout the North Pacific Ocean (Salo 1991). They are highly migratory with fry heading seaward immediately after emergence (NPFMC 1990, Salo 1991). Chum salmon do not have the clearly defined smolt stages that occur in other salmonids; however they are capable of adapting to seawater soon after emergence from the gravel (Salo 1991). Migrations of juvenile chum are correlated with the warming of nearshore waters (Salo 1991). They migrate to estuaries during their first spring or summer and spend little time rearing in freshwater (Pauley et al. 1988). Juveniles enter estuaries from March to mid-May where they remain for several months (Emmett et al. 1991). As chum salmon grow, there is a general movement toward the ocean, moving offshore from April to June (Emmett et al. 1991). They then head north along the continental shelf until they reach the Gulf of Alaska (Emmett et al. 1991). Adults return to their natal streams at various ages but generally within 2 to 5 years (Salo 1991). Chum salmon return to their natal streams from June to January with more northern populations returning earlier than those to the south (NMFS-AKR 2005). The majority of chum spawning in Alaska is finished by November (NMFS-AKR 2005). For chum salmon, two spawning stocks exist: a northern stock that spawns from June to September and a southern (late-run) stock that spawns from August to January (Emmett et al. 1991).

Within the TMAA, early life history stages for chum salmon occur in freshwater but juveniles and adults utilize marine habitats. Juvenile chum migrations follow the GOA coastal belt to the north, west, and south during their first summer at sea (Salo 1991). While overall migration patterns of juvenile chum salmon within the GOA are understood, nearshore residency times and offshore migrations patterns are still unclear (Salo 1991). Migrations of immature fish during the late summer, fall, and winter occur in a broad southeasterly fashion, primarily south of 50°N and east of 155°W in the GOA. During the spring and early summer, chum salmon migrate to the north and west (Salo 1991). Maturing fish destined for North American streams are widely distributed throughout the GOA during the spring and summer (Salo 1991).

Sockeye Salmon

The sockeye salmon are primarily anadromous, where they migrate as juveniles from freshwater habitats to marine environments and return to freshwater habitats to spawn, but there are also distinct landlocked populations (kokanee) which never migrate to marine waters, spending their entire life cycle in fresh water habitats (Burgner 1991, Emmett et al. 1991).

After emergence, sockeye typically rear in lakes or glacial river sloughs for 1 to 3 years before migrating to the ocean (NPFMC 1990, Burgner 1991). Anadromous sockeye spend 1 to 4 years at sea before returning to their natal streams in the summer and autumn to spawn and eventually die. Offshore movements of sockeye are complex and are affected by a variety of physical factors (e.g., season, temperature, and salinity) and biological factors (e.g., life stage, age and size, availability and distribution of prey, and stock-of-origin; Burgner 1991). Juveniles generally remain in a band close to the coast upon entering the ocean environment (NMFS-AKR 2005). In British Columbia and southeast Alaska, juveniles are usually present in the open sea by late June. These fish are found moving northwestward into the GOA during July. This northwestward movement up the eastern Pacific Rim is followed by a southwestward migration along the Alaskan Peninsula (NMFS-AKR 2005).

In North America, spawning populations are found from the Sacramento River in California, north to Kotzebue Sound (Burgner 1991). Spawning is temperature-dependent and varies by location generally occurring from August to December and peaking in October (Emmett et al. 1991). Sockeye generally spawn in streams associated with lakes where the juveniles rear in the limnetic zone before they smoltify and migrate to the ocean (Pauley et al. 1989, Burgner 1991, Emmett et al. 1991). For this reason, the two largest spawning complexes are the Bristol Bay watershed in southwestern Alaska and the Fraser River watershed in British Columbia, both of which have extensive lake rearing habitats accessible to sockeye (Burgner 1991).

Within the TMAA, early life history stages for sockeye occurs in lakes and streams, but juveniles and adults utilize marine habitats and vicinity. Seaward migrations in Alaska begin in mid-May in association with salinity gradients (NPFMC 1990). Soon after entering the ocean, juvenile sockeye (excluding those from Bristol Bay) begin moving north into the GOA where they remain along the coastal belt until late-fall or early-winter. They then disperse offshore moving west and south (Emmett et al. 1991). In the GOA, sockeye move north during the spring and summer and south and west during the winter (Emmett et al. 1991). Ocean residency for sockeye is 1 to 4 years (Pauley et al. 1989).

Steelhead Trout

Steelhead trout exhibit a great diversity of life history patterns, and are phylogenetically and ecologically complex. Steelhead may exhibit either an anadromous life style, or a freshwater residency, where they spend their entire life in freshwater (NMFS 1997). Freshwater residents are referred to as rainbow trout. Different life history forms include anadromous and nonanadromous, winter or summer steelhead, inland or coastal groupings, and half-pounder strategies. Some anadromous forms spend up to 7 years in freshwater and 3 years in the ocean prior to their first spawning (Busby et al. 1996), while other anadromous steelhead typically spend the first 2 years of their lives in freshwater, migrate to the marine environment and spend 2 to 3 years there, before returning to the freshwater environment to spawn at 4 to 5 years of age (McEwan and Jackson 1996, Schultz 2004).

Steelhead have excellent homing abilities and have been separated into two races depending on their return to their natal stream (winter-run and summer-run; Emmett et al. 1991). Winter-run steelhead migrate upstream during the fall, winter, and early spring, whereas summer-run steelhead migrate during the spring, summer, and early fall (Emmett et al. 1991). Winter steelhead enter their home stream in various stages of sexual maturation from November to April, and spawn within a few months of entering the river between late March and early May (Pauley et al. 1986). They are the most widespread of the two reproductive types. Coastal streams are dominated by winter steelhead, and there are only a few occurrences of inland winter steelhead populations (Busby et al. 1996). Juveniles generally rear in freshwater for 1 to 4 years before migrating to the ocean where they reside from 1 to 5 years (Emmett et al. 1991). Steelhead may also exhibit a “half-pounder” run (mostly summer steelhead) where they return to natal streams after only a few months at sea, overwinter, and then migrate back to the ocean (Emmett et al. 1991). Steelhead spend little time in estuaries and are abundant throughout the North Pacific and Gulf of Alaska (Emmett et al. 1991).

Spawning typically occurs from December to June; peaks are in February and March (McEwan and Jackson 1996). Steelhead can spawn more than once (iteroparity); all other species of Pacific *Oncorhynchus* spawn once and then die (semelparity). North of Oregon, repeat spawning is relatively uncommon and more than two spawning migrations is rare. Iteroparity occurs predominantly in females (Busby et al. 1996).

In the TMAA and vicinity, early life history stages of the steelhead are found only in freshwater habitats, while the later life history stages of the anadromous life form (i.e., juveniles and adults) utilize the marine environment. In the spring, Alaskan steelhead smolt leave their natal streams and enter the ocean where they reside for 1 to 3 years before returning to spawn (NMFS-AKR 2005). Populations may return in July (summer-run) or in August, September, and October (fall-run; NMFS-AKR 2005). Summer returns are rare in Alaska and are only found in a few southeast Alaska streams. Fall-run steelhead are much more common in Alaska, north of Federick Sound, and are found in rivers, such as the Anchor, Nahu, Karluk, and Situk. Steelhead also exhibit spring runs (April, May, and June), but they are predominately found in southeast Alaska.

3.6.1.4 Hearing in Fish

All fish have two sensory systems that are used to detect sound in the water including the inner ear, which functions very much like the inner ear found in other vertebrates, and the lateral line, which consists of a series of receptors along the body of the fish (Popper 2008). The inner ear generally detects higher frequency sounds while the lateral line detects water motion at low frequencies (below a few hundred Hz) (Hastings and Popper 2005). A sound source produces both a pressure wave and motion of the medium particles (water molecules in this case), both of which may be important to fish. Fish detect particle motion with the inner ear. Pressure signals are initially detected by the gas-filled swim bladder or other air pockets in the body, which then re-radiate the signal to the inner ear (Popper 2008). Because particle motion attenuates relatively quickly, the pressure component of sound usually dominates as distance from the source increases.

The lateral line system of a fish allows for sensitivity to sound (Hastings and Popper 2005). This system is a series of receptors along the body of the fish that detects water motion relative to the fish that arise from sources within a few body lengths of the animal. The sensitivity of the lateral line system is generally from below 1 Hz to a few hundred Hz (Coombs and Montgomery 1999, Webb et al. 2008). The only study on the effect of exposure to sound on the lateral line system (conducted on one freshwater species) suggests no effect on these sensory cells by intense pure tone signals (Hastings et al. 1996). While studies on the effect of sound on the lateral line are limited, Hasting et al.'s (1996) work, showing limited sensitivity to within a few body lengths and to sounds below a few hundred Hz, make the effect of the mid-frequency sonar of the Proposed Action unlikely to affect a fish's lateral line system. Therefore, further discussion of the lateral line in this analysis in unwarranted.

Broadly, fish can be categorized as either hearing specialists or hearing generalists (Scholik and Yan 2002). Fish in the hearing specialist category have a broad frequency range with a low auditory threshold due to a mechanical connection between an air filled cavity, such as a swimbladder, and the inner ear. Specialists detect both the particle motion and pressure components of sound and can hear at levels above 1 kilohertz (kHz). Generalists are limited to detection of the particle motion component of low-frequency sounds at relatively high sound intensities (Amoser and Ladich 2005). It is possible that a species will exhibit characteristics of generalists and specialists and will sometimes be referred to as an "intermediate" hearing specialist. For example, most damselfish are typically categorized as generalists, but because some larger damselfish have demonstrated the ability to hear higher frequencies expected of specialists, they are sometimes categorized as intermediate.

Of the fish species with distributions overlapping the TMAA for which hearing sensitivities are known, most are hearing generalists, including salmonid species.

Although hearing capability data only exists for fewer than 100 of the 29,000 fish species (Popper 2008), current data suggest that most species of fish detect sounds from 0.05 to 1.0 kHz, with few fish hearing sounds above 4 kHz (Popper 2008). Moreover, studies indicate that hearing specializations in marine species are quite rare and that most marine fish are considered hearing generalists (Popper 2003, Amoser and Ladich 2005). Specifically, the following species are all believed to be hearing generalists: elasmobranchs (i.e., sharks and rays) (Casper et al. 2003, Casper and Mann 2006, Myrberg 2001), scorpaeniforms (i.e., scorpionfishes, searobins, sculpins) (Lovell et al. 2005), scombrids (i.e., albacores, bonitos, mackerels, tunas) (Iversen 1967, Iversen 1969, Popper 1981, Song et al. 2006), damselfishes (Egner and Mann 2005, Kenyon 1996, Wright et al. 2005, Wright et al. 2007), and more specifically, midshipman fish (*Porichthys notatus*) (Sisneros and Bass 2003), Atlantic salmon (*Salmo salar*) (Hawkins and Johnstone 1978), and Gulf toadfish (*Opsanus beta*) (Remage-Healey et al. 2006). Moreover, it is believed that the majority of marine fish have their best hearing sensitivity at or below 0.3 kHz (Popper 2003). However, it has been demonstrated that marine hearing specialists, such as some Clupeidae, can detect sounds above 100 kHz. A list of fish hearing sensitivities is presented in Table 3.6-3.

In contrast to marine fish, several thousand freshwater species are thought to be hearing specialists. Nelson (1994) estimates that 6,600 of 10,000 freshwater species are otophysans (catfish and minnows), which are hearing specialists. Interestingly, many generalist freshwater species, such as perciforms (percids, gobiids) and scorpaeniforms (sculpins) are thought to have derived from marine habitats (Amoser and Ladich 2005). It is also thought that Clupeidae may have evolved from freshwater habitats (Popper et al. 2004). This supports the theory that hearing specializations likely evolved in quiet habitats common to freshwater and the deep sea because only in such habitats can hearing specialists use their excellent hearing abilities (Amoser and Ladich 2005).

Table 3.6-3: Marine Fish Hearing Sensitivities

Family	Description of Family	Common Name	Scientific Name	Hearing Range (kHz)		Greatest Sensitivity (kHz)	Sensitivity Classification
				Low	High		
Albulidae	Bonefishes	Bonefish	*Albula vulpes*	0.1	0.7	0.3	Generalist
Anguillidae	Eels	European eel	*Anguilla anguilla*	0.01	0.3	0.04-0.1	Generalist
Ariidae	Catfish	Hardhead sea catfish	*Ariopsis felis*	0.05	1	0.1	Generalist
Batrachoididae	Toadfishes	Midshipman	*Porichthys notatus*	.065	0.385		Generalist
		Gulf toadfish	*Opsanus beta*			<1	Generalist
Clupeidae	Herrings, shads, menhadens, sardines	Alewife	*Alosa pseudoharengus*		0.12		Specialist
		Blueback herring	*Alosa aestivalis*		0.12		Specialist
		American shad	*Alosa sapidissima*	0.1	0.18	0.2-0.8 and 0.025-0.15	Specialist
		Gulf menhaden	*Brevoortia patronus*		0.1		Specialist
		Bay anchovy	*Anchoa mitchilli*		4		Specialist
		Scaled sardine	*Harengula jaguana*		4		Specialist
		Spanish sardine	*Sardinella aurita*		4		Specialist
		Pacific herring	*Clupea pallasii*	0.1	5		Specialist
Chondrichthyes [Class]	Cartilaginous fishes, rays, sharks, skates			0.2	1		Generalist
Gadidae	Cods, gadiforms, grenadiers, hakes	Cod	*Gadus morhua*	0.002	0.5	0.02	Generalist
Gobidae	Gobies	Black goby	*Gobius niger*	0.1	0.8		Generalist

Table 3.6-3: Marine Fish Hearing Sensitivities (continued)

Family	Description of Family	Common Name	Scientific Name	Hearing Range (kHz)		Greatest Sensitivity (kHz)	Sensitivity Classification
				Low	High		
Holocentridae	Squirrelfish and soldierfish	Shoulderbar soldierfish	*Myripristis kuntee*	0.1	3.0	0.4-0.5	Specialist
		Hawaiian squirrelfish	*Adioryx xantherythrus*	0.1	0.8		Generalist
Labridae	Wrasses	Tautog	*Tautoga onitis*	0.01	0.5	0.037-0.050	Generalist
		Blue-head wrasse	*Thalassoma bifasciatum*	0.1	1.3	0.3-0.6	Generalist
Lutjanidae	Snappers	Schoolmaster snapper	*Lutjanus apodus*	0.1	1.0	0.3	Generalist
Myctophidae	Lanternfishes	Warming's lanternfish	*Ceratoscopelus warmingii*				Specialist
Pleuronectidae	Flatfish	Dab	*Limanda limanda*	0.03	0.27	0.1	Generalist
		European plaice	*Pleuronectes platessa*	0.03	0.2	0.11	Generalist
Pomadasyidae	Grunts	Blue striped grunts	*Haemulon sciurus*	0.1	1.0		Generalist
Pomacentridae	Damselfish	Sergeant major damselfish	*Abudefduf saxatilis*	0.1	1.6	0.1-0.4	Generalist/ Intermediate
		Bicolor damselfish	*Stegastes partitus*	0.1	1.0	0.5	Generalist/ Intermediate
		Nagasaki damselfish	*Pomacentrus nagasakiensis*	0.1	2.0	<0.3	Generalist/ Intermediate
Salmonidae	Salmons	Atlantic salmon	*Salmo salar*	<0.1	0.58		Generalist
Sciaenidae	Drums, weakfish, croakers	Atlantic croaker	*Micropogonias undulatus*	0.1	1.0	0.3	Generalist
		Spotted sea trout	*Cynoscion nebulosus*				Generalist
		Kingfish	*Menticirrhus americanus*				Generalist
		Spot	*Leiostomus xanthurus*	0.2	0.7	0.4	Generalist
		Black drum	*Pogonias cromis*	0.1	0.8	0.1-0.5	Generalist
		Weakfish	*Cynoscion regalis*	0.2	2.0	0.5	Specialist
		Silver perch	*Bairdiella chrysoura*	0.1	4.0	0.6-0.8	Specialist
Scombridae	Albacores, bonitos, mackerels, tunas	Bluefin tuna	*Thunnus thynnus*		1.0		Generalist
		Yellowfin tuna	*Thunnus albacares*	0.5	1.1		Generalist
		Kawakawa	*Euthynnus affinis*	0.1	1.1	0.5	Generalist
		Skipjack tuna	*Katsuwonus pelamis*				Generalist

Table 3.6-3: Marine Fish Hearing Sensitivities (continued)

Family	Description of Family	Common Name	Scientific Name	Hearing Range (kHz)		Greatest Sensitivity (kHz)	Sensitivity Classification
				Low	High		
Scorpaenidae	Scorpionfishes searobins, sculpins	Sea scorpion	*Taurulus bubalis*				Generalist
Serranidae	Seabasses, groupers	Red hind	*Epinephelus guttatus*	0.1	1.1	0.2	Generalist
Sparidae	Porgies	Pinfish	*Lagodon rhomboides*	0.1	1.0	0.3	Generalist
Triglidae	Scorpionfish, searobins, sculpins	Leopard searobin	*Prionotus scitulus*	0.1	0.8	0.39	Generalist

Sources: Astrup 1999; Astrup and Mohl 1993; Casper and Mann 2006; Casper et al. 2003; Coombs and Popper 1979; Dunning et al. 1992; Egner and Mann 2005; Gregory and Clabburn 2003; Hawkins and Johnstone 1978; Higgs et al. 2004; Iversen 1967, 1969; Jorgensen et al. 2005; Kenyon 1996; Lovell et al. 2005; Mann et al. 1997, 2001, 2005; Myrberg 2001; Nestler 2002; Popper 1981; Popper and Carlson 1998; Popper and Tavolga 1981; Ramcharitar and Popper 2004; Ramcharitar et al. 2001, 2004, 2006a; Remage-Healey et al. 2006; Ross et al. 1996; Sisneros and Bass 2003; Song et al. 2006; Wright et al. 2005, 2007; Popper 2008

Some investigators (e.g., Amoser and Ladich 2005) hypothesize that, within a family of fish, different species can live under different ambient sound conditions, which requires them to adapt their hearing abilities. Under this scenario, a species' probability of survival would be greater if it increased the range over which the acoustic environment, consisting of various biotic (sounds from other aquatic animals) and abiotic (wind, waves, precipitation) sources, could be detected. For the marine environment, Amoser and Ladich (2005) cite the differences in the hearing ability of two species of Holocentridae as a possible example of such environmentally-derived specialization. Both the shoulderbar soldierfish (*Myripristis kuntee*) and the Hawaiian squirrelfish (*Adioryx xantherythrus*) can detect sounds at 0.1 kHz. However, the high-frequency end of the auditory range extends towards 3 kHz for the shoulderbar soldierfish but only to 0.8 kHz for the Hawaiian squirrelfish (Coombs and Popper 1979). Though these two species live in close proximity on the same reefs, it is not certain that differing environmental conditions cause the hearing variations (Popper 2008). Generally, a clear correlation between hearing capability and the environment cannot be asserted or refuted due to limited knowledge of ambient sound levels in marine habitats and a lack of comparative studies.

Susceptibility to the effects of anthropogenic sounds has been shown to be influenced by developmental and genetic differences in the same species of fish. In an exposure experiment, Popper et al. (2007) found that experimental groups of rainbow trout had substantial differences in hearing thresholds. While fish were attained from the same supplier, it is possible different husbandry techniques may be the reason for the differences in hearing sensitivity. These results emphasize that caution should be used in extrapolating data beyond their intent.

Among all fishes studied to date, perhaps the greatest variability is found within the family Sciaenidae (i.e., drumfish, weakfish, croaker), where there is extensive diversity in inner ear structure and the relationship between the swim bladder and the inner ear. Specifically, the Atlantic croaker's (*Micropogonias undulatus*) swim bladder has forwardly directed diverticulae that come near the ear but do not actually touch it. However, the swim bladders in the spot (*Leiostomus xanthurus*) and black drum (*Pogonias cromis*) are further from the ear and lack anterior horns or diverticulae. These differences are associated with variation in both sound production and hearing capabilities (Ladich and Popper 2004; Ramcharitar et al. 2006a). Ramcharitar and Popper (2004) discovered that the black drum responded to sounds from 0.1 to 0.8 kHz and was most sensitive between 0.1 and 0.5 kHz, while the Atlantic croaker responded to sounds from 0.1 to 1 kHz and was most sensitive at 0.3 kHz. Additional sciaenid research by Ramcharitar et al. (2006b) investigated the hearing sensitivity of weakfish (*Cynoscion regalis*) and spot. Weakfish were found to detect frequencies up to 2 kHz, while spot detected frequencies only up to 0.7 kHz.

The sciaenid with the greatest hearing sensitivity discovered thus far is the silver perch (*Bairdiella chrysoura*), which has demonstrated auditory thresholds similar to goldfish, responding to sounds up to 4 kHz (Ramcharitar et al. 2004). Silver perch swim bladders have anterior horns that terminate close to the ear. The Ramcharitar et al. (2004) research supports the suggestion that the swim bladder can potentially expand the frequency range of sound detection. Furthermore, Sprague and Luczkovich (2004) calculated silver perch are capable of producing drumming sounds ranging from 128 to 135 decibels (dB). Since drumming sounds are produced by males during courtship, it can be inferred that silver perch detect sounds within this range.

The most widely noted hearing specialists are otophysans (i.e., members of the super order Ostariophysi), which have bony Weberian ossicles (bones that connect the swim bladder to the ear), along which vibrations are transmitted from the swim bladder to the inner ear (Amoser and Ladich 2003). However, only a few otophysans inhabit marine waters. In an investigation of a marine otophysan, the hardhead sea catfish (*Ariopsis felis*), Popper and Tavolga (1981) determined that this species was able to detect sounds from 0.05 to 1 kHz, which is considered a much lower and narrower frequency range than that common to freshwater otophysans (i.e., above 3 kHz) (Ladich and Bass 2003). The difference in hearing capabilities in the respective freshwater and marine catfish appears to be related to the inner ear structure (Popper and Tavolga 1981).

Experiments on marine fish have obtained responses to frequencies up to the range of ultrasound; that is, sounds between 40 and 180 kHz (University of South Florida 2007). These responses were from several species of the Clupeidae (i.e., herrings, shads, and menhadens) (Astrup 1999); however, not all clupeid species tested have responded to ultrasound. Astrup (1999) and Mann et al. (1998) hypothesized that these ultrasound detecting species may have developed such high sensitivities to avoid predation by odontocetes (i.e., members of the suborder of cetaceans that have teeth). Studies conducted on the following species showed avoidance to sound at frequencies over 100 kHz: alewife (*Alosa pseudoharengus*) (Dunning et al. 1992, Ross et al. 1996), blueback herring (*A. aestivalis*) (Nestler 2002), Gulf menhaden (*Brevoortia patronus*) (Mann et al. 2001) and American shad (*A. sapidissima*) (Popper and Carlson 1998). The highest frequency to solicit a response in any marine fish was 180 kHz for the American shad (Gregory and Clabburn 2003, Higgs et al. 2004). The *Alosa* species have relatively low thresholds (about 145 dB re 1 micropascal [µPa]), which should enable the fish to detect odontocete clicks at distances up to about 656 feet (ft) (200 meters [m]) (Mann et al. 1997). For example, echolocation clicks ranging from 200 to 220 dB could be detected by shad with a hearing threshold of 170 dB at distances from 82 to 591 ft (25 to 180 m) (University of South Florida 2007). In contrast, the Clupeidae bay anchovy (*Anchoa mitchilli*), scaled sardine (*Harengula jaguana*), and Spanish sardine (*Sardinella aurita*) did not respond to frequencies over 4 kHz (Gregory and Clabburn 2003, Mann et al. 2001).

Wilson and Dill (2002) demonstrated that there was a behavioral response seen in Pacific herring (*Clupea pallasii*) to energy levels associated with frequencies from 1.3 to 140 kHz, although it was not clear whether the herring were responding to the lower frequency components of the experiment or to the ultrasound. However, Mann et al. (2005) advised that acoustic signals used in the Wilson and Dill (2002) study were broadband and contained energy of less than 4 kHz to ultrasonic frequencies. Mann et al. (2005) found that Pacific herring could not detect ultrasonic signals at received levels up to 185 dB re 1 µPa. Pacific herring had hearing thresholds (0.1 to 5 kHz) that are typical of Clupeidae that do not detect ultrasound signals.

Species that can detect ultrasound do not perceive sound equally well at all detectable frequencies. Mann et al. (1998) reported that the American shad can detect sounds from 0.1 to 180 kHz with two regions of best sensitivity: one from 0.2 to 0.8 kHz, and the other from 25 to 150 kHz. The poorest sensitivity was found from 3.2 to 12.5 kHz.

Although few non-clupeid species have been tested for ultrasound (Mann et al. 2001), the only other non-clupeid species shown to possibly be able to detect ultrasound is the cod (*Gadus morhua*) (Astrup and Mohl 1993). However, in Astrup and Moh's (1993) study it is feasible that the cod was detecting the stimulus using touch receptors that were over driven by very intense fish-finding sonar emissions (Astrup 1999, Ladich and Popper 2004). Nevertheless, Astrup and Mohl (1993) indicated that cod have ultrasound thresholds of up to 38 kHz at 185 to 200 dB re 1 μPa, which likely only allows for detection of odontocete's clicks at distances no greater than 33 to 98 ft (10 to 30 m) (Astrup 1999).

As mentioned above, investigations into the hearing ability of marine fishes have most often yielded results exhibiting poor hearing sensitivity. Experiments on elasmobranch fish (i.e., sharks and rays) have demonstrated poor hearing abilities and frequency sensitivity from 0.02 to 1 kHz, with best sensitivity at lower ranges (Casper et al. 2003, Casper and Mann 2006, Myrberg 2001). Though only five elasmobranch species have been tested for hearing thresholds, it is believed that all elasmobranchs will only detect low-frequency sounds because they lack a swim bladder, which resonates sound to the inner ear. Theoretically, fishes without an air-filled cavity are limited to detecting particle motion and not pressure and, therefore have poor hearing abilities (Casper and Mann 2006).

By examining the morphology of the inner ear of bluefin tuna (*Thunnus thynnus*), Song et al. (2006) hypothesized that bluefin tuna probably do not detect sounds too much over 1 kHz (if that high). This research concurred with the few other studies conducted on tuna species. Iversen (1967) found that yellowfin tuna (*T. albacares*) can detect sounds from 0.05 to 1.1 kHz, with best sensitivity of 89 dB (re 1 μPa) at 0.5 kHz. Kawakawa (*Euthynnus affinus*) appear to be able to detect sounds from 0.1 to 1.1 kHz but with best sensitivity of 107 dB (re 1 μPa) at 0.5 kHz (Iversen 1969). Additionally, Popper (1981) looked at the inner ear structure of a skipjack tuna (*Katsuwonus pelamis*) and found it to be typical of a hearing generalist. While only a few species of tuna have been studied, and in a number of fish groups both generalists and specialists exist, it is reasonable to suggest that unless bluefin tuna are exposed to very high intensity sounds from which they cannot swim away, short- and long-term effects may be minimal or nonexistent (Song et al. 2006).

Some damselfish have been shown to be able to hear frequencies of up to 2 kHz, with best sensitivity well below 1 kHz. Egner and Mann (2005) found that juvenile sergeant major damselfish (*Abudefduf saxatilis*) were most sensitive to lower frequencies (0.1 to 0.4 kHz); however, larger fish (greater than 50 millimeters [mm]) responded to sounds up to 1.6 kHz. Still, the sergeant major damselfish is considered to have poor sensitivity in comparison even to other hearing generalists (Egner and Mann 2005). Kenyon (1996) studied another marine generalist, the bicolor damselfish (*Stegastes partitus*), and found the bicolor damselfish responded to sounds up to 1.6 kHz with the most sensitive frequency at 0.5 kHz. Further, larval and juvenile Nagasaki damselfish (*Pomacentrus nagasakiensis*) have been found to hear at frequencies between 0.1 and 2 kHz, however, they are most sensitive to frequencies less than 0.3 kHz (Wright et al. 2005, Wright et al. 2007). Thus, damselfish appear to be primarily generalists with some ability to hear slightly higher frequencies expected of specialists (Popper 2008).

Female midshipman fish apparently use the auditory sense to detect and locate vocalizing males during the breeding season. Interestingly, female midshipman fish go through a shift in hearing sensitivity depending on their reproductive status. Reproductive females showed temporal encoding up to 0.34 kHz, while nonreproductive females showed comparable encoding only up to 0.1 kHz (Sisneros and Bass 2003).

The hearing capability of Atlantic salmon (*Samo salar*), a hearing generalist, indicates a rather low sensitivity to sound (Hawkins and Johnstone 1978). Laboratory experiments yielded responses only to 0.58 kHz and only at high sound levels. Salmon's poor hearing is likely due to the lack of a link between the swim bladder and inner ear (Jorgensen et al. 2004).

Furthermore, investigations into the inner ear structure of fishes belonging to the order Scorpaeniformes have suggested that these fishes have generalist hearing abilities (Lovell et al. 2005). Although an audiogram (which provides a measure of hearing sensitivity) has yet to be performed, the lack of a swimbladder is indicative of these species having poor hearing ability (Lovell et al. 2005). However, studies of the leopard robin (*Prionotus scitulus*), another species in this order that do contain swim bladders, indicated that they are hearing generalists as well (Tavolga and Wodinski 1963), which makes extrapolation on hearing from this species to all members of the group very difficult to do (Popper 2008).

3.6.1.5 Current Requirements and Practices

Mitigation measures, implemented for marine mammals and sea turtles, also offer protections to habitats associated with fish communities. Mitigation is discussed in more detail in Chapter 5.

3.6.2 Environmental Consequences

As noted in Section 3.6.1, the ROI for fish is the GOA TMAA, which is more than 12 nm (22 km) from the closest point of land. As such, this section distinguishes between U.S. territorial seas (shoreline to 12 nm) and nonterritorial seas, (seaward of 12 nm) for the purposes of applying the appropriate regulations (National Environmental Policy Act [NEPA] or Executive Order [EO] 12114) to analyze potential environmental effects. Environmental effects in the open ocean beyond the U.S. territorial seas are analyzed in this EIS/OEIS pursuant to EO 12114.

3.6.2.1 Approach to Analysis

This section describes potential environmental effects on fish associated with conducting naval activities for three alternative scenarios in the TMAA. The activities include active sonar activities; surface vessel, submarine, and aircraft warfare training activities; weapons firing; explosives ordnance use; nonexplosives ordnance use; electronic combat; and discharges of expendable materials. These activities are configured in various combinations to define seven warfare areas, as previously described in Chapter 2.

The effects on fish could include direct physical injury, such as potential for death, injury, or failure to reach (or an increase in the time needed to reach) the next developmental stage. Potential effects of fish eggs, larvae, and adult fish were evaluated in the analysis and results presented in the following subsections as well as a review of the literature regarding potential effects on fish common to most activities. These include warfare areas and environmental stressors, acoustic effects of underwater sounds to fish, effects of underwater impulsive sounds, explosive ordnance, nonexplosive ordnance, and expended materials.

<u>Regulatory Framework</u>

The primary laws that make up the regulatory framework for fish and EFH include the MSFCMA and the ESA. These, along with other applicable laws, are briefly described below:

Magnuson-Stevens Fishery Conservation and Management Act

The NPFMC manages the groundfish fisheries, while management of the salmon fisheries is deferred to the State of Alaska. All waters that support anadromous fish are considered EFH by NMFS (NPFMC 2008), while EFH for groundfish varies by species. For the purpose of this analysis, potential effects were considered to determine adverse impacts to EFH, and an EFH Assessment has been prepared for the TMAA.

Sustainable Fisheries Act

In 1996 (later amended in 2002 and 2006), the MSFCMA was reauthorized and amended by the Sustainable Fisheries Act (SFA). The SFA provides a new habitat conservation tool in the form of the EFH mandate. The EFH mandate requires that the regional FMCs, through federal FMP, describe and identify EFH for each federally managed species, minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitats. Authority to implement the SFA is given to the Secretary of Commerce through the NMFS. The SFA requires that the EFH be identified and described for each federally managed species. The SFA requires federal agencies to consult with the NMFS on activities that may adversely affect EFH. For actions that affect a threatened or endangered species, its critical habitat, and its EFH, federal agencies must initiate ESA and EFH consultations. Adverse effects mean any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 C.F.R. 600.810(a)).

Endangered Species Act

The ESA (16 U.S.C. §§ 1531 to 1543) established protection over and conservation of threatened and endangered species. The ESA applies to federal actions in two separate respects: the ESA requires that federal agencies, in consultation with the responsible wildlife agency, ensure that Proposed Actions are not likely to jeopardize the continued existence of any endangered species or threatened species, or result in the destruction or adverse modification of a critical habitat. Regulations implementing the ESA expand the consultation requirement to include those actions that “may affect” a listed species or adversely modify critical habitat.

If an agency’s Proposed Action would take a listed species, the agency must obtain an incidental take statement from the responsible wildlife agency. The ESA defines the term “take” to mean “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt any such conduct.”

Executive Order 12962

EO 12962 on Recreational Fisheries (60 Federal Register [FR] 30769) was enacted in 1995 to ensure that federal agencies strive to improve the “quantity, function, sustainable productivity, and distribution of U.S. aquatic resources” so that recreational fishing opportunities nationwide can increase. The primary goal of this order is to promote the conservation, restoration, and enhancement of aquatic systems and fish populations by increasing fishing access, education and outreach, and multiagency partnerships. The National Recreational Fisheries Coordination Council, co-chaired by the Secretaries of the Interior and Commerce, is charged with overseeing federal actions and programs that are mandated by this order.

Northern Pacific Halibut Act

The Northern Pacific Halibut Act of 1982 (16 U.S.C. §§ 773-773k) calls for the United States and Canada to implement the 1979 Protocol for the Preservation of the Halibut Fishery of the Northern Pacific Ocean and the Bering Sea. The Act provides for the appointment of U.S. Commissioners to the International Pacific Halibut Commission. In addition, the Act authorizes the NPFMC to develop regulations to limit access and govern the Pacific halibut catch in waters off Alaska. All Council action must be approved and implemented by the U.S. Secretary of Commerce.

National Fishery Enhancement Act

In 1984, Congress passed the National Fishery Enhancement Act (NFEA) (33 U.S.C. §§ 2101 et seq.) in recognition of the social and economic value of artificial reefs in enhancing fishery resources. Under this act, the Secretary of Commerce and the U.S. Army Corps of Engineers are charged with the responsibility for encouraging and regulating artificial reefs in the navigable waters of the United States. One of the primary directives of the NFEA was the preparation of a long-term National Artificial Reef Plan (33 U.S.C. §§ 2103).

Pacific Salmon Treaty

The Pacific Salmon Treaty (PST) of 1985 (16 U.S.C. §§ 3631 et seq.) was established between Canada and the United States to establish a framework for managing salmon populations between the two countries. The Treaty principles were to (a) prevent overfishing and provide for optimum production; and (b) provide equivalent production benefits from salmon originating from the respective country's waters. The Treaty requires the United States and Canada to meet international conservation and allocation objectives by taking into account ways of reducing interceptions and avoiding disruption of existing fisheries and stock abundances.

This Treaty also called for the establishment of the Pacific Salmon Commission (PSC), to oversee the implementation of the Treaty. The PSC is composed of representatives of both countries to provide regulatory and technical advice. Fisheries regulation is a shared responsibility of the United States and Canada.

On June 30, 1999, the following PST provisions were implemented: (a) establish abundance-based fishing regimes for Pacific salmon fisheries under the jurisdiction of the PSC; (b) create two bilaterally based funds to promote cooperation, improve fishery management, and aid stock and habitat enhancement. Additionally, the PST includes provisions to enhance bilateral cooperation, improve the scientific basis for salmon management, and apply institutional changes to the PSC.

Data Sources

A comprehensive and systematic review of relevant literature and data has been conducted in order to complete this analysis for fish and EFH. Of the available scientific literature (both published and unpublished), the following types of documents were utilized in the assessment: journals, books, periodicals, bulletins, Department of Defense (DoD) operations reports, EISs, and other technical reports published by government agencies, private businesses, consulting firms, or nongovernmental conservation organizations. The scientific literature was also consulted during the search for geographic location data on the occurrence of resources within the TMAA. The primary sources of information used to describe the affected environment for fish and EFH was the U.S. Pacific Fleet Marine Resource Assessment (MRA) for the GOA Operating Area (Department of Navy [DoN] 2006). The MRA report provides compilations of the most recent data and information on the occurrence of marine resources in the TMAA.

3.6.2.2 Assessment Framework

Impact Thresholds

This EIS/OEIS analyzes potential effects to fish and EFH in the context of the MSFCMA (federally managed species and EFH), ESA (species listed under the ESA only), and EO 12114. The factors used to assess the significance of effects vary under these Acts. Under the MSFCMA an "adverse affect" is defined as any impact that reduces the quality and/or quantity of EFH (NMFS 2004a, 2004b). The EFH regulations in 50 C.F.R. 600.815(a)(2)(ii) (NMFS 2002a) establish a threshold for determining adverse effects (NMFS 2002b). Adverse effects are more than minimal and not temporary in nature. Temporary effects are those that are limited in duration and allow the particular environment to recover without measurable impact (NMFS 2002b). Minimal effects are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions. To help identify Navy activities falling within the adverse effect determination, the Navy has determined that temporary or minimal impacts are not considered to "adversely affect" EFH (Chief of Naval Operations Instruction [OPNAVINST] 5090.1C). The EFH Final Rule (67 FR 2354) and 50 C.F.R. 600.815(a)(2)(ii) were used as guidance for this determination, as they highlight activities with impacts that are more than minimal and not temporary in nature, as opposed to those activities resulting in inconsequential changes to habitat. Whether an impact is minimal will depend on a number of factors:

- The intensity of the impact at the specific site being affected;
- The spatial extent of the impact relative to the availability of the habitat type affected;
- The sensitivity/vulnerability of the habitat to the impact;
- The habitat functions that may be altered by the impact (e.g., shelter from predators); and
- The timing of the impact relative to when the species or life stage needs the habitat.

The factors outlined above were also considered in determining the significance of effects under EO 12114. For purposes of ESA compliance, effects of the action were analyzed to make the Navy's determination of effect for listed species. The definitions used in making the determination of effect under Section 7 of the ESA are based on the USFWS and NMFS *Endangered Species Consultation Handbook* (USFWS 1998).

Warfare Areas and Associated Environmental Stressors

The Navy used a screening process to identify aspects of the Proposed Action that could act as stressors to fish and EFH. Navy subject matter experts de-constructed the warfare areas and activities included in the Proposed Action to identify specific activities that could act as stressors. Public and agency scoping comments, previous environmental analyses, previous agency consultations, laws, regulations, EOs, and resource-specific information were also evaluated. This process was used to focus the information presented and analyzed in the affected environment and environmental consequences sections of this EIS/OEIS. Potential stressors to fish and EFH include vessel movements (disturbance and collisions), aircraft overflights (disturbance), explosive ordnance, sonar training (disturbance), weapons firing/nonexplosive ordnance use (disturbance and strikes), and expended materials (ordnance-related materials, targets, sonobuoys, and marine markers).

Acoustic Effects of Underwater Sounds to Fish

There have been very few studies on the effects that human-generated sound may have on fish; these have been reviewed in a number of places (e.g., NRC, 1994, 2003; Popper 2003; Popper et al. 2004; Hastings and Popper 2005; Popper 2008), and some more recent experimental studies have provided additional insight into the issues (e.g., Govoni et al. 2003; McCauley et al. 2003; Popper et al. 2005, 2007). Most investigations, however, have been in the gray literature (non peer-reviewed reports – see Hastings and Popper 2005; and Popper 2008 for extensive critical reviews of this material). While some of these studies provide insight into effects of sound on fish, the majority of the gray literature studies often lack appropriate controls, statistical rigor, and/or expert analysis of the results.

There are a wide range of potential effects on fish that range from no effect at all (e.g., the fish does not detect the sound or it "ignores" the sound) to immediate mortality. In between these extremes are a range of potential effects that parallel the potential effects on marine mammals that were illustrated by Richardson et al. (1995). These include, but may not be limited to:

- No effect behaviorally or physiologically: The animal may not detect the signal, or the signal is not one that would elicit any response from the fish.
- Small and inconsequential behavioral effects: Fish may show a temporary "awareness" of the presence of the sound but soon return to normal activities.
- Behavioral changes that result in the fish moving from its current site: This may involve leaving a feeding or breeding ground. Some behavioral changes can result in lost feeding or reproduction opportunities, or make fish vulnerable to other stressors in the environment such as the presence of predators. This effect may be temporary, in that the fish return to the site after some period of time (perhaps after a period of acclimation or when the sound terminates), or permanent.
- Temporary loss of hearing (often called Temporary Threshold Shift – TTS): This recovers over minutes, hours, or days.
- Physical damage to auditory or nonauditory tissues (e.g., swim bladder, blood vessels, brain): The damage may be only temporary, and the tissue "heals" with little impact on fish survival, or it may be more long term, permanent, or may result in death. Death from physical damage could be a direct effect of the tissue damage or the result of the fish being more subject to predation than a healthy individual.

Studies on effects on hearing have generally been of two types. In one set of studies, the investigators exposed fish to long-term increases in background sound to determine if there are changes in hearing, growth, or survival of the fish. While data are limited to a few freshwater species, it appears that some increase in ambient sound level, even to above 170 dB re 1 μPa, does not permanently alter the hearing ability of the hearing generalist species studied, even if the increase in sound level is for an extended period of time. However, this may not be the case for all hearing generalists, though it is likely that any temporary hearing loss in such species would be considerably less than for specialists receiving the same sound exposure. It is critical to note that more extensive data are needed on additional species, and if there are places where the ambient levels exceed 170 to 180 dB, it would be important to do a quantitative study of effects of long-term sound exposure at these levels. It is also clear that there is a larger temporary hearing loss in hearing specialists. Again, however, extrapolation from the few freshwater species to other species (freshwater or marine) must be done with caution until there are data for a wider range of species, and especially species with other types of hearing specializations than those found in the species studied to date (all of which are otophysan fishes and have the same specializations to enhance hearing).

In the second type of studies, fish were exposed to short duration but high intensity signals such as might be found near a high intensity sonar, pile driving, or seismic air gun survey. The investigators in such studies were examining whether there was not only hearing loss and other long-term effects, but also short-term effects that could result in death to the exposed fish. Because study results vary, it is difficult to speculate why there are many differences in the studies, including species, precise sound source, and spectrum of the sound (Popper 2008).

One study tested effects of seismic air guns, a highly impulsive and intense sound source. This study demonstrated differences in the effects of air guns on the hearing thresholds of different species. In effect, these results substantiate the argument made by Hastings et al. (1996) and McCauley et al. (2003) that it is difficult to extrapolate between species with regard to the effects of intense sounds.

Another study examined the effects of Surveillance Towed Array Sensor System Low-Frequency Active (SURTASS LFA) sonar; this study determined there was no effect on ear tissue (Popper et al. 2007).

Other earlier studies suggested that there may be some loss of sensory hair cells due to high intensity sources. However, these studies did not concurrently investigate effects on hearing or nonauditory tissues (Enger 1981, Hastings et al. 1996). In neither study was the hair cell loss more than a relatively small percent of the total sensory hair cells in the hearing organs (Popper 2008).

Effects of Underwater Impulsive Sounds

Air gun studies on very few species resulted in a small hearing loss in several species, with complete recovery within 18 hours (Popper et al. 2005). Other species showed no hearing loss with the same exposure. There appeared to be no effects on the structure of the ear (Song et al., submitted), and a limited examination of nonauditory tissues, including the swim bladder, showed no apparent damage (Popper et al. 2005). One other study of effects of an air gun exposure showed some damage to the sensory cells of the ear (McCauley et al. 2003); it is difficult to differentiate these two studies. However, the two studies employed different methods of exposing fish, and used different species. Other studies have demonstrated some behavioral effects on fish during air gun exposure used in seismic exploration (e.g., Pearson et al. 1987, 1992; Engås et al. 1996; Engås and Løkkeborg 2002; Slotte et al. 2004), but the data are limited and it would be very difficult to extrapolate to other species, as well as to other sound sources.

Explosive Sources

A number of studies have examined the effects of explosives on fish; these are reviewed in detail in Hastings and Popper (2005). However, these studies are often variable, so extrapolation from one study to another, or to other sources, such as those used by the Navy, is not really possible. While many of these studies show that fish are killed if they are near the source, and there are some suggestions that there is a correlation between size of the fish and death (Yelverton et al. 1975), little is known about the very important issues of nonmortality damage in the short- and long-term, and nothing is known about effects on behavior of fish.

The major issue in explosives is that the gas oscillations induced in the swim bladder or other air bubble in fishes caused by high sound pressure levels can potentially result in tearing or rupturing of the chamber. This has been suggested to occur in some (but not all) species in several gray literature unpublished reports on effects of explosives (e.g., Aplin 1947, Coker and Hollis 1950, Gaspin 1975, Yelverton et al. 1975), whereas other published studies do not show such rupture (e.g., the peer reviewed study by Govoni et al. 2003). Key variables that appear to control the physical interaction of sound with fishes include the size of the fish relative to the wavelength of sound, mass of the fish, anatomical variation, and location of the fish in the water column relative to the sound source (e.g., Yelverton et al. 1975, Govoni et al. 2003).

Explosive blast pressure waves consist of an extremely high peak pressure with very rapid rise times (< 1 millisecond [ms]). Yelverton et al. (1975) exposed eight different species of freshwater fish to blasts of 1-pound (lb) spheres of Pentolite (high explosive) in an artificial pond. The test specimens ranged from 0.02 grams (g) (guppy) to 744 g (large carp) body mass and included small and large animals from each species. The fish were exposed to blasts having extremely high peak overpressures with varying impulse lengths. The investigators found what appears to be a direct correlation between body mass and the magnitude of the "impulse," characterized by the product of peak overpressure and the time it took the overpressure to rise and fall back to zero (units in pounds per square inch (psi)-ms), which caused 50 percent mortality (see Hastings and Popper 2005 for detailed analysis).

One issue raised by Yelverton et al. (1975) was whether there was a difference in lethality between fish which have their swim bladders connected by a duct to the gut and fish which do not have such an opening. The issue is that it is possible that a fish with such a connection could rapidly release gas from the swim bladder on compression, thereby not increasing its internal pressure. However, Yelverton et al. (1975) found no correlation between lethal effects on fish and the presence or lack of connection to the gut.

While these data suggest that fishes with both types of swim bladders are affected in the same way by explosive blasts, this may not be the case for other types of sounds, and especially those with longer rise or fall times that would allow time for a biomechanical response of the swim bladder (Hastings and Popper 2005). Moreover, there is some evidence that the effects of explosives on fishes without a swim bladder are less than those on fishes with a swim bladder (e.g., Gaspin 1975, Goertner et al. 1994, Keevin et al. 1997). Thus, if internal damage is, even in part, an indirect result of swim bladder (or other air bubble) damage, fishes without this organ may show very different secondary effects after exposure to high sound pressure levels. Still, it must be understood that the data on effects of impulsive sources and explosives on fish are limited in number and quality of the studies, and in the diversity of fish species studied. Thus, extrapolation from the few studies available to other species or other devices must be done with the utmost caution.

In a more recent published report, Govoni et al. (2003) found damage to a number of organs in juvenile pinfish (*Lagodon rhomboids*) and spot (*Leiostomus xanthurus*) when they were exposed to submarine detonations at a distance of 11.8 ft (3.6 m), and most of the effects, according to the authors, were sublethal. Effects on other organ systems that would be considered irreversible (and presumably lethal) only occurred in a small percentage of fish exposed to the explosives. Moreover, there was virtually no effect on the same sized animals when they were at a distance of 24.6 ft (7.5 m), and more pinfish than spot were affected.

Based upon currently available data it is not possible to predict specific effects of Navy impulsive sources on fish. At the same time, there are several results that are at least suggestive of potential effects that result in death or damage. First, there are data from impulsive sources such as pile driving and seismic air guns that indicate that any mortality declines with distance, presumably because of lower signal levels. Second, there is also evidence from studies of explosives (Yelverton et al. 1975) that smaller animals are more affected than larger animals. Finally, there is also some evidence that fish without an air bubble, such as flatfish and sharks and rays, are less likely to be affected by explosives and other sources than are fish with a swim bladder or other air bubble.

Yet, as indicated for other sources, the evidence of short- and long-term behavioral effects, as defined by changes in fish movement, etc., is nonexistent. Thus, it is unknown if the presence of an explosion or an impulsive source at some distance, while not physically harming a fish, will alter its behavior in any significant way.

Expended Materials

Falling Material and Small-Arms Rounds

Inert bombs, intact missiles, and targets could impact the water with great force and produce a large impulse and loud sound. Physical disruption of the water column by the shock wave and bubble pulse is a localized, temporary effect, and would be limited to within tens of meters of the impact area and would persist for a matter of minutes. Large objects hitting the water produce sounds with source levels on the order of 240 to 271 dB re 1 µPa and pulse durations of 0.1 to 2 ms, depending on the size of the object (McLennan 1997). Physical and chemical properties of seawater would be temporarily affected (e.g., increased oxygen concentrations due to turbulent mixing with the atmosphere), but there would be no lasting adverse effect on the water column habitat from this physical disruption. A remote possibility exists that some individual fish at or near the surface may be directly impacted (i.e., direct strike) if they are in the target area at the point of physical impact at the time of nonexplosive ordnance delivery. Therefore, effects of shock waves from inert bombs and intact missiles and targets hitting the water surface on fish are expected to be localized and minimal.

However, most missiles hit their target or are disabled before hitting the water. Thus, most of these missiles and aerial targets hit the water as fragments, which quickly dissipate their kinetic energy within a short distance from the surface. Similarly, expended small-arms rounds may also strike the water surface with sufficient force to cause injury. Most fish swim some distance below the surface of the water. Therefore, fewer fish are exposed to mortality from falling fragments whose effects are limited to the near surface, than mortality from intact missiles and targets whose effects can extend well below the water surface.

Munitions Constituents

Munitions constituents can be released from sonobuoys, targets, torpedoes, missiles, aerial targets, and at sea explosions. Petroleum hydrocarbons released during an accident are harmful to fish. Jet fuel is toxic to fish but floats and vaporizes very quickly. Assuming that a target disintegrates on contact with the water, any residual unburned fuel may be spread over a large area and dissipate quickly. In addition, fuel spills and material released from weapons and targets could occur at different locations and at different times.

Potential impacts from Navy explosives training include degradation of substrate and introduction of toxic chemicals into the water column. Combustion products from the detonation of high explosives—carbon monoxide (CO), carbon dioxide (CO_2), hydrogen (H_2), water (H_2O), nitrogen (N_2), and ammonia (NH_3)—are commonly found in sea water. The primary constituents that would be released from explosives training are nitroaromatic compounds such as trinitrotoluene (TNT), cyclonite (Royal Demolition Explosive or RDX), and octogen (High Melting Explosive or HMX) (URS 2000). Initial concentrations of explosion by-products are not expected to be hazardous to marine life (DoN 2001) and would not accumulate in the training area because exercises are spread out over time and the chemicals disperse in the ocean. The water quality effects of the explosions would be infrequent, temporary, and localized, and would have no long-term adverse effect on water quality. Effects on marine fish associated with the release of munitions constituents and other materials are expected to be minimal.

3.6.2.3 No Action Alternative

Under the No Action Alternative, baseline levels of activities would remain unchanged from current conditions. Fish would have the potential to be affected by vessel movement, aircraft overflights, explosive ordnance, nonexplosive ordnance use, weapons firing disturbance, and expended materials.

Vessel Movements

Many of the ongoing and proposed activities within the TMAA involve maneuvers by various types of surface vessels, most of which use propellers for propulsion. When moving, vessels generally displace water from the hull, and an even greater volume from propeller wash. Currently, approximately four Navy vessels will be operating in the TMAA, but the number can vary based on training schedules and scenarios. Activities involving vessel movements occur intermittently and are short in duration, generally a few hours in duration. These activities are widely dispersed throughout the TMAA, which is a vast area encompassing 42,146 square nm (nm^2) (144,557 square km [km^2]) of surface/subsurface ocean.

Vessel movements have the potential to expose fish to sound and general disturbance, which could result in short-term behavioral and/or physiological responses (swimming away, increased heart rate). Such responses would not be expected to compromise the general health or condition of individual fish. The probability of collisions between vessels and adult fish, which could result in injury or mortality, would be extremely low because this life stage is highly mobile and Navy vessel density in the TMAA is low. Vessel movements would result in short-term and localized disturbances to the water column, but benthic habitats would not be affected. Ichthyoplankton (fish eggs and larvae) in the upper portions of the water column could be displaced, injured, or killed by vessel and propeller movements. However, no measurable effects on fish recruitment would occur because the number of eggs and larvae exposed to vessel movements would be low relative to total ichthyoplankton biomass. Vessel movements under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with EO 11214, harm to fish populations or habitat from vessel movements in nonterritorial seas would be minimal under the No Action Alternative.

Aircraft Overflights

Aircraft overflights produce airborne sound and some of this energy would be transmitted into the water. However, sound does not transmit well from air to water. Predicted sound levels resulting from HC-130 aircraft flying at 1,000 ft (305 m) and 250 ft (76 m) were 110 and 121 dB re 1 µPa, respectively, directly under the flight path at a depth of 1 ft (maximum one-third octave level for frequencies 20 hertz [Hz]–5 kHz). The same sound levels resulting from an HH-60 helicopter flying at 1,000 ft (305 m), flying at 100 ft (30 m), and hovering 10 ft (3 m) were 110, 129, and 143 dB re 1 µPa (respectively) directly under the helicopter at a depth of 1 ft (0.3 m) (USAF 1999). The sound levels would decline at increasing lateral distances from the aircraft's track or location and with increasing depth in the water, and the underwater sounds originating from the aircraft would decline rapidly after the aircraft has passed. It is unlikely that these sound levels would cause physical damage or even behavioral effects in fish based on the sound levels that have been found to cause such effects. In addition to sound, helicopters flying at low levels can create a vertical down wash of air (rotor wash) that becomes a surface wind, which may disturb the water surface below the aircraft and displace any fishes in the general vicinity.

Such responses would not compromise the general health or condition of individual fish. Aircraft overflights under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under MSFCMA. In accordance with EO 11214, harm to fish populations or habitat from aircraft overflight movements in nonterritorial seas under the No Action Alternative would be minimal.

Explosive Ordnance

Explosions that occur under the No Action Alternative in the TMAA are associated with training exercises that use explosive ordnance, including bombs (BOMBEX), missiles (MISSILEX), and naval gun shells (GUNEX), 5-inch (in) high explosive rounds. Potential effects of explosive charge detonations on fish and EFH include disruption of habitat; exposure to chemical by-products; disturbance, injury, or death from the shock (pressure) wave; acoustic impacts; and indirect effects including those on prey species and other components of the food web.

Concern about potential fish mortality associated with the use of at-sea explosives led military researchers to develop mathematical and computer models that predict safe ranges for fish and other animals from explosions of various sizes (e.g., Yelverton et al. 1975, Goertner 1982, Goertner et al. 1994). Young's (1991) equations for 90-percent survivability were used to estimate fish mortality in the Seawolf Shipshock Trial EIS (DoN 1998). In that document, Yelverton's (1981) equations were used to predict survival of fish with swim bladders, although the equations apply to simple explosives, and may not apply to all the explosives used in the TMAA. The impulse levels that kill or damage fish with swim bladders have been determined empirically to be as follows (from Yelverton 1981):

- 50 percent Mortality $\ln(I)=3.6136 + 0.3201 \ln(M)$
- 1 percent Mortality $\ln(I)=3.0158 + 0.3201 \ln(M)$
- No Injuries $\ln(I)=2.0042 + 0.3201 \ln(M)$

Where I = impulse (in Pascal•seconds or Pa•s) and M = body mass of a fish (g) with a swim bladder.

Yelverton (1981) cautioned against using these equations for fish weighing more than a few kg because fish used in the experiments from which these equations were derived did not weigh more than 2.2 lb (1 kg). Young's parameters include the size of the fish and its location relative to the explosive source, but are independent of environmental conditions (e.g., depth of fish and explosive shot frequency). An example of such model predictions is shown in Table 3.6-4, which provides the radius of effect of various charges, depths, and fish size. The 10-percent mortality range is the distance beyond which 90 percent of the fish present would be expected to survive.

Table 3.6-4: Range of Effects for at-Sea Explosions

Charge	Charge Depth	Effect Criterion	Range of Effect
1 lb	9.8 ft (3.0 m)	10% Mortality	338 ft (103 m) for 1-ounce fish 180 ft (55 m) for 1-pound. fish 89 ft (27 m) for 30-pound fish
10 lbs	125 ft (38 m)	10% Mortality	656 ft (200 m) for 1-ounce fish 423 ft (129 m)s for 1-pound fish 259 ft (79 m) for 30-pound fish
20 lbs	62 ft (19 m)	10% Mortality	856 ft (261 m) for 1-ounce fish 554 ft (169 m) for 1-pound fish 348 ft (106 m) for 30-pound fish
20 lbs	125 ft (38 m)	10% Mortality	928 ft (283 m) for 1-ounce fish 597 ft (182 m) for 1-pound fish 364 ft (111 m) for 30-pound fish

Typically, BOMBEX at sea involve one or more aircraft bombing a target simulating a hostile surface vessel. Practice bombs entering the water would be devoid of combustion chemicals found in the warheads of explosive bombs, and would generate physical shock entering the water, but would not explode. After sinking to the bottom, the physical structure of bombs would be incorporated into the marine environment by natural encrustation and/or sedimentation (discussed later in Expended Materials Section). Air-to-ground bombing using explosive ordnance is mostly conducted on land ranges which are outside the scope of the ROI; however, some live bombs may be dropped at sea.

As with underwater detonations, the range within which fish may sustain injury or death from an exploding bomb would depend on environmental parameters, the size, location, and species of the fish, and its internal anatomy (e.g., whether it has a swim bladder) (DoN 2005). Fish without swim bladders are far more resistant to explosions than those with swim bladders (Keevin and Hempen 1997). Explosive bombs will be fused to detonate on contact with the water and it is estimated that 99 percent of them will explode within 5 ft (1.5 m) of the ocean surface (DoN 2005). Table 3.6-5, based on Young's (1991) model, displays 10-percent mortality (90-percent survival) ranges for the largest explosive bombs that may be deployed during at-sea exercises.

Table 3.6-5: Estimated Fish-Effects Ranges for Explosive Bombs

Warhead Weight NEW (lb-TNT)	10% Mortality Range by Weight of Fish		
	1 ounce	1 pound	30 pounds
500 lbs	1,289 ft (393 m)	899 ft (274 m)	578 ft (176 m)
1,000 lbs	1,343 ft (409 m)	937 ft (286 m)	602 ft (184 m)
2,000 lbs	1,900 ft (579 m)	1,325 ft (404 m)	852 ft (260 m)

Note: NEW = Net Explosive Weight

Potential effects from the use of Naval gun systems have been analyzed in a variety of environmental documents (DoN 2000, 2001, 2002, 2004, 2007). The 5-inch gun has the largest warhead fired during routine gunnery exercises. Most training uses nonexplosive 5-in rounds. The surface area of the ocean impacted by a nonexplosive 5-in round has been estimated to be 20 square in (in^2) (129 square cm [cm^2]) (DoN 2007). Considering the vast expanse of the TMAA, few fish would be directly struck by a shell from a 5-in gun.

Explosive rounds would have the greatest potential for impacts to fish in surface waters. As previously indicated, biological effects of at sea explosions depend on many factors, including the size, type, and depth of both the animal and the explosive, the depth of the water column, the standoff distance from the charge to the animal, and the sound-propagation properties of the environment. Potential impacts can range from brief acoustic effects, tactile perception, and physical discomfort, to slight injury to internal organs and the auditory system, to death of the animal (Keevin and Hempen 1997).

Table 3.6-6 provides an estimation of the potential range of lethal effects on swim bladder fish based on Young's (1991) model for five-in explosive projectiles. These rounds have a Net Explosive Weight (NEW) of TNT of approximately 8 lb (3.6 kg) and are assumed to detonate at a depth of 5 ft (1.3 m). Behavioral reactions of fish would extend over a substantially larger area. The overall impacts to water-column habitat would, however, be minor as fish would return following the activity. The abundance and diversity of fish and the quality and quantity of fish habitat within the range is unlikely to decrease as a result of gun fire training.

Table 3.6-6: Estimated Fish-Effects Ranges for 5-in Naval Gunfire Rounds

Weight of Fish	10% Mortality Range	
	feet	meters
1 ounce (28 g)	405	123
1 lb (0.4 kg)	282	86
30 lbs (13.6 kg)	181	55

Impacts to fish under the No Action Alternative from explosions would be possible, but these elements of the action are not expected to have measurable or detectable impacts to fish given the vast area encompassing the TMAA (42,146 nm^2 [144,557 km^2]); further reduced using conservative estimates assuming that activities occur across 20 percent of the TMAA (Table 3.6-7). While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of explosive ordnance use, explosions under the No Action Alternative would not result in impacts to fish populations based on the low number of fish that would be affected. Disturbances to the water column would be short-term and localized, while disturbance to benthic habitats from explosions would be unlikely due to the water depth where training activities occur. Habitat disturbance and fish injury and mortality from explosions are reduced by Navy mitigation measures, as discussed in Chapter 5. In accordance with EO

11214, harm to fish populations or habitat from explosive ordnance use in nonterritorial seas would be minimal under the No Action Alternative.

Table 3.6-7: Number of Explosive Ordnance Expended Annually in 20% of the TMAA for the No Action Alternative, Alternative 1, and Alternative 2

Ordnance	No Action Alternative		Alternative 1			Alternative 2		
	Number	Number per nm^2 (km^2)	Number	% Increase from No Action	Number per nm^2 (km^2)	Number	% Increase from No Action	Number per nm^2 (km^2)
Bombs	48	0.006 (0.002)	72	50%	0.009 (0.002)	166	246%	0.017 (0.005)
Naval Gunshells (5-inch/76 mm)	40	0.005 (0.001)	56	40%	0.007 (0.002)	112	180%	0.013 (0.004)
IEER Sonobuoys	0	0	40	NA	0.005 (0.001)	80	NA	0.009 (0.003)
SINKEX	0	0	0	NA	0	858	NA	0.102 (0.030)
Total	**88**	0.010 (0.003)	**168**	**91%**	0.020 (0.006)	**1,194**	**1,257%**	0.142 (0.041)

Weapons Firing Disturbance

When a gun is fired from a surface ship, a blast wave propagates away from the gun muzzle. When the blast wave meets the water, most of the energy is reflected back into the air, but some energy is transmitted into the water. A series of pressure measurements were taken during the firing of a 5-in gun aboard the *USS Cole* in June 2000 (Dahlgren 2000). The average peak pressure measured was about 200 dB re 1 µPa at the point of the air and water interface. Down-range peak pressure level, estimated for spherical spreading of the sound in water**,** would be 160 dB re 1 µPa at 328 ft (100 m) and 185 dB re 1 µPa at ~18 ft (5.5 m). The resulting ensonified areas (semi-circles with radius 328 ft [100 m] and 18 ft [5.5 m]) would be 0.004 nm^2 (0.015 km^2) and ~60 yd^2 (50 m^2), respectively.

Because effects to fish can occur from impulsive sounds greater than 180 dB (Popper et al. 2005), only those in the immediate vicinity (0.004 nm^2 [0.015 km^2] area) would be affected and effects would be limited to short-term, transitory alarm or startle responses. Since activities are infrequent (see Table 3.6-7) and widely dispersed throughout the TMAA, weapons firing under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. Furthermore, harm to fish populations or habitat from weapons firing disturbance movements in nonterritorial seas would be minimal in accordance with EO 11214.

Expended Materials

The Navy uses a variety of expended materials during training exercises conducted in the TMAA. The types and quantities of expended materials used and information regarding fate and transport of these materials within the marine environment are summarized in Table 3.6-8, and are discussed in Sections 3.2

(Expended Materials) and 3.3 (Water Resources). The analyses presented in these sections predict that the majority of the expended materials would rapidly sink to the sea floor, become encrusted by natural processes, and incorporated into the sea floor, with no significant accumulations in any particular area and no significant negative effects to water quality or marine benthic communities.

Table 3.6-8: Expended Training Materials in the TMAA – All Alternatives

Training Material	No Action Alternative	Alternative 1		Alternative 2	
	Number	Number	% Increase from No Action	Number	% Increase from No Action
Bombs	120	180	50%	360	200%
Missiles	22	33	50%	66	200%
Targets and Pyrotechnics	252	322	28%	644	160%
Naval Gunshells	10,564	13,188	25%	26,376	150%
Small Caliber Rounds	5,000	5,700	14%	11,400	128%
Sonobuoys	24	793	3,204%	1,587	6,513%
PUTR	0	7	NA	7	NA
SINKEX	0	0	NA	858	NA
Total	**15,982**	**20,223**	**26%**	**41,298**	**160%**
Number per nm^2 (km^2) within 20% of TMAA	**1.9 (0.5)**	**2.4 (0.7)**		**4.9 (1.4)**	

Nonexplosive Ordnance

Current Navy training activities in the TMAA such as MISSILEX, BOMBEX, and GUNEX include firing a variety of weapons and employ a variety of nonexplosive training rounds, including bombs, naval gun shells, cannon shells, and small caliber ammunition. These materials are used in the TMAA located in the open ocean beyond 20 nm (37 km). Direct ordnance strikes from firing weapons are potential stressors to fish.

Nonexplosive bombs and intact targets could impact the water with great force and produce a large impulse and loud sound. Physical disruption of the water column by the shock wave and bubble pulse is a localized, temporary effect, and would be limited to within tens of meters of the impact area and persist for a matter of minutes. Physical and chemical properties would be temporarily affected (e.g., increased oxygen concentrations due to turbulent mixing with the atmosphere), but there would be no lasting adverse effect on the water column habitat from this physical disruption.

Large objects hitting the water produce sounds with source levels on the order of 240 to 271 dB re 1 µPa and pulse durations of 0.1 to 2 ms, depending on the size of the object (McLennan 1997). Impulses of this magnitude could potentially injure fish. Because the rise times of these shock waves are very short, the impulses causing injury and mortality derived for explosive sources were used to estimate effects of shock pulses created by missile and target effects.

While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of a nonexplosive ordnance use, under the No Action Alternative, the total number of nonexplosive ordnance in the TMAA would be 15,770 items per year. Based on a TMAA size of 42,146 nm^2 (144,557 km^2) and conservatively assuming that activities occur across 20 percent of the TMAA, the concentration of expended ordnance would be 1.9 per nm^2 (0.5 per km^2). More than 97 percent of these items would be from gunshells and small caliber rounds. Based on the low density of use, nonexplosive ordnance use would not result in significant impacts to fish populations. Disturbances to the water column would be short-term and localized, while disturbance to benthic habitats would be unlikely due to the water depth where training activities are proposed. Nonexplosive ordnance use under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. Harm to fish populations or habitat from nonexplosive ordnance use in nonterritorial seas would be minimal in accordance with EO 11214.

The probability of fish ingesting expended ordnance would depend on factors such as the location of the spent materials, size of the materials, and the level of benthic foraging that occurs in the impact area, which is a function of benthic habitat quality, prey availability, and species-specific foraging strategies. It is possible that persistent expended ordnance could be colonized by benthic organisms, and mistaken for prey, or that expended ordnance could be accidentally ingested while foraging for natural prey items. As discussed in Section 3.2, no long-term impacts to water or sediment quality are anticipated from ordnance-related materials.

Ingestion of expended ordnance may affect individual fish; however, ordnance-related expended materials under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. Harm to fish populations or habitat from ordnance-related materials in nonterritorial seas would be minimal in accordance with EO 11214 under the No Action Alternative.

Target Related Materials

A variety of at-sea targets would be used in the TMAA, ranging from high-tech remotely operated airborne and surface targets (such as airborne drones) to low-tech floating at-sea targets (such as inflatable targets) and airborne towed banners. Many of the targets are designed to be recovered for reuse and are not destroyed during training. Under the No Action Alternative, LUU-2B/B illuminating flares, Tactical Air Launched Decoys (TALDs), Killer Tomatoes, BQM-74E unmanned aircraft, and MK-58 marine markers will not be recovered, resulting in approximately 1.53 tons (1,388 kg) of expended training materials. Floating nonhazardous expended material (e.g., Killer Tomato) will either degrade over time or wash ashore as flotsam, and pose no impact to fish.

Illuminating flares and marine markers are consumed during use. Smoke from marine markers rapidly diffuses by air movement. The MK-58 marine marker is approximately 2 ft (0.6 m) in length, and sinks to the bottom intact; these targets present no ingestion hazard to fish. It produces chemical flames and regions of surface smoke and are used in various training exercises to mark a surface position to simulate divers, ships, and points of contact on the surface of the ocean. The smoke dissipates in the air, having little effect on the marine environment. The marker itself is not designed to be recovered, and will eventually sink to the bottom and become encrusted or incorporated into the sediments. Phosphorus contained in the marker settles to the sea floor, where it reacts with the water to produce phosphoric acid until all phosphorus is consumed. Combustion of red phosphorus produces phosphorus oxides, which have a low toxicity to aquatic organisms. Red phosphorus released during training is not anticipated to substantially affect the marine environment (DoN 2006). Approximately 20 marine markers would be used in the TMAA under the No Action Alternative. Given the size of the TMAA and the low number of markers used, it would be very unlikely that fish would be affected by use of marine markers.

Under the No Action Alternative, eight TALDs would be used annually. TALDs operate as an expendable vehicle with no recovery capabilities, and use lithium sulfur dioxide batteries. An important component of the thermal battery is a hermetically-sealed casing of welded stainless steel 0.03- to 0.1-in thick that is resistant to the battery electrolytes. As discussed in Section 3.2, in the evaluation of the potential effects associated with seawater batteries, it is expected that in the marine environment, lithium potentially released from these batteries would be essentially nontoxic in seawater. Because of these factors, lithium batteries would not adversely affect fish.

The TALD will not result in any significant physical impacts to the sea floor, as it is unlikely that it would remain intact upon contact with the water. Therefore, small sections would be dispersed by currents prior to settling to the bottom. These pieces would sink into a soft bottom or would lie on a hard bottom, where they may provide a substrate for benthic colonization or eventually be covered by shifting sediments. Metal components are corroded by seawater at slow rates. Natural encrustation of exposed surfaces would eventually occur as invertebrates grow on the surfaces of the sunken objects. As the exterior becomes progressively more encrusted, the rates at which the metals will dissolve into the surrounding water will also decrease. Rates of deterioration would vary, depending on material and conditions in the immediate marine and benthic environment. Factors such as oxygen content, salinity, temperature, and pH all contribute to the manner and speed at which metals will dissolve. Over a period of years, the TALDs would degrade, corrode, and become encrusted or incorporated into the sediments, thus precluding adverse effects to fish.

The BQM-74E is a remote-controlled, subsonic, jet-powered aerial target that can be launched from the air or surface and recovered on land or at sea. It is powered by a jet engine, and thus contains oils, hydraulic fluid, batteries, and explosive cartridges. The hazardous materials of concern include propellant, petroleum products, metals, and batteries; however, the hazardous materials in aerial targets would be mostly consumed during training use.

As discussed in Section 3.2, expended seawater-activated batteries will not have a substantial impact to the environment because chemical reactions in batteries continue until battery life ends, with only a small amount of reactants remaining. Remaining chemicals will leach slowly, and will be diluted by ocean and tidal currents. Also discussed in Section 3.2, most target fragments will sink quickly in the sea. Expended material that sinks to the sea floor would gradually degrade, be overgrown by marine life, or be incorporated into bottom sediments. Floating nonhazardous expended material will either degrade over time or wash ashore as flotsam.

Chaff

Chaff consists of aluminum-coated polymer fibers inside of a launching mechanism. Upon deployment, the chaff and small pieces of plastic are expended. Chaff may be deployed mechanically or pyrotechnically. Mechanical deployment results in expended paper materials, along with the chaff. Pyrotechnic deployment uses a small explosive cartridge to eject the chaff from a small tube. Chaff fibers are widely dispersed on deployment. Chaff settling on the ocean surface may temporarily raise turbidity, but will quickly disperse with particles eventually settling to the ocean floor.

An extensive review of literature, combined with controlled experiments, revealed that chaff use pose little risk to the environment or animals (U.S. Air Force 1997, Naval Research Laboratory 1999). The materials in chaff are generally nontoxic except in quantities significantly larger than those any marine fish could reasonably be exposed to from normal usage. Particulate tests and a screening health risk assessment concluded that the concern about chaff breaking down into respirable particle sizes is not a significant issue. Experiments have shown that animals should not suffer toxic or physical effects from chaff ingestion (U.S. Air Force 1997, Naval Research Laboratory 1999). There is no published evidence that chaff exposure has caused the death of a marine fish, and experiments have shown no direct effects of chaff on marine animals (U.S. Air Force 1997, Naval Research Laboratory 1999), therefore no effects of chaff on fish are expected.

Sonobuoys

Under the No Action Alternative, 24 SSQ-36 Bathythermograph (BT) sonobuoys will be expended. The SSQ-36 BT is designed to record the thermal gradient of the water at various depths. The primary source of contaminants in each sonobuoy is the seawater battery; these batteries have a maximum operational life of 8 hours, after which the chemical constituents in the battery are consumed. As described in Section 3.2, the immediate water and sediment quality may be affected by chemical leaching from expended sonobuoys, but ocean and tidal current will quickly disperse chemicals to nontoxic levels.

Given the size of the TMAA and the low number of sonobuoys used, it would be very unlikely that fish would be affected by use of sonobuoys. Sonobuoy emissions are not anticipated to accumulate or result in additive effects on water or sediment quality as would occur within an enclosed body of water since the constituents of sonobuoys would be widely dispersed in space and time throughout training areas. In addition, dispersion of released metals and other chemical constituents due to currents near the ocean floor would help minimize any long-term degradation of water and sediment quality. Therefore, sonobuoy-related materials under the No Action Alternative may have a short-term and localized effect, but would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with EO 11214, harm to fish populations or habitat from sonobuoy related materials in nonterritorial seas would be minimal under the No Action Alternative.

Summary of Impacts from Expended Materials

Nonexplosive training round, target, sonobuoy, chaff, and marine marker use under the No Action Alternative may affect fish, but the effects would be minimal because these elements of the action are not expected to have measurable or detectable impacts to fish. Expended materials under the No Action Alternative would not result in adverse affects to fish populations or EFH as defined under the MSFCMA. In accordance with EO 11214, harm to fish populations or habitat from expended materials in nonterritorial seas would be minimal under the No Action Alternative.

Threatened and Endangered Species, and Critical Habitat

As discussed in Section 3.6.1.3, species of ESA-designated salmonids with known or potential occurrence in the TMAA include: Chinook, coho, chum, and sockeye salmon; and steelhead. No critical habitat (e.g., riparian, estuarine, nearshore marine, or offshore marine) occurs within the TMAA. However, impacts may occur to migratory juvenile or adult individuals, as discussed above for each activity. Based on analysis methods presented in Section 3.6.2, physical injury to salmonids could occur within the distances of an explosion shown in Tables 3.6-5 and 3.6-6. Fish injury and mortality from explosions are reduced by Navy protective measures, as discussed in Chapter 5. The Navy finds the activities associated with the No Action Alternative may affect the threatened salmonid species in the TMAA and the Navy is in Section 7 consultations with NMFS and results of the consultation will be incorporated into the Final EIS; however, no destruction or adverse modification of designated critical habitat would result from implementation of the No Action Alternative.

Essential Fish Habitat

This section discusses the potential impacts of the No Action Alternative to EFH and managed species. Species within all FMPs may utilize both nearshore and offshore areas during their lives, as eggs and larvae for most species are planktonic and can occur in nearshore and offshore waters, while adults may be present in nearshore and/or offshore waters. Therefore, all project activities under the No Action Alternative can potentially affect a lifestage of a managed species.

The proposed activities in the TMAA have the potential to result in the following impacts:

- Physical disruption of habitat;
- Physical destruction or adverse modification of benthic habitats;
- Alteration of water or sediment quality from expended material or discharge; and

- Cumulative impacts.

Effects to EFH could potentially result from vessel movements, aircraft overflights, explosive ordnance use, sonar activities, nonexplosive ordnance use, weapons firing disturbance, expended materials, and target related materials, all of which have been analyzed in the previous sections, and with a more focused analysis in a separate EFH Assessment. The analyses indicate that impacts to the water column habitat and fish would be short-term and localized, that adverse disturbance to benthic habitats would be unlikely due to the water depth where training activities occur, with the low probability of affecting HAPCs (see Section 3.5, Marine Plants and Invertebrates). Therefore, the No Action Alternative would not result in adverse affects to fish populations or EFH as defined under the MSFCMA.

3.6.2.4 Alternative 1

Under Alternative 1, the general level of some activities in the TMAA would increase relative to those under the No Action Alternative. In addition, training activities associated with force structure changes would be implemented for the EA-18G Growler, SSGN, P-8 MMA, DDG 1000, and UASs. Force structure changes associated with new weapons systems would include new sonobuoys. Force structure changes associated with new training instrumentation include the PUTR.

Vessel Movements

As described for the No Action Alternative, the number of Navy vessels operating during training activities varies, but generally includes up to seven surface ships and one submarine (collectively referred to as vessels). Under Alternative 1, steaming hours would increase from current conditions, although the increase in steaming hours would not measurably increase potential effects to fish. Disturbance impacts to fish from vessel movements under Alternative 1 would be the same as those described for the No Action Alternative.

Vessel movements under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with EO 11214 harm to fish populations or habitat from vessel movements in nonterritorial seas would be minimal under Alternative 1.

Aircraft Overflights

As described for the No Action Alternative, aircraft overflight responses would not compromise the general health or condition of individual fish or fish populations, and under Alternative 1, overflights would increase from current conditions. The increase in potential exposure to visual and sound disturbance would not measurably increase effects to fish. Thus, the impacts of overflights under Alternative 1 would be the same as those for the No Action Alternative.

Aircraft overflights under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under MSFCMA. In accordance with EO 11214, harm to fish populations or habitat from aircraft overflights in nonterritorial seas would be minimal under Alternative 1.

Explosive Ordnance

Explosive ordnance use would increase under Alternative 1 compared to the No Action Alternative (Table 3.6-7). In addition, Alternative 1 would include the use of the Improved Extended Echo Ranging (IEER) sonobuoys (IEER will be replaced by the Multi-Static Active Coherent [MAC] sonobuoy). Unlike other sonobuoys, IEER sonobuoys contain two Signal, Underwater Sound (SUS) explosive payloads (Class A) weighing 4.2 lb (1.9 kg) each. Explosive source sonobuoys could affect water quality by the release of explosive by-products, and could affect bottom habitats releasing chemicals (primarily from batteries) into the sediment. The sonobuoy explosive package consists primarily of HLX (i.e., explosive cord) and small amounts of plastic-bonded molding powder. Explosions create gaseous by-products, many of which travel to the surface and escape into the atmosphere. A small amount of the gas, however, dissolves into the water column. Although several by-products are produced, the products with greatest potential to result in toxicity are hydrogen fluoride compounds. However, only a minute amount of these substances are expected to be introduced, and they would be rapidly diluted by water movement. It is therefore considered unlikely that the explosive reactions associated with sonobuoys will result in localized impacts.

As described for the No Action Alternative, impacts to fish from explosions would be possible, but these elements of the action are not expected to have measurable or detectable impacts to fish given the vast area encompassing the TMAA (42,146 nm^2 [144,557 km^2]); impacts are further reduced using conservative estimates assuming that activities occur across 20 percent of the TMAA (Table 3.6-7). Habitat disturbance and fish injury and mortality from explosions are reduced by Navy mitigation measures, as discussed in Chapter 5. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of explosive ordnance use, explosions under Alternative 1 would not result in impacts to fish populations based on the low number of fish that would be affected. Disturbance to water column and benthic habitats from explosions would be short-term and localized. The effects of other expended materials in sonobuoys (e.g., batteries) are discussed in Section 3.2. In accordance with EO 11214, harm to fish populations or habitat from explosive ordnance use in nonterritorial seas would be minimal under Alternative 1.

Impacts to fish under the No Action Alternative from explosions would be possible, but because these elements of the action are not expected to have measurable or detectable impacts to fish given the vast area encompassing the TMAA (42,146 nm^2 [144,557 km^2]); impacts are further reduced using conservative estimates assuming that activities occur across 20 percent of the TMAA (Table 3.6-7).

Sonar

Effects to fish populations and EFH from sonar use could potentially result from acoustic impacts (Table 3.6-9). Anti-Submarine Warfare (ASW) exercises include training sonar operators to detect, classify, and track underwater objects and targets. There are two basic types of sonar: passive and active. Passive sonars only listen to incoming sounds and, since they do not emit sound energy in the water, lack the potential to acoustically affect the environment. Active sonars emit acoustic energy to obtain information about a distant object from the reflected sound energy. Active sonars are the most effective detection systems against modern, ultra-quiet submarines and sea mines in shallow water.

Table 3.6-9: Active Systems and Platforms Proposed for Use in the TMAA

System	Hours Modeled (Annual)		Associated Platform/Use
	Alt 1	Alt 2	
AN/SQS-53	289	578	DDG and CG hull-mounted sonar
AN/SQS-56	26	52	FFG hull-mounted sonar
AN/BQQ-10	24	48	Submarine hull-mounted sonar
AN/AQS-13 or AN/AQS-22	96	192	Helicopter dipping sonar
BQS-15	12	24	SSN navigation
PUTR Transponders	40	80	Portable Undersea Tracking Range
MK-84 Range Tracking Pingers	40	80	Ships, submarines, ASW targets
DICASS sonobuoy (AN/SSQ-62)	133	266	MPA deployed sonobuoys
IEER Sonobuoy (AN/SSQ-110A)	20	40	MPA deployed sonobuoys

Table 3.6-9: Active Systems and Platforms Proposed for Use in the TMAA (continued)

System	Hours Modeled (Annual)		Associated Platform/Use
	Alt 1	Alt 2	
MAC Sonobuoy (AN/SSQ-125)	20	40	MPA deployed sonobuoys
SUS, MK-84	12	24	Surface Ships and Aircraft
EMATT	6	12	Surface Ships and Aircraft

CG – Guided Missile Cruiser; DDG – Guided Missile Destroyer; FFG – Fast Frigate; DICASS – Directional Command-Activated Sonobuoy System; HF – High-Frequency; MF – Mid-Frequency.

Modern sonar technology has developed a multitude of sonar sensor and processing systems. In concept, the simplest active sonars emit acoustic pulses (“pings”) and time the arrival of the reflected echoes from the target object to determine range. More sophisticated active sonars emit a ping and then scan the received beam to provide directional as well as range information. Only about half of the Navy’s ships are equipped with active sonar and their use is generally limited to training and maintenance activities; 90 percent of sonar activity by the Navy is passive (DoN 2007).

Active sonars operate at different frequencies, depending on their purpose. High-frequency sonar (>10 kHz) is mainly used for establishing water depth, detecting mines, and guiding torpedoes. At higher frequencies, sound energy is greatly attenuated by scattering and absorption as it travels through the water. This results in shorter ranges, typically less than 5 nm (9.2 km). Mid-frequency sonar is the primary tool for identifying and tracking submarines. Mid-frequency sonar (1 kHz - 10 kHz) suffers moderate attenuation and has typical ranges of 1-10 nm (1.8-18.5 km). Low-frequency sonar (<1 kHz) has the least attenuation, achieving ranges over 100 nm (185 km). Low-frequency sonars are primarily used for long-range search and surveillance of submarines. SURTASS LFA is the U.S. Navy’s low-frequency sonar system (DoN 2001b); it employs a vertical array of 18 projectors using the 100-500 Hz frequency range.

Sonars used in ASW are predominantly in the mid-frequency range (DoN 2007). ASW sonar systems may be deployed from surface ships, submarines, and rotary and fixed wing aircraft. The surface ships are typically equipped with hull-mounted sonar but may tow sonar arrays as well. Helicopters are equipped with dipping sonar (lowered into the water). Helicopters and fixed wing aircraft may also deploy both active and passive sonobuoys and towed sonar arrays to search for and track submarines.

Submarines also use sonars to detect and locate other subs and surface ships. A submarine’s mission revolves around stealth, and therefore submarines use their active sonar very infrequently since the pinging of active sonar gives away their location. Submarines are also equipped with several types of auxiliary sonar systems for mine avoidance, for top and bottom soundings to determine the submarine’s position in the water column, and for acoustic communications. ASW training targets simulating submarines may also emit sonic signals through acoustic projectors.

Torpedoes use high-frequency, low-power, active sonar. Their guidance systems can be autonomous or electronically controlled from the launching platform through an attached wire. The autonomous guidance systems are acoustically based. They operate either passively, exploiting the emitted sound energy by the target, or actively, ensonifying the target and using the received echoes for tracking and targeting.

Military sonars for establishing depth and most commercial depth sounders and fish finders operate at high frequencies, typically between 24 and 200 kHz. Although low-frequency sonar is not proposed for use in the TMAA, the following text summarizes the types and potential impacts associated with the three main types of sonar.

Low-Frequency Sonar

Low-frequency sound travels efficiently in the deep ocean and is used by whales for long-distance communication (Richardson et al. 1995; NRC 2003, 2005). Concern about the potential for low-frequency sonar (<1 kHz) to interfere with cetacean behavior and communication has prompted extensive debate and research (DoN 2001b, 2007; NRC 2000, 2003).

Some studies have shown that low-frequency sound will alter the behavior of fish. For example, research on low-frequency devices used to deter fish away from turbine inlets of hydroelectric power plants showed stronger avoidance responses from sounds in the infrasound range (5-10 Hz) than from 50 and 150 Hz sounds (Knudsen et al. 1992, 1994). In test pools, wild salmon exhibit an apparent avoidance response by swimming to a deeper section of the pool when exposed to low-frequency sound (Knudsen et al. 1997).

Turnpenny et al. (1994) reviewed the risks to marine life, including fish, of high intensity, low-frequency sonar. Their review focused on the effects of pure tones (sine waves) at frequencies between 50 Hz and 1 kHz. Johnson (2001) evaluated the potential for environmental impacts of employing the SURTASS LFA sonar system. While concentrating on the potential effects on whales, the analysis did consider the potential effects on fish, including bony fish and sharks. It appears that the swimbladders of most fish are too small to resonate at low frequencies and that only large pelagic species such as tunas have swimbladders big enough to resonate in the low-frequency range. However, investigations by Sand and Hawkins (1973) and Sand and Karlsen (1986) revealed resonance frequencies of cod swim bladders from 2 kHz down to 100 Hz.

Popper et al. (2005, 2007) investigated the impact of Navy SURTASS LFA sonar on hearing and on nonauditory tissues of several fish species. In this study, three species of fish in Plexiglass cages suspended in a freshwater lake were exposed to high-intensity LFA sonar pulses for periods of time considerably longer than likely LFA exposure. Results showed no mortality and no damage to body tissues either at the gross or histological level. Some individuals exhibited temporary hearing loss but recovered within several days of exposure. The study suggests that SURTASS LFA sonar does not kill or damage fish even in a worst case scenario.

Mid-Frequency Sonar

ASW training activities use mid-frequency (1-10 kHz) sound sources. Most fish only detect sound within the 1 to 3 kHz range (Popper 2003, Hastings and Popper 2005). Thus, it is expected that most fish species would be able to detect the ASW mid-frequency sonar at the lower end of its frequency range.

Some investigations have been conducted on the effect on fish of acoustic devices designed to deter marine mammals from gillnets (Gearin et al. 2000, Culik et al. 2001). These devices generally have a mid-frequency range, similar to the sonar devices that would be used in ASW exercises. Adult sockeye salmon exhibited an initial startle response to the placement of inactive acoustic alarms designed to deter harbor porpoise. The fish resumed their normal swimming pattern within 10 to 15 seconds. After 30 seconds, the fish approached the inactive alarm to within 1 ft. (30 cm). The same experiment was conducted with the alarm active. The fish exhibited the same initial startle response from the insertion of the alarm into the tank; however, within 30 seconds, the fish were swimming within 1 ft. (30 cm) of the active alarm. After 5 minutes of observation, the fish did not show any reaction or behavior change except for the initial startle response. This demonstrated that the alarms were either inaudible to the fish, or the fish were not disturbed by the mid-frequency sound.

Jørgensen et al. (2005) carried out experiments examining the effects of mid-frequency (1 to 6.5 kHz) sound on survival, development, and behavior of fish larvae and juveniles. Experiments were conducted on the larvae and juveniles of Atlantic herring, Atlantic cod, saithe (*Pollachius virens),* and spotted wolfish (*Anarhichas minor)*. Swimbladder resonance experiments were attempted on juvenile Atlantic herring, saithe, and Atlantic cod. Sound exposure simulated Naval sonar signals. These experiments did not cause any significant direct mortality among the exposed fish larvae or juveniles, except in two (of a total of 42) experiments on juvenile herring where significant mortality (20 to 30 percent) was observed. Among fish kept in tanks 1 to 4 weeks after sound exposure, no significant differences in mortality or growth related parameters (length, weight, and condition) between exposed groups and control groups were observed. Some incidents of behavioral reactions were observed during or after the sound exposure: “panic” swimming or confused and irregular swimming behavior. Histological studies of organs, tissues, or neuromasts from selected Atlantic herring experiments did not reveal obvious differences between control and exposed groups.

The work of Jørgensen et al. (2005) was used in a study by Kvadsheim and Sevaldsen (2005) to examine the possible “worst case” scenario of sonar use over a spawning ground. They conjectured that normal sonar operations would affect less than 0.06 percent of the total stock of a juvenile fish of a species, which would constitute less than 1 percent of natural daily mortality. However, these authors did find that the use of continuous-wave transmissions within the frequency band corresponding to swim bladder resonance will escalate this impact by an order of magnitude. The authors therefore suggested that modest restrictions on the use of continuous-wave transmissions at specific frequencies in areas and at time periods when there are high densities of Atlantic herring present would be appropriate.

The results of several studies have indicated that acoustic communication and orientation of fish, in particular of hearing specialists, may be limited by sound regimes in their environment (Wysocki and Ladich 2005). Most marine fish are hearing generalists, though a few have been shown to detect sounds in the mid-frequency and ultrasonic range. While these species can detect mid-frequency sounds, their best hearing sensitivities are not in the mid-frequency range. If a sound is at the edge of a fish’s hearing range, the sound must be louder in order for it to be detected than if in the more sensitive range.

Experiments on fish classified as hearing specialists (but not those classified as hearing generalists) have shown that exposure to loud sound can result in temporary hearing loss, but it is not evident that this may lead to long-term behavioral disruptions in fish that are biologically significant (Amoser and Ladich 2003, Smith et al. 2004a,b). There is no information available that suggests that exposure to nonimpulsive acoustic sources results in fish mortality.

In summary, while some marine fish may be able to detect mid-frequency sounds, most marine fish are hearing generalists and have their best hearing sensitivity below mid-frequency sonar. If they occur, behavioral responses would be brief, reversible, and not biologically significant. Sustained auditory damage is not expected. Sensitive life stages (juvenile fish, larvae and eggs) very close to the sonar source may experience injury or mortality, but area-wide effects would likely be minor. The use of Navy mid-frequency sonar would not compromise the productivity of fish or adversely affect their habitat.

High-Frequency Sonar

Although most fish cannot hear sound frequencies over 10 kHz, some shad and herring species can detect sounds in the ultrasonic range, i.e., over 20 kHz. (Mann et al. 2001, Higgs et al. 2004). Ross et al. (1996) reviewed the use of high-frequency sound to deter alewives from entering power station inlets and suggested that impingement of alewives was reduced by 81–84%. The alewife, a member of the shad family (Alosinae) which can hear sounds at ultrasonic frequencies (Mann et al. 2001), uses high-frequency hearing to detect and avoid predation by cetaceans. Wilson and Dill (2002) demonstrated that exposure to broadband sonar-type sounds with high frequencies cause behavioral modification in Pacific herring.

Since high-frequency sound attenuates quickly in water, high levels of sound from mine hunting sonars would be restricted to within a few meters of the source. Even for fish able to hear sound at high frequencies, only short-term exposure would occur, thus high-frequency military sonars are not expected to have significant effects on resident fish populations.

Because a torpedo emits sonar pulses intermittently and is traveling through the water at a high speed, individual fish would be exposed to sonar from a torpedo for a brief period. At most, an individual animal would hear one or two pings from a torpedo and would be unlikely to hear pings from multiple torpedoes over an exercise period. Most fish hear best in the low- to mid-frequency range and, therefore, are unlikely to be disturbed by torpedo pings.

The effects of high-frequency sonar on fish behavior for species that can hear high-frequency sonar would be transitory and of little biological consequence. Most species would probably not hear these sounds and would therefore experience no disturbance.

Conclusion – Sonar Use

While the impact of anthropogenic sound on marine mammals has been extensively studied, the effects of sound on fish are largely unknown (Popper 2003, Hastings and Popper 2005, Popper 2008). There is a dearth of empirical information on the effects of exposure to sound, let alone sonar, for the vast majority of fish. The few studies on sonar effects have focused on behavior of individuals of a few species and it is unlikely their responses are representative of the wide diversity of other marine fish species (Jorgensen et al. 2005). The literature on vulnerability to injury from exposure to loud sounds is similarly limited, relevant to particular species, and, because of the great diversity of fish, not easily extrapolated. More well-controlled studies are needed on the hearing thresholds for fish species and on temporary and permanent hearing loss associated with exposure to sounds. The effects of sound may not only be species specific, but also depend on the mass of the fish (especially where any injuries are being considered) and life history phase (eggs and larvae may be more or less vulnerable to exposure than adult fish). The use of sounds during spawning by some fish, and their potential vulnerability to masking by anthropogenic sound sources, also requires further investigation. No studies have established effects of cumulative exposure of fish to any type of sound or have determined whether subtle and long-term effects on behavior or physiology could have an impact upon survival of fish populations. The use of sounds during spawning by some fish and their potential vulnerability to masking by anthropogenic sound sources requires closer investigation.

With these caveats and qualifications in mind, the limited information currently available suggests that populations of fish are unlikely to be affected by the projected rates and areas of use of military sonar. Most fish species would be able to detect mid-frequency sonar at the lower end of its range. Short-term behavioral responses such as startle and avoidance may occur, but are not likely to adversely affect indigenous fish communities. Auditory damage from sonar signals is not expected and there is no indication that nonimpulsive acoustic sources would result in fish mortality. Thus, sonar use in TMAA training is not anticipated to result in adverse affects to fish populations or EFH as defined under the MSFCMA. In accordance with EO 11214, harm to fish populations or habitat from sonar use movements in nonterritorial seas would be minimal under Alternative 1.

Weapons Firing Disturbance

Under Alternative 1, weapons firing activities would increase by 40 percent (Table 3.6-7), but because fish apparently only react to impulsive sounds greater than 160 dB, only those in the immediate vicinity

(0.004 nm^2 [0.015 km^2] area) would be affected and effects would be limited to short-term, transitory alarm or startle responses. Since activities are infrequent and widely dispersed throughout the TMAA, the impacts to fish would be the same as those described for the No Action Alternative.

Under Alternative 1, weapons firing may affect fish, but this effect would be minimal. Weapons firing under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. Furthermore, harm to fish from weapons firing would not be likely in nonterritorial seas in accordance with EO 12114.

Expended Materials

Under Alternative 1, the total number of expended ordnance in the TMAA would be 20,223 items per year, an increase of 26 percent. Based on an open ocean area of 42,146 nm^2 (144,557 km^2) and conservatively assuming that activities occur across 20 percent of the TMAA, 2.4 items per nm^2 (0.07 per km^2) per year would be deposited in the ocean (see Table 3.6-8). More than 93 percent of these items would be from gunshells and small caliber rounds.

The increase in potential exposure would not measurably increase effects to fish. Given the large area of the TMAA and low concentration of expended materials, with no potential for long-term degradation of water and sediment quality (See Section 3.2, Expended Materials, and 3.3, Water Resources), the impacts to fish would be the same as those described for the No Action Alternative. Similarly, ingestion of expended materials is possible, but has a low potential for occurrence, as described for the No Action Alternative. Habitat disturbance and fish injury and mortality from expended materials use are reduced by Navy mitigation measures, as discussed in Chapter 5. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of expended materials contacting the ocean surface, implementation of Alternative 1 would not result in impacts to fish populations based on the low number of fish that would be affected. Disturbances to water column and benthic habitats from expended materials would be short-term and localized.

Expended materials under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with EO 11214, harm to fish populations or habitat from expended materials in nonterritorial seas would be minimal under Alternative 1.

Portable Undersea Tracking Range

The PUTR is a self-contained, portable, undersea tracking capability that employs modern technologies to support coordinated undersea warfare training for Forward Deployed Naval Forces (FDNF). PUTR will be available in two variants to support both shallow and deep water remote activities in keeping with Navy requirements to exercise and evaluate weapons systems and crews in the environments that replicate the potential combat area. The system will be capable of tracking submarines, surface ships, weapons, targets, and Unmanned Underwater Vehicles (UUVs) and distribute the data to a data processing and display system, either aboard ship, or at a shore site.

No area supporting a PUTR system has been identified; however, potential impacts to EFH can be assessed based on several assumptions. Assuming that transponders are deployed on soft-bottom habitats, impacts would be similar to those discussed for expended materials. There would be direct impact to soft bottom habitat where the clump weight contacted the bottom, which may result in localized mortality to epifauna and infauna within the footprint, although it is anticipated that recolonization would occur within a relatively short period of time. Upon completion of the exercise, the transponders are recovered, which eliminates any potential impacts associated with hazardous materials such as batteries and electronic components. The clump weight is not recovered, and since it is composed of inert material, it is not a potential source of contaminants, and could provide a substrate for benthic fauna. There may also be indirect effects associated with increased turbidity due to resuspension of sediments from the clump weight contacting the bottom. The turbidity plume is expected to be localized and temporary, as sediment would eventually settle to the ocean floor or be dispersed by ocean currents. Therefore, localized and temporary impacts to benthic fauna, water quality, and EFH may occur from the PUTR, but no long-term adverse impact is anticipated.

Threatened and Endangered Species and Critical Habitat

As discussed in Section 3.6.1.3, species of ESA-designated salmonids with known or potential occurrence in the TMAA include Chinook, coho, chum, and sockeye salmon; and steelhead. No critical habitat (e.g., riparian, estuarine, nearshore marine, or offshore marine) occurs within the TMAA. However, impacts may occur to migratory juvenile or adult individuals, as discussed for No Action Alternative. Based on analysis methods presented in Section 3.6.2, physical injury to salmonids could occur within the distances of an explosion shown in Tables 3.6-5 and 3.6-6. Fish injury and mortality from explosions are reduced by Navy protective measures, as discussed in Chapter 5.

Pursuant to the ESA, Section 7, the Navy finds the activities associated with Alternative 1 may affect the threatened salmonid species in the TMAA; the Navy is in Section 7 consultations with NMFS and results of the consultation will be incorporated into the Final EIS. No destruction or adverse modification of designated critical habitat would result from implementation of Alternative 1.

Essential Fish Habitat

Under Alternative 1, the level of activities in the TMAA would increase relative to the baseline No Action Alternative. However, these increases would not measurably increase potential effects to EFH. The EFH assessment concludes that vessel movements, aircraft overflights, explosive ordnance use, sonar activities, weapons firing disturbance, expended materials, and target related materials under Alternative 1 would not result in adverse affects to fish populations or EFH as defined under the MSFCMA.

3.6.2.5 Alternative 2

Implementation of Alternative 2 would include all elements of Alternative 1 (accommodating training activities currently conducted, increasing specific training activities to include the use of active sonar, and accommodating force structure changes). In addition, under Alternative 2 the following activities would occur:

- Conduct one additional separate summertime CSG exercise lasting up to 21 days within the ATA.
- Conduct a SINKEX in each summertime exercise (a maximum of 2) in the TMAA.

Vessel Movements

As described for the other alternatives, the number of Navy vessels operating during training exercises varies and would average eight vessels per activity. Under Alternative 2, steaming hours would increase from current conditions, although the increase in steaming hours would not measurably increase potential effects to fish. Disturbance impacts to fish from vessel movements under Alternative 2 would be the same as those described for the No Action Alternative.

Vessel movements under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. Furthermore, harm to fish populations or habitat from vessel movements in nonterritorial seas would be minimal in accordance with EO 11214.

Aircraft Overflights

As described for the No Action Alternative, aircraft overflight responses would not compromise the general health or condition of individual fish or fish populations, and under Alternative 2, overflights would increase from current conditions. The increase in potential exposure to visual and sound disturbance would not measurably increase effects to fish. Thus, the impacts of overflights under Alternative 2 would be the same as those for the No Action Alternative.

Aircraft overflights under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under MSFCMA. Furthermore, harm to fish populations or habitat from aircraft overflights in nonterritorial seas would be minimal in accordance with EO 11214.

Explosive Ordnance

Explosive ordnance use would increase under Alternative 2 compared to the No Action Alternative (Table 3.6-7). And similar to Alternative 1, Alternative 2 would include the use of the IEER sonobuoy. As described for the No Action Alternative, impacts to fish from explosions would be possible, but these elements of the action are not expected to have measurable or detectable impacts to fish given the vast area encompassing the TMAA (42,146 nm^2 [144,557 km^2]); impacts are further reduced using conservative estimates assuming that activities occur across 20 percent of the TMAA (Table 3.6-7). Habitat disturbance and fish injury and mortality from explosions are reduced by Navy mitigation measures, as discussed in Chapter 5. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of explosive ordnance use, explosions under Alternative 2 would not result in impacts to fish populations based on the low number of fish that would be affected. Disturbances to water column and benthic habitats from explosions would be short-term and localized. The effects of other expended materials in sonobuoys are discussed in Section 3.2.

Sonar

Under Alternative 2, sonar would have the potential to affect fish in the TMAA. Most fish species would be able to detect mid-frequency sonar at the lower end of their range. Short-term behavioral responses such as startle and avoidance may occur, but are not likely to adversely affect indigenous fish communities. Auditory damage from sonar signals is not expected and there is no indication that nonimpulsive acoustic sources result in fish mortality. Sonar use under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. Furthermore, harm to fish populations or habitat from sonar use in nonterritorial seas would be minimal in accordance with EO 11214.

Weapons Firing Disturbance

Under Alternative 2, weapons firing activities would increase by 180 percent (Table 3.6-7), but because fish apparently only react to impulsive sounds greater than 160 dB, only those in the immediate vicinity (0.015 km^2 area) would be affected and effects would be limited to short-term, transitory alarm or startle responses. Since activities are infrequent and widely dispersed throughout the TMAA, the impacts to fish would be the same as those described for the No Action Alternative.

Under the Alternative 2, weapons firing may affect fish, but this affect would be minimal. Weapons firing under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. Furthermore, harm to fish from weapons firing would not be likely in nonterritorial seas in accordance with EO 12114.

Expended Materials

Under Alternative 2, expended materials in the TMAA would increase approximately 160 percent over the No Action Alternative (see Table 3.6-8). Based on an open ocean area of 42,146 nm^2 (144,557 km^2) and conservatively assuming that activities occur across 20 percent of the TMAA, 4.9 items per nm^2 (1.4 per km^2) per year would be deposited in the ocean. More than 91 percent of these items would be from gunshells and small caliber rounds. Despite the increase in expended materials, given the large area of the TMAA and low concentration of expended materials, with no potential for long-term degradation of water and sediment quality (See Section 3.2, Expended Materials, and 3.3, Water Resources), the impacts to fish would be the same as those described for the No Action Alternative.

Under Alternative 2, ingestion of expended materials is possible, but has a low potential for occurrence, as described for the No Action Alternative. Expended materials under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. Furthermore, harm to fish populations or habitat from expended materials in nonterritorial seas would be minimal in accordance with EO 11214.

Portable Undersea Tracking Range

Under Alternative 2, impacts from the PUTR would be similar to those described for Alternative 1, with localized and temporary impacts to benthic fauna, water quality, and EFH, but no long-term adverse impacts are anticipated.

SINKEX

Under Alternative 2, a SINKEX is typically conducted by aircraft, surface ships, and submarines in order to take advantage of a full size ship target and an opportunity to fire live weapons. The target is typically a decommissioned combatant or merchant ship that has been made environmentally safe for sinking according to standards set by the U.S. Environmental Protection Agency (USEPA). It is placed in a specific location that is greater than 50 nm (93 km) out to sea and in water depths greater than 6,000 ft (1,830 m) (40 C.F.R. § 229.2) so that when it sinks it will serve another purpose, such as a reef, or be in deep water where it will not be a navigation hazard to other shipping. Ship, aircraft, and submarine crews typically are scheduled to attack the target with coordinated tactics and deliver live ordnance to sink the target.

Aspects of the exercise that have potential effects on fish are vessel movement, aircraft overflights, active sonar, surface firing noise, shock waves from munitions hitting the water, munitions constituents, missile launches, shock waves, underwater detonations, and presence of expended materials (fragments of missiles and bombs). These stressors have been analyzed separately in previous sections, and while serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of several of these stressors (e.g., explosive ordnance), SINKEX under Alternative 2 would not result in impacts to fish populations based on the low number of fish that would be affected. Disturbances to water column and benthic habitats from SINKEX would be short-term and localized (See Section 3.5).

Threatened and Endangered Species and Critical Habitat

As discussed in Section 3.6.1.3, species of ESA-designated salmonids with known or potential occurrence in the TMAA include Chinook, coho, chum, and sockeye salmon; and steelhead. No critical habitat (e.g., riparian, estuarine, nearshore marine, or offshore marine) occurs within the TMAA. However, impacts may occur to migratory juvenile or adult individuals, as discussed for No Action Alternative. Based on analysis methods presented in Section 3.6.2, physical injury to salmonids could occur within the distances of an explosion shown in Tables 3.6-5 and 3.6-6. Fish injury and mortality from explosions are reduced by Navy protective measures, as discussed in Chapter 5.

Pursuant to the ESA, Section 7, the Navy finds the activities associated with Alternative 2 may affect the threatened salmonid species in the TMAA; the Navy is in Section 7 consultations with NMFS and results of the consultation will be incorporated into the Final EIS. No destruction or adverse modification of designated critical habitat would result from implementation of Alternative 2.

Essential Fish Habitat

Under Alternative 2, the level of activities in the TMAA would increase relative to the baseline No Action Alternative. However, these increases would not measurably increase potential effects to EFH. The EFH assessment concludes that vessel movements, aircraft overflights, explosive ordnance use, sonar activities, weapons firing disturbance, expended materials, and target-related materials under Alternative 2 would not result in adverse affects to fish populations or EFH as defined under the MSFCMA.

3.6.3 Mitigation

As summarized in Section 3.6.4, the alternatives proposed in the EIS/OEIS would be expected to affect individual fish and have localized effects on their habitats, but would not affect communities or populations of species or their use of the TMAA. The current protective measures described in Chapter 5 would continue to be implemented, and no further mitigation measures would be needed to protected fish in the TMAA.

3.6.4 Summary of Effects by Alternative

Table 3.6-10 summarizes the effects of the No Action Alternative, Alternative 1, and Alternative 2 on fish and EFH under both NEPA and EO 12114.

Table 3.6-10: Summary of Effects by Alternative

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
No Action Alternative	• Overflights would not adversely affect fish populations or EFH as defined under the MSFCMA. See page 3.6-30.	• Vessel movement, aircraft overflight, weapons firing disturbance, and expended materials would result in minimal harm to fish or EFH. Given the TMAA size and using conservative estimates, the concentration of expended materials would be 1.9 per nm^2 (0.5 per km^2). More than 97 percent of these items would be from gunshells and small caliber rounds. See pages 3.6-30 to 3.6-37. • Explosive ordnance use may result in injury or mortality to individual fish but would not result in impacts to fish populations. Given the TMAA size and using conservative estimates, the concentration of explosive ordnance would be 0.010 per nm^2 (0.003 per km^2). See pages 3.6-30 to 3.6-33. • Activities would not adversely affect fish populations or EFH as defined under the MSFCMA. See page 3.6-37. • May affect threatened and endangered species. See page 3.6-37. • No effect to designated critical habitat. See page 3.6-37.

Table 3.6-10: Summary of Effects by Alternative (continued)

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
Alternative 1	• Overflights would not adversely affect fish populations or EFH as defined under the MSFCMA. See page 3.6-38.	• Vessel movement, aircraft overflight, weapons firing disturbance, and expended materials would result in minimal harm to fish or EFH. Given the TMAA size and using conservative estimates, the concentration of expended materials would be 2.4 per nm^2 (0.7 per km^2). More than 93 percent of these items would be from gunshells and small caliber rounds. See pages 3.6-38 to 3.6-44. • Explosive ordnance use may result in injury or mortality to individual fish but would not result in impacts to fish populations. Given the TMAA size and using conservative estimates, the concentration of explosive ordnance would be 0.020 per nm^2 (0.006 per km^2). See pages 3.6-38 to 3.6-39. • Because only a few species of fish may be able to hear the relatively higher frequencies of mid-frequency sonar, sonar used in Navy exercises would result in minimal harm to fish or EFH. See pages 3.6-39 to 3.6-43. • Activities would not adversely affect fish populations or EFH as defined under the MSFCMA. See page 3.6-45. • May affect threatened and endangered species. See page 3.6-45. • No effect to designated critical habitat. See page 3.6-45.

Table 3.6-10: Summary of Effects by Alternative (continued)

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
Alternative 2 (Preferred Alternative)	• Overflights would not adversely affect fish populations or EFH as defined under the MSFCMA. See page 3.6-45.	• Vessel movement, aircraft overflight, weapons firing disturbance, and expended materials would result in minimal harm to fish or EFH. Given the TMAA size and using conservative estimates, the concentration of expended materials would be 4.9 per nm^2 (1.4 per km^2). More than 91 percent of these items would be from gunshells and small caliber rounds. See pages 3.6-45 to 3.6-47. • Explosive ordnance use may result in injury or mortality to individual fish but would not result in impacts to fish populations. Given the TMAA size and using conservative estimates, the concentration of explosive ordnance would be 0.142 per nm^2 (0.041 per km^2). See page 3.6-46. • Because only a few species of fish may be able to hear the relatively higher frequencies of mid-frequency sonar, sonar used in Navy exercises would result in minimal harm to fish or EFH. See page 3.6-46. • Activities would not adversely affect fish populations or EFH as defined under the MSFCMA. See page 3.6-48. • May affect threatened and endangered species. See page 3.6-47. • No effect to designated critical habitat. See page 3.6-47.

3.7 SEA TURTLES

3.7.1 Affected Environment

For the purposes of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the region of influence (ROI) for sea turtles is the Temporary Maritime Activities Area (TMAA). With the exception of Cape Cleare on Montague Island located over 12 nautical miles (nm) (22 kilometers [km]) from the northern point of the TMAA, the nearest shoreline (Kenai Peninsula) is located approximately 24 nm (44 km) north of the TMAA's northern boundary. The approximate middle of the TMAA is located 140 nm (259 km) offshore. Given that the TMAA is more than 12 nm (22 km) from the closest point of land, it is therefore outside of United States (U.S.) territorial seas.

3.7.1.1 Existing Conditions

Sea turtles are long-lived reptiles that can be found throughout the world's tropical, subtropical, and temperate seas (Caribbean Conservation Corporation and Sea Turtle Survival League 2003). Sea turtles are highly adapted for life in the marine environment. Sea turtles possess powerful, modified forelimbs (or flippers) that enable them to swim continuously for extended periods of time (Wyneken 1997). Sea turtles are among the longest and deepest diving of the air-breathing marine vertebrates, spending as little as 3 to 6 percent of their time at the water's surface (Lutcavage and Lutz 1997). Sea turtles often travel thousands of miles between their nesting beaches and feeding grounds (Ernst et al. 1994, Meylan 1995). Sea turtles cannot withdraw their head or limbs into their shell, so growing to a large size as adults is important to avoid predation.

The distribution of sea turtles in ocean waters off the U.S. West Coast and the GOA is strongly affected by seasonal changes in water temperature. Cool water temperatures also prevent sea turtles from nesting on U.S. west coast beaches and may also inhibit reproductive activity by reducing the quality and availability of food resources in the area (Fuentes et al. 2000). In general, sea turtle sightings off the U.S. west coast south of the GOA peak during July through September and in abnormally warm water years such as in El Niño years. During El Niño years, changes in ocean currents bring warmer waters north, which can bring more sea turtles (and their preferred prey) to the west coast region (Washington to California) and as far north as Alaska (National Marine Fisheries Service [NMFS] 2003). There are no known sea turtle nesting areas in the Alaska region.

All sea turtles are listed as endangered or threatened under the Endangered Species Act (ESA). There are seven living species of sea turtles from two taxonomic families, the Cheloniidae (hard-shelled sea turtles; six species) and the Dermochelyidae (leatherback turtles; one species). Five species of sea turtles occur in the North Pacific: leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), green (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), and hawksbill (*Eretmochelys imbricata*). However, only four species have been observed, albeit rarely, in Alaska waters between 1960 and 1998: the leatherback, loggerhead, green, and olive ridley (Hodge and Wing 2000).

Although members of the Cheloniidae family of sea turtles occur in the warm, subtropical areas of the Pacific such as southern California and Hawaii, the GOA is considered beyond their normal range of occurrence because of cold water temperatures. The ocean waters of the TMAA have an average sea surface temperature in summer in the upper 100 m (328 feet [ft]) of approximately 51.8 degree Fahrenheit (°F) (11 degrees Celsius [°C]). Most hard-shell turtles seek optimal seawater temperatures near 65°F and are cold-stressed at seawater temperatures below 50°F (Mrosovsky 1980, Schwartz 1978). In contrast, leatherback sea turtles regularly occur in cold temperate waters of high latitudes (Bleakney 1965, Pritchard 1980, and Eckert et al. 1989). Individuals will often move into cooler temperate waters and sometimes cold northern waters during late summer and early fall (Keinath and Musick 1990, James et al. 2005).

After analyzing 363 records of sea turtles sighted along the Pacific coast of North America, Stinson (1984) concluded that the leatherback was the most common sea turtle in U.S. waters north of Mexico. In Alaska, 19 leatherback sea turtle occurrences were documented between 1960 and 2006, including two summer occurrences recorded near Cordova, Alaska, which is north of the TMAA (Hodge and Wing 2000, DoN 2006). Also recorded during that time frame were 9 green sea turtle occurrences, 2 olive ridley occurrences, and 2 loggerheads. Therefore, although sightings of sea turtles from the Chelonidae family have been documented in Alaska, most of these involve individuals that were either cold-stressed, likely to become cold-stressed, or already deceased (Hodge and Wing 2000, McAlpine et al. 2002). Thus, the TMAA is considered to be outside the normal range for sea turtle species of the Cheloniidae family and this family of sea turtles is not considered for further analysis in this EIS/OEIS.

The leatherback turtle, however, is distributed globally in tropical, subtropical, and temperate waters throughout the year and is the only species of sea turtle expected to occur in the TMAA and thus is considered further in this analysis.

The issues of concern for leatherback sea turtles include potential effects of sounds in the water, and impacts related to vessel movements, ordnance use, and possible entanglement or contact with expended materials that are not recovered. The analysis of effects addresses these issues by grouping effects based on activities with common components such as vessel movement, ordnance use, and expended materials.

Species Accounts and Life History

The leatherback sea turtle is listed under the ESA as endangered throughout its range. There is a recovery plan for this species. Critical habitat is designated for this species in waters near the U.S. Virgin Islands (44 FR 17710, March 23, 1979). Critical habitat has not been identified for this species along the U.S. Pacific coast, including the TMAA, largely because nesting is not known to occur and important foraging areas have not been identified (NMFS and USFWS 1998a).

The leatherback sea turtle is the most oceanic and has the widest range (71°N to 47°S) of the seven living species of sea turtles (Boulon et al. 1988, Pritchard and Trebbau 1984). Leatherback sea turtles have been documented in Alaska waters as far north as approximately 60º latitude (approximately 50 miles north of the northern edge of the TMAA) and as far west in the GOA as the Aleutian Islands (Eckert 1993) Although leatherback turtles are expected to be present within the TMAA, they are likely few in number given the TMAA is near the northern edge of the known extent of their Pacific range (Eckert 1993, DoN 2006). No numbers or density estimates are available for leatherback turtles in the TMAA, but given their distribution patterns based on water temperature elsewhere (Eckert 1993) the number of leatherback sea turtles in the GOA are likely very low. The analysis in this EIS/OEIS therefore assumes leatherback turtles may be encountered in the TMAA during the summer (April to October) although they will be extremely rare (very few in number).

The leatherback, which is the largest living sea turtle, has a unique carapace structure. The carapace lacks the outer layer of external plates or scales possessed by all other sea turtles. Instead, it is composed of a flexible layer of dermal bones underlying tough, oily connective tissue and smooth skin. The body of a leatherback is barrel-shaped, tapered to the rear, with seven longitudinal dorsal ridges; the body is almost completely black with variable spotting (McDonald and Dutton 1996). Carapace lengths in adult leatherbacks range from about 50 to 70 inches (in) (1.2 to 1.8 meters [m]), with an average around 57 in (1.4 m) and weighing between 450 and 1,575 pounds (lb) (200 to 700 kilograms [kg]) (NMFS and U.S. Fish and Wildlife Service [USFWS] 1998b), although there is documentation suggesting this average may be greatly exceeded (Eckert and Luginbuhl 1988).

In contrast with other sea turtles, leatherback sea turtles have physiological traits that allow for the conservation of body heat which enable them to maintain body core temperatures well above the ambient water temperatures (Mrosovsky and Pritchard 1971, Greer et al. 1973, Neill and Stevens 1974, Goff and Stenson 1988, Paladino et al. 1990, Eckert 1993, Lutz and Musick 1996, DoN 2006). Shells, or carapaces, of adult leatherbacks are 4 cm (1.5 inches) thick on average, contributing to the leatherback's thermal tolerance that enables this species to forage in water temperatures far lower than the leatherback's core body temperature (Center for Biological Diversity et al. 2007). In an analysis of available sightings (Eckert 2002), researchers found that leatherback turtles with carapace lengths smaller than 100 cm (39 inches) were sighted only in waters 79°F or warmer, while adults were found in waters as cold as 32°F to 59°F off Newfoundland (Goff and Lien 1988). As a result, they are more capable of surviving for extended periods of time in cooler waters than the hard-shelled sea turtles (Bleakney 1965, Lazell 1980).

Historically, some of the world's largest nesting populations of leatherback turtles were found in the Pacific Ocean, although nesting on Pacific beaches under U.S. jurisdiction has always been rare (NMFS and USFWS 1998c). The northernmost nesting sites in the eastern Pacific Ocean are located in the Mexican states of Baja California Sur and Jalisco (Fritts et al. 1982). Post-nesting adults appear to migrate along bathymetric contours from 656 to 11,483 ft (200 to 3,500 m) (Morreale and Standora 1994), and most of the eastern Pacific nesting stocks migrate south (NMFS 2002). Other principal nesting sites in the Pacific Ocean indicate that gene flow between eastern and western Pacific nesting populations is restricted (Dutton et al. 1998, 1999, 2000a, 2000b).

Leatherbacks are highly pelagic and specialized for life at sea. Occasionally, sea turtles can end up on the shore if they are dead, sick, injured, or cold-stressed. These events, known as strandings, can be caused by either biological factors (e.g., predation and disease) or environmental factors (e.g., water temperature). In addition, leatherbacks approach coastal waters only during the reproductive season (EuroTurtle 2001). Male leatherbacks do not return to land after they hatch from their nests whereas mature females return to land only to lay eggs (Carr 1995, Spotila et al. 1997). Aside from this brief terrestrial period, which lasts approximately three months during egg incubation and hatching, leatherback turtles are rarely encountered out of the water. Sea turtles bask on the water surface to regulate their body temperatures, elude predators, avoid harmful mating encounters, possibly accelerate the development of their eggs, and destroy aquatic algae growth on their carapaces (Whittow and Balazs 1982, Spotila et al. 1997). Hatchling leatherbacks are pelagic, but nothing is known about their distribution during the first 4 years of life (Musick and Limpus 1997).

The leatherback is one of the deepest divers in the ocean, with dives as deep as 3,937 ft (1,200 m), although it spends most of its time feeding at a depth of less than 328 ft (100 m) (DoN 2006). Leatherback turtles primarily feed on gelatinous zooplankton such as cnidarians (jellyfish and siphonophores) and tunicates (salps and pyrosomas) (Bjorndal 1997, NMFS and USFWS 1998b). The leatherback dives continually and spends short periods of time on the surface between dives (Eckert et al. 1986, Southwood et al. 1999). Typical dive durations averaged 6.9 to 14.5 minutes (min) per dive, with a maximum of 42 min (Eckert et al. 1996). Sea turtles typically remain submerged for several minutes to several hours depending upon their activity state (Standora et al. 1984, Renaud and Carpenter 1994). Long periods of submergence hamper detection and confound census efforts. Leatherbacks dive continually and spend short periods on the surface between dives (Eckert et al. 1986, Southwood et al. 1999). During migrations or long distance movements, leatherbacks maximize swimming efficiency by traveling within 15 ft (5 m) of the surface (Eckert 2002).

The world female leatherback turtle population is estimated at 35,860 (Spotila 2004). The western Pacific (west of the International Date Line) leatherback population was estimated to contain 2,700 to 4,500 nesting females (Dutton et al. 2007). A subset of these females, and an unknown number of males, forage off the U.S. west coast (Washington to California) each year from about May to November, when dense aggregations of jellyfish (leatherback prey) are present (Benson et al. 2007a, 2007b). Foraging abundance estimates are only available for nearshore waters off California, where the estimated minimum leatherback abundance has ranged from 12 to 379 individuals per year, based on aerial surveys.

Natural and Induced Mortality

The decline of sea turtles is believed primarily to be the result of exploitation by humans for the eggs and meat, commercial and recreational fishing with nets, longlines, trawls, seines, and hook-and-lines, loss or degradation of nesting habitat from coastal development, pollution and contaminants, marine debris, and watercraft strikes. Leatherbacks are seriously declining at all major Pacific basin nesting beaches, including those in Indonesia, Malaysia, and southwestern Mexico (NMFS and USFWS 1998b).

A major factor in the decline of the leatherback turtle worldwide is commercial harvesting for meat and eggs. The crash of the Pacific leatherback turtle population, once the world's largest, is believed to be primarily the result of exploitation by humans for their eggs and meat. Enforcement of existing laws in remote areas is also a major problem.

It was estimated that worldwide, more than 50,000 leatherbacks were incidentally taken as pelagic longline bycatch in 2000 and that thousands die from longline gear interactions every year in the Pacific Ocean (Lewison et al. 2004). They have been known to ingest longline hooks used to catch tuna and swordfish (Davenport and Balazs 1991, Skillman and Balazs 1992, Grant 1994, Work and Balazs 2002).

Incidental capture of leatherbacks by the north Pacific high seas driftnet fleet, which targets squid and tuna, was also a source of mortality during the 1980s and early 1990s (Eckert 1993). In 2001, NMFS prohibited drift gillnet fishing in California and Oregon from August 15 to November 15 from Monterey, California to 45ºN latitude within 13 nm (24 km) of the coast. This ruling was necessary to avoid the likelihood that this fishery would jeopardize the continued existence of the leatherback turtle population in the Pacific as leatherbacks annually migrated through this area (NOAA 2001).

Environmental contamination from coastal runoff, marina and dock construction, dredging, aquaculture, oil and gas exploration and extraction, increased underwater noise, and boat traffic can degrade marine habitats used by marine turtles. The development of marinas and docks in inshore waters can negatively impact nearshore habitats. Fueling facilities at marinas can sometimes discharge oil, gas, and sewage into sensitive estuarine and coastal habitats. An increase in the number of docks built may also increase boat and vessel traffic. Sea turtles swimming or feeding at or just beneath the surface of the water are particularly vulnerable to boat and vessel strikes, which can result in serious propeller injuries and death.

Marine debris is a continuing contaminant problem for marine turtles. Marine turtles living in the open ocean commonly ingest or become entangled in marine debris (e.g., tar balls, plastic bags, plastic pellets, balloons, and ghost fishing gear) as they feed along oceanographic fronts, where debris and their natural food items converge. This is especially problematic for sea turtles that spend all or significant portions of their life cycle in the open ocean (e.g., leatherbacks, juvenile loggerheads, and juvenile green turtles).

Investigation of clutch hatching success suggests that the leatherback turtle has lower hatching success levels than other sea turtles. Reasons for this condition are unknown. Excessive nest predation of eggs and new hatchlings by native and nonnative predators and degradation of foraging habitats are primary natural mortality factors. Predators of eggs and hatchlings include several species of mammals, birds, invertebrates, and fish. Eggs and hatchlings have high mortality rates, but as the survivors grow, natural mortality declines markedly.

Sea Turtle Hearing

Sea turtles do not have an external ear pinnae or eardrum. Instead, they have a cutaneous layer and underlying subcutaneous fatty layer that function as a tympanic membrane (TM). The subcutaneous fatty layer receives and transmits sounds to the middle ear and into the cavity of the inner ear (Ridgway et al. 1969). Sound also arrives by bone conduction through the skull. Sound arriving at the inner ear via the columella (homologous to the mammalian stapes or stirrup) is transduced by the bones of the middle ear. Sea turtle auditory sensitivity is not well studied, though a few preliminary investigations suggest that it is limited to low frequency bandwidths, such as the sounds of waves breaking on a beach. The role of underwater low-frequency hearing in sea turtles is unclear. It has been suggested that sea turtles may use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Lenhardt et al. 1983).

Lenhardt et al. (1983) applied audiofrequency vibrations at 250 hertz (Hz) and 500 Hz to the heads of loggerheads and Kemp's ridleys submerged in salt water to observe their behavior, measure the attenuation of the vibrations, and assess any neural-evoked response. These stimuli (250 Hz, 500 Hz) were chosen as representative of the lowest sensitivity area of marine turtle hearing (Wever 1978). At the maximum upper limit of the vibratory delivery system, the sea turtles exhibited abrupt movements, slight retraction of the head, and extension of the limbs in the process of swimming. Lenhardt et al. (1983) concluded that bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving surfaces. Finally, sensitivity even within the optimal hearing range was low as threshold detection levels in water are relatively high at 160 to 200 decibels referenced to one micro Pascal at a distance of one meter (dB re 1 µPa-m), which is the standard reference measure for underwater sound energy in this regard; Lenhardt 1994).

Ridgway et al. (1969) used aerial and mechanical stimulation to measure the cochlea in three specimens of green turtle, and concluded that they have a useful hearing span of perhaps 60 to 1,000 Hz, but hear best from about 200 Hz up to 700 Hz, with their sensitivity falling off considerably below 200 Hz. The maximum sensitivity for one animal was at 300 Hz, and for another was at 400 Hz. At the 400 Hz frequency, the green turtle's hearing threshold was about 64 dB in air (approximately 126 dB in water). At 70 Hz, it was about 70 dB in air (approximately 132 dB in water). We may be able to extrapolate this data to pertain to all hard-shell sea turtles (i.e., the olive ridley, green, loggerhead, hawksbill, and Kemp's ridley turtles). No audiometric data are available for the leatherback turtle, but based on other sea turtle hearing capabilities, they probably also hear best in the low frequencies.

For exposures to impulsive sound, a recent study on the effects of air guns on sea turtle behavior also suggests that sea turtles are most likely to respond to low-frequency sounds (McCauley et al. 2000). Green and loggerhead sea turtles will avoid air-gun arrays at 2 km and at 1 km, with received levels of 166 dB re 1 µPa-m and 175 dB re 1 µPa, respectively (McCauley et al. 2000). The sea turtles' response was consistent: above a level of about 166 dB re 1 µPa, the sea turtles noticeably increased their swimming activity. Above 175 dB re 1 µPa, their behavior became more erratic, possibly indicating that they were agitated (McCauley et al. 2000).

Currently it is believed that the range of maximum sensitivity for sea turtles is 200 to 800 Hz, with an upper limit of about 2,000 Hz (Lenhardt 1994, Moein et al. 1994). Hearing below 80 Hz is less sensitive but still potentially usable to the animal. Green turtles are most sensitive to sounds between 200 and 700 Hz, with peak sensitivity at 300 to 400 Hz (Ridgway et al. 1997). They possess an overall hearing range of approximately 60 to 1,000 Hz (Ridgway et al., 1969). Juvenile loggerhead turtles hear sounds between 250 and 1,000 Hz and, therefore, often avoid low-frequency sounds (Bartol et al. 1999). Finally, sensitivity even within the optimal hearing range is apparently low—threshold detection levels in water are relatively high at 160 to 200 dB re 1 µPa-m (Lenhardt 1994). Given the lack of audiometric information for leatherback turtles, the potential for temporary threshold shifts among leatherback turtles must be classified as unknown but would likely follow those of other sea turtles. In terms of sound emission, nesting leatherback turtles produce sounds in the 300 to 500 Hz range (Mrosovsky 1972).

Mid-Frequency and High-Frequency Sound Sources

The lowest center frequency of any mid-frequency sonar proposed for use in ASW training (the AN/SQS-53) operates at 3,500 Hz. The best available information indicates that sea turtles hear in the range of 60 Hz to 2,000 Hz with best sensitivity between 200 to 800 Hz (Ridgway et al. 1969, Lenhardt 1994), which is well below the center operating frequency of any sonar proposed for use in the TMAA. Hearing sensitivity is low, even within the sea turtle's optimal hearing range, requiring received levels as high as 160 to 200 dB re 1 μPa for the sound to be heard (Lenhardt 1994). The nominal source level of the AN/SQS-53 sonar would attenuate below the upper end of this required received level within 175 meters of the ship. Because the remaining mid-frequency and high-frequency sources (Table 2-4 and 2-5, Section 2.5.2.1 Sonars Used in the TMAA) have lower source levels, are above the known hearing range of sea turtles, and because high levels of received sound are required for perception to occur, it is not likely that auditory impacts would occur from the use of mid-frequency and high-frequency sources during training in the TMAA.

Any potential role of long-range acoustical perception in sea turtles has not been studied. The concept of sound masking (the ability of one sound to make the ear incapable of perceiving another) is difficult, if not impossible, to apply to sea turtles. The best available science however, suggests that sea turtles cannot hear the mid- and high-frequency sound sources proposed for use in the TMAA.

3.7.1.2 Current Requirements and Practices

As summarized in Chapter 5, the comprehensive suite of protective measures and standard operating procedures (SOPs) implemented by the Navy to reduce impacts to marine mammals also serves to mitigate potential impacts on sea turtles. In particular, personnel and watchstander training, establishment of turtle-free exclusion zones for at-sea explosions, and pre- and postexercise surveys all serve to reduce or eliminate potential impacts of Navy activities on sea turtles that may be present in the vicinity.

3.7.2 Environmental Consequences

As noted in Section 3.7.1, the ROI for sea turtles is the TMAA, which is more than 12 nm (22 km) from the closest point of land. As such, this section distinguishes between U.S. territorial seas (shoreline to 12 nm) and nonterritorial seas, (seaward of 12 nm) for the purposes of applying the appropriate regulations (National Environmental Policy Act [NEPA] or Executive Order [EO] 12114) to analyze potential environmental effects. Environmental effects in the open ocean beyond the U.S. territorial seas are analyzed in this EIS/OEIS pursuant to EO 12114.

3.7.2.1 Regulatory Framework

This EIS/OEIS analyzes potential effects to the leatherback turtle in the context of the ESA, NEPA, and EO 12114. For purposes of ESA compliance, effects of the action were analyzed to make the Navy's determination of effect for listed species (i.e., no effect or may affect). The definitions used in making the determination of effect under Section 7 of the ESA are based on the USFWS and NMFS *Endangered Species Consultation Handbook* (USFWS and NMFS 1998).

"No effect" is the appropriate conclusion when a listed species will not be affected, either because the species will not be present or because the project does not have any elements with the potential to affect the species. "No effect" does not include a small effect or an effect that is unlikely to occur.

If effects are insignificant (in size) or discountable (extremely unlikely), a “may affect” determination is appropriate. Insignificant effects relate to the magnitude or extent of the impact (that is, they must be small and would not rise to the level of a take of a species). Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur. These factors were also considered in determining the significance of effects under the NEPA and EO 12114.

3.7.2.2 Approach to Analysis

Assessment Methods and Data Used

The Navy used a screening process to identify aspects of the Proposed Action that could act as stressors to sea turtles. Public and agency scoping comments, previous environmental analyses, previous agency consultations, laws, regulations, EOs, and resource-specific information were also evaluated. This process was used to focus the information presented and analyzed in the Affected Environment and Environmental Consequences sections (Sections 3.7.1 and 3.7.3) of this EIS/OEIS. Potential stressors to sea turtles include vessel movements (disturbance and collisions), aircraft overflights (disturbance), weapons firing and ordnance use (disturbance and strikes), explosions, and expended materials (ordnance-related materials, targets, and marine markers).

As discussed in Section 3.2, Expended Materials, and Section 3.3, Water Resources, potential pollutants in sediments, water, and air would be released into the environment as a result of the alternatives. The analyses presented in those sections indicate that any increases in pollutants resulting from Navy training in the TMAA would be negligible and localized, and impacts would not be significant. Based on these analyses, water quality changes would have negligible effects on sea turtles. Accordingly, the effects of water quality changes on sea turtles are not addressed further in this EIS/OEIS.

Data Sources

A systematic review of relevant literature and data was conducted of both published and unpublished sources. The following types of documents were used in the assessment: journals, books, periodicals, bulletins, Department of Defense (DoD) operations reports, theses, dissertations, endangered species recovery plans, species management plans, and other technical reports published by government agencies, private businesses, and consulting firms. The scientific literature was also consulted during the search for geographic location data (geographic coordinates) on the occurrence of sea turtles within the TMAA.

Sea Turtle Density

Given leatherback turtles have seldom been encountered in the GOA (19 documented occurrences in 47 years; Hodge and Wing 2000, DoN 2006), there is no data available and no density estimates for leatherback turtles in the TMAA. Extrapolation of numbers from temperate waters where numerical estimates have been made is not a valid approach given the cold waters of the GOA.

Sound in the Water

The acoustic abilities of marine species are important in communicating with others of their species, navigating, foraging, and avoiding predators. Human activities that affect their hearing could have adverse consequences for their survival and recovery. The approach to estimating the potential acoustic effects of Anti-Submarine Warfare (ASW) training activities in the TMAA on marine species uses methods that were developed for the Navy’s Hawaii Range Complex Final EIS/OEIS in cooperation with the National Oceanic and Atmospheric Administration (NOAA) (DoN 2008).

As discussed previously in Sea Turtle Hearing, effects on leatherback turtles are not likely from the use of mid-frequency or high-frequency sound sources given that all available information indicates the leatherback turtle hearing range is likely well below those frequencies. Acoustic masking of leatherback hearing should not occur as a result of the proposed use of the sources in those mid- and high-frequency ranges. Under ESA, use of sonar during training activities in the TMAA may effect leatherback turtles since it is possible that they may be exposed to sonar although not perceive it via hearing mechanisms.

Consideration of a physiological or stress response as a result of the proposed training activities must be discussed given the possible duration of the combined (exercise) activities (a maximum of 21 days). Although an individual training activity (such as an anti-submarine tracking exercise) may be hours in duration, the participants and activities are dispersed in the TMAA, the majority of sources are generally active only intermittently once or twice each minute, the sources have a small range of effect based on the hearing sensitivity of a sea turtle, and the sources are almost always moving rapidly (in relation to a sea turtle). Based on the discussion and citations provided in Section 3.7.1.1, leatherback turtles are not expected to be able to perceive the sounds from mid- and high-frequency sound sources and, given the likely short duration of any exposure to these sources, there should be no physiological or stress response as a result of their use in the TMAA.

Further discussion of potential effects from use of mid-frequency and high-frequency sound sources is not carried through in the analysis of the various alternatives for sea turtles.

At-Sea Explosions

Ordnance cannot be released and explosives cannot be detonated until the target area is determined to be clear. Training activities are halted immediately if cetaceans, pinnipeds, or sea turtles are observed in the target area. Training activities are delayed until the animal clears the target area. All observers are in continuous communication to be able to immediately halt training activities. The event can be delayed as necessary to ensure the target area is clear. If the area cannot be cleared, the operation is relocated or canceled. These practices lower the risk of harming leatherback turtles.

The lead time to set up and clear the impact area before an event using explosives takes place may be 30 minutes to several hours. There will, therefore, be a long period of area monitoring before any detonation or live-fire event begins.

Criteria and thresholds for estimating the impacts to leatherback turtles from a single at-sea explosion event were determined from information on marine species used for the environmental assessments for the two Navy ship-shock trials: the *Seawolf* Final EIS (DoN 1998) and the *Churchill* Final EIS (DoN 2001). During the analysis of the effects of explosions on marine mammals and sea turtles conducted by the Navy for the *Churchill* EIS, analysts compared the injury levels reported by these experiments to the injury levels that would be predicted using the modified-Goertner method and found them to be similar (DoN 2001, Goertner 1982). While the criteria and thresholds for injury and harassment summarized in Table 3.7-1 were developed based on data from marine mammals, extrapolation from human and marine mammal data to sea turtles may be inappropriate given the morphological differences between the auditory systems of mammals and turtles. However, they are also used for sea turtles because no other criteria exist.

The criteria for non-injurious harassment include acoustic annoyance and physical discomfort (Viada et al. 2007). Temporary threshold shift (TTS) is the criterion for acoustic annoyance; TTS is a temporary, recoverable, loss of hearing sensitivity (NMFS 2001, DoN 2001). There are two criteria for TTS: (1) 182 dB re 1 squared micropascal-second (μPa^2-s) maximum Energy Flux Density Level (EL) level in any 1/3-octave band at frequencies greater than 100 Hz for sea turtles, and (2) 12 pounds per square inch (psi) peak pressure. Navy policy is to use a peak pressure level of 23 psi as a criterion for explosive charges less than 2,000 lb (900 kg) and a peak pressure level of 12 psi as a criterion for explosive charges larger than 2,000 lb. It was introduced to provide a safety zone for TTS when the explosive or the animal approaches the sea surface (for which case the explosive energy is reduced but the peak pressure is not). In addition to acoustic annoyance, non-injurious harassment may also include physical discomfort and tactile detection, particularly in areas around the eyes, mouth, external nares, and vent (Viada et al. 2007).

Table 3.7-1: Summary of Criteria and Acoustic Thresholds for at-Sea Explosion Impacts to Sea Turtles

Impact to Marine Mammal	Criterion	Threshold
Level A harassment Mortality	Onset of severe lung injury	Goertner Modified Positive Impulse indexed to 31 psi-ms
Injury	Tympanic membrane (TM) rupture Onset of slight lung injury	50 percent rate of rupture 205 dB re 1 µPa^2-s (Energy Flux Density) Goertner Modified Positive Impulse Indexed to 13 psi-ms
Level B harassment Noninjury	Temporary threshold shift (TTS)	182 dB re 1 µPa^2-s maximum Energy Flux Density level in any 1/3-octave band at frequencies above 100 Hz for sea turtles
Dual criteria	Onset TTS	23 psi peak pressure level (for small explosives)

psi-ms = pounds per square inch-milliseconds, dB = decibel, µPa^2-s = squared micropascal-second, Hz = hertz

Two criteria are used for injury: onset of slight lung hemorrhage and 50 percent eardrum (TM) rupture. These criteria are considered indicative of the onset of injury. The threshold for onset of slight lung injury is calculated for a small animal (a dolphin calf weighing 27 lb [12 kg]), and is given in terms of the “Goertner modified positive impulse,” indexed to 13 psi-millisecond (ms) (DoN 2001). This threshold is conservative since the positive impulse needed to cause injury is proportional to animal mass, and therefore, larger animals require a higher impulse to cause the onset of injury. The threshold for TM rupture corresponds to a 50 percent rate of rupture (i.e., 50 percent of animals exposed to the level are expected to suffer TM rupture); this is stated in terms of an EL value of 205 dB re 1 µPa^2-s. The criterion reflects the fact that TM rupture is not necessarily a serious or life-threatening injury, but is a useful index of possible injury that is well correlated with measures of permanent hearing impairment (e.g., Ketten 1998), and indicates a 30 percent incidence of permanent threshold shift [PTS] at the same threshold. Another slight injury that may result from at-sea explosions includes hemorrhage of the gastrointestinal tract. This is caused by excitation of radial oscillations of small gas bubbles normally present in the intestine. Hemorrhage of the gastrointestinal tract is not expected to be debilitating, and a sea turtle would be expected to recover on its own (Viada et al. 2007).

The criterion for mortality for marine mammals used in the *Churchill* Final EIS is “onset of severe lung injury.” In the absence of analogous data for sea turtles, the criteria developed for marine mammals are also applied to sea turtles. This is conservative for marine mammals in that it corresponds to a 1 percent chance of mortal injury, and yet any animal experiencing onset severe lung injury is counted as a lethal exposure. The threshold is stated in terms of the Goertner (1982) modified positive impulse with value “indexed to 31 psi-ms.” Since the Goertner approach depends on propagation, source/animal depths, and animal mass, the actual impulse value corresponding to the 31 psi-ms index is a complicated calculation. Again, to be conservative, the *Churchill* analysis used the mass of a dolphin calf (27 lb [12 kg]), so that the threshold index is 30.5 psi-ms. Gastrointestinal tract injuries are associated with lung hemorrhage and would be expected to include contusions with ulcerations throughout the tract, ultimately resulting in tract ruptures. Mortality is highly likely under these conditions (Viada et al. 2007). Lethal injuries may also result from shock waves with high peak pressure. These high peak pressure shock waves may result in concussive brain damage; cranial, skeletal, or shell fractures; hemorrhage; or massive inner ear trauma, leading either directly or indirectly to mortality (Viada et al. 2007).

Weapons Firing Disturbance

A gun fired from a vessel on the surface of the water propagates a blast wave away from the gun muzzle. As the blast wave hits the water, sound is carried into the water in proportion to the blast strike. Propagating energy is transmitted into the water in a finite region below the gun. The fraction of sound transmitted from air to water depends on the angle at which the sound approaches the air-water interface. The greater the angle, the less transmission of sound from air to water. This critical angle (about 13°, as measured from the vertical) can be calculated to determine the region of transmission in relation to a vessel and gun (DoN 2006). When the critical angle is exceeded, all of the acoustic energy is reflected from the air-water interface and does not enter the water column.

The largest proposed shell size for training activities is a 5-in shell. This will produce the greatest pressure of all ammunition used in the study area. All analysis was done using the 5-in shell as a source of produced and transmitted pressure, with the recognition that smaller ammunition sizes would have lesser impacts.

In June 2000, the Navy collected a series of pressure measurements during the firing of a 5-in gun. Average pressure measured approximately 200 dB with reference pressure of one micropascal (200 dB re 1 μPa) at the point of the air and water interface. Based on these values, down-range peak pressure levels were calculated to be less than 186 dB re 1 μPa at 100 m (DoN 2000), and down-range pressure levels decreased with increasing distance. The rapid dissipation of the sound pressure wave, the low potential for occurrence of leatherback turtles in the TMAA, and the protective measures implemented by the Navy (see Chapter 5 for details) to detect leatherback turtles in an area prior to implementing training activities would result in the gun muzzle blasts having no effect on leatherback turtles. This topic is not addressed further in the analyses of effects on sea turtles.

3.7.2.3 No Action Alternative

Under the No Action Alternative, baseline levels of activities would remain unchanged from current conditions. Leatherback turtles would have the potential to be affected by vessel movements, aircraft overflights, ordnance strikes, explosions, and expended materials.

Vessel Movements

Training activities within the study area involve maneuvers by various types of surface vessels and submarines (collectively referred to as vessels). Vessel movements have the potential to affect leatherback turtles by directly striking or disturbing individual animals. The probability of vessel and leatherback turtle interactions depends on factors such as the presence or absence and density of leatherback turtles; numbers, types, and speeds of vessels; duration and spatial extent of activities; and protective measures implemented by the Navy.

The number of Navy vessels participating in training under the No Action Alternative is 23, consisting of 4 military vessels and up to 19 contracted vessels and boats. Although Navy vessels are capable of much faster speeds, specific training activities will generally be at speeds in the range of 10 to 14 knots (kts) (18 to 26 kilometers per hour [km/h]). Training activities are widely dispersed throughout the TMAA, which encompasses 42,146 square nm (nm^2) (145,482 square km [km^2]) of surface and subsurface ocean.

Disturbance from Vessel Movement

The ability of sea turtles to detect approaching vessels via auditory or visual cues would be expected based on knowledge of their sensory biology (Bartol and Musick 2003, Ketten and Bartol 2006, Bartol and Ketten 2006, Levenson et al. 2004). Little information is available on how sea turtles respond to vessel approaches. Hazel et al. (2007) reported that greater vessel speeds increased the probability that sea turtles would fail to flee from an approaching vessel. Sea turtles fled frequently in encounters with a slow-moving (2.2 kts) (4.4 km/h) vessel, but infrequently in encounters with a moderate-moving (5.9 kts) (10.6 km/h) vessel, and only rarely in encounters with a fast-moving (10.3 kts) (18.5 km/h) vessel. It is difficult to differentiate whether a sea turtle reacts to a vessel due to the produced sound, the presence of the vessel itself, or a combination of both. As discussed previously in Sea Turtle Hearing, sea turtles have highest sensitivity to sounds between approximately 200 to 800 Hz, with an upper limit of 2,000 Hz (Ridgway et al. 1969, Lenhardt 1994, Bartol et al. 1999, Ketten and Bartol 2006). Although it is difficult to determine whether sea turtle response to vessel traffic is visual or auditory in nature, it is assumed sea turtles can hear approaching vessels given their hearing range.

Leatherback turtles exposed to the general disturbance associated with a passing Navy vessel could exhibit short-term behavioral responses. In accordance with EO 12114, harm to leatherback turtles from vessel movements in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, vessel visual or acoustic disturbance under the No Action Alternative may affect leatherback turtles.

Vessel Collisions

Vessel collisions or strikes have the potential to affect leatherback turtles in the TMAA. Sea turtles swimming or feeding at or just beneath the surface of the water are particularly vulnerable to a vessel strike. Sea turtles struck by vessels could be unharmed, injured, or killed. Collisions between vessels and leatherback turtles are possible, but have a low potential for occurrence. The probably extreme low density for leatherback turtles, low number of steaming hours over a large area (42,146 nm^2 [144,556 km^2]), and Navy standard lookouts meant to reduce the collision potential would combine to limit the likelihood of vessel-sea turtle collisions.

As noted above, there is little information available on how sea turtles respond to vessel approaches. Hazel et al. (2007) found that sea turtles reacted to approaching vessels in a variety of ways. Benthic sea turtles launched upwards at a shallow angle and began swimming. The majority of the sea turtles swam away from the vessel, while some swam along the vessel's track, and some crossed in front of the vessel's track before swimming away. Sea turtle reaction time was greatly dependent on the speed of the vessel; sea turtles were able to react faster to slower moving vessels than to faster moving vessels. Sea turtle reactions to vessels elicited short-term responses.

Human disturbance to wild animals, such as vessel movement, may elicit similar reactions to those caused by natural predators (Gill et al. 2001, Beale and Monaghan 2004). Behavioral responses may also be accompanied by a physiological response (Romero 2004), although this is very difficult to study in the wild. Immature Kemp's ridley turtles have shown physiological responses to the acute stress of capture and handling through increased levels of corticosterone (Gregory and Schmid 2001). In the short term, exposure to stressors results in changes in immediate behavior (Frid 2003). For sea turtles, this can include intense behavioral reactions such as biting and rapid flipper movement (Gregory and Schmid 2001). Repeated exposure to stressors, including human disturbance such as vessel disturbance and anthropogenic sound, can result in negative consequences to the health and viability of an individual or population. Chronic stress can result in decreased reproductive success (Lordi et al. 2000, Beale and Monaghan 2004), decreased energy budget (Frid 2003), displacement from habitat (Southerland and Crockford 1993), and lower survival rates of offspring (Lordi et al. 2000). Although this study related to natural induced stressors, similar physiological changes may result from other types of stressors such as anthropogenic disturbance. At this time, it is unknown what the long-term implications of chronic stress may be on sea turtle species.

The Navy's SOPs include a number of measures that will prevent a collision between a naval vessel and a leatherback turtle (see Chapter 5). Navy vessels use lookouts 24 hours a day, who serve to alert the bridge to any and all objects in the water, including sea turtles. Ships and surfaced submarines use caution and operate at safe speeds consistent with weather and sea state conditions. Ships and submarines will maneuver to avoid a collision with a sea turtle to the extent possible, with safety of the vessel paramount. The combination of the low initial probability of collision with a leatherback turtle and the procedures to avoid such an event makes it extremely unlikely a ship would collide with a leatherback turtle. In accordance with EO 12114, harm to leatherback turtles from vessel movements in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, vessel strikes under the No Action Alternative may affect leatherback turtles.

Aircraft Overflights

Under the No Action Alternative, overflights associated with 300 sorties would occur above the TMAA. Most aircraft overflights would occur over the TMAA at elevations in excess of 15,000 ft (915 m). All aircraft overflights between the shore and 12 nm (22 km) from land would occur at altitudes at or above 15,000 ft (915 m). There would be 32 training events that may involve helicopter flights conducted over water.

Aircraft overflights produce noise, and some of this sonic energy would be transmitted into the water. Sea turtles could be exposed to noise associated with fixed-wing aircraft overflights and helicopter activities while at the surface or while submerged. In addition, low-flying aircraft passing overhead could create a visual shadow effect that could induce a reaction in sea turtles.

It is difficult to differentiate between reactions that sea turtles may experience to the presence of aircraft and reactions to sound. Based on information on their sensory biology as discussed in Sea Turtle Hearing (Ridgway et al. 1969, Lenhardt 1994, Bartol et al. 1999, Bartol and Musick 2003, Ketten and Bartol 2006), sound from low-flying aircraft could be heard by a sea turtle at or near the surface. Exposures to elevated noise levels that are associated with current activities are brief and infrequent, based on the transitory and dispersed nature of the overflights. Sound exposure levels are relatively low because sea turtles spend only 3 to 6 percent of the time at the sea surface and because most of the overflights would be above 15,000 ft. In addition, overflights do not generate underwater sound levels that result in harm to sea turtles (Eller and Cavanagh 2000, Laney and Cavanagh 2000).Hazel et al. (2007) suggested that green turtles rely more on visual cues than auditory cues when reacting to approaching water vessels. This suggests that sea turtles might not respond to aircraft overflights based on noise alone.

Leatherback turtles exposed to aircraft overflights that occur under the No Action Alternative may exhibit no response, or may exhibit behavioral reactions such as quick diving. Any behavioral avoidance reaction would be short-term and would not permanently displace animals or result in physical harm. Overflights are not expected to result in chronic stress because it is extremely unlikely that individual animals would be repeatedly exposed to low-altitude overflights. In accordance with EO 12114, harm to leatherback turtles from aircraft overflights in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, aircraft overflights under the No Action Alternative may affect leatherback turtles.

At-Sea Explosions

Explosions that would occur in the No Action Alternative in the TMAA would result from training exercises that use explosive ordnance, including bombs (BOMBEX), high explosive (HE) rounds (Gunnery Exercise [GUNEX]) as identified in Table 2-8. At-sea explosions conducted under the No Action Alternative have the potential to adversely affect sea turtles in the study area by causing temporary behavioral effects, sub-lethal or lethal injuries, or direct mortality.

Missiles used in air to air training events at sea, although part of a live fire event, are designed to detonate in the air and do not constitute an at-sea explosion occurring in water as analyzed in this document.

However, the same factors that would limit other adverse effects to sea turtles would result in a low potential for impacts from explosions. These include the relatively low potential for sea turtles to occur in the study area, the limited number of training activities using explosive ordnance over a large area, and consistent implementation of Navy resource protection measures.

Under the No Action Alternative, approximately 48 live bombs may be used during a BOMBEX. During Surface-to-Surface (S-S) GUNEX, 30 5-in rounds and 10 76-millimeter (mm) rounds could be fired each year during training activities under the continuing activities of the No Action Alternative. Their use would occur in all areas of the TMAA.

An analysis of potential impacts from at-sea explosions using acoustic modeling could not be conducted for leatherback turtles, given there is no data regarding the abundance or distribution in the Pacific (NMFS and USFWS 1998c) and no known density or information available to derive an estimate for the number of leatherback turtles in the GOA or in the TMAA. In analyses undertaken for similar actions at other locations, modeling to predict potential impacts required that the zone of influence resulting from each explosion or detonation be multiplied by the sea turtle density to assess the potential for and number of impacts likely (see Sea Turtle Hearing Section and Section 3.7.2.2 for sea turtle-specific thresholds and Section 3.8, Marine Mammals, for a full description of the modeling and methods). Modeling efforts in these cases are completed as if no mitigation measures were in effect. The purpose of this is to model without consideration for reduction in the predicted impact numbers as a result of standard mitigations (regarding standard mitigations, see Current Requirements and Practices Section).

Given the indications there are likely to be very low numbers of leatherback turtles present in the TMAA, modeling would likely result in a conclusion that there were no exposures in any event. However, without density information and modeling of potential impacts, there remains a possibility there could be an exposure of a leatherback to at-sea explosions. Based on this possibility, under the No Action Alternative, the explosions and detonations that would take place in the TMAA may affect leatherback turtles. No sea turtle mortalities would be expected under this alternative.

In accordance with EO 12114, harm to leatherback turtles from explosive ordnance use in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, use of explosive ordnance in the TMAA under the No Action Alternative may affect leatherback turtles.

Expended Materials

The Navy expends a variety of materials during training exercises. Under the No Action Alternative, 15,982 expendable items may be used. The types and quantities of materials expended and information regarding fate and transport of these materials within the marine environment are discussed in Section 3.2 (Expended Materials), and Section 3.3 (Water Resources). The analyses in these sections determined that most expended materials rapidly sink to the seafloor where they become encrusted by natural processes or are incorporated into the seafloor, with no substantial accumulations in any particular area and no significant negative effects to water quality or marine benthic communities. Given that materials expended during training do not remain at the surface and are generally used in areas where the water depth is beyond that of foraging sea turtles, it is unlikely expended materials would affect sea turtles.

Sea turtles of all sizes and species are known to ingest a wide variety of marine debris, which they might mistake for prey. Plastic bags and plastic sheeting are most commonly swallowed by sea turtles, but balloons, styrofoam beads, monofilament fishing line, and tar are also known to be ingested (National Research Council [NRC] 1990). Most materials expended during Navy training are larger in size than the marine debris ingested by sea turtles. Marine debris can pass through the digestive tract and be voided naturally without causing harm, or it can cause sublethal or lethal effects (Balazs 1985). Sublethal effects include nutrient dilution, which occurs when nonnutritive debris displaces nutritious food in the gut, leading to slow growth or reduced reproductive success (McCauley and Bjorndal 1999).

Lutz (1997) found that hungry sea turtles will actively seek and consume marine debris if other food is not available. In most cases, this debris passed through the gut within a few days, but latex was found to take up to 4 months to clear the intestinal system. While ingestion of marine debris has been linked to sea turtle mortalities, sublethal effects are more common (NRC 1990, McCauley and Bjorndal 1999).

Ordnance-Related Materials

Ordnance-related materials include nonexplosive training rounds and shrapnel from explosive rounds. Under the No Action Alternative, 15,706 items of ordnance or related materials would be expended. The solid materials of high metal content quickly sink through the water column and into the seafloor in the TMAA where they would generally be beyond the reach of foraging leatherback turtles (although leatherbacks have been known to dive to a depth of 1,200 m [DoN 2006]).

Leatherbacks feed throughout all zones of the water column (Davenport 1988, Eckert et al. 1989, Grant and Ferrell 1993, Salmon et al. 2004, James et al. 2005). Prey is predominantly gelatinous zooplankton such as jellyfish and tunicates (Grant and Ferrell 1993, Bjorndal 1997, James and Herman 2001, Salmon et al. 2004), and as discussed in Species Accounts and Life History, they typically do not feed in the benthic environment. Therefore, although leatherbacks could reach ordnance-related materials resting on the bottom at depths up to 1,000 m, they are unlikely to ingest it.

Ingestion of expended ordnance is not expected to occur in the water column because ordnance quickly sinks. Leatherbacks would not be expected to ingest ordnance expended under the No Action Alternative because they do not typically feed in the benthic environment. In accordance with EO 12114, harm to leatherback turtles from expended materials in nonterritorial seas would not be likely to occur. In accordance with the ESA effects determination language, ordnance-related materials under the No Action Alternative may affect leatherback turtles.

Nonexplosive Ordnance Use

Current Navy training activities in the TMAA include firing a variety of weapons that employ nonexplosive training rounds, including inert bombs, missiles, naval gun shells, cannon shells, and small-caliber ammunition. These materials are used in the open ocean beyond 12 nm (22 km) and represent potential stressors to sea turtles. Ordnance strikes have the potential to injure or kill sea turtles swimming or feeding at or just beneath the water surface.

Approximately 10,454 nonexplosive ordnance rounds would be used in the TMAA under the No Action Alternative. Given the few number of leatherback turtle likely in the TMAA, the large area encompassed by the training activities, and area clearance procedures, the potential for leatherback turtles to be struck by ordnance is very low.

In accordance with EO 12114, harm to leatherback turtles from nonexplosive ordnance use in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, nonexplosive ordnance strikes under the No Action Alternative may affect leatherback turtles.

Target-Related Materials

At-sea targets used in the TMAA could range from high-technology, remotely operated airborne and surface targets (such as airborne drones) to low-technology, floating, at-sea targets (such as inflatable targets) and airborne, towed banners. Many of the targets are designed to be recovered for reuse and are not destroyed during training. There are 252 target related items used under the No Action Alternative and all but eight of these would be recovered. The expendable targets used in the study area under this alternative are the Tactical Air Launched Decoy (TALD), BQM-74E, and Killer Tomato. When not recovered after use, these units are large and remain in large pieces when they sink to the bottom after use. Because of this characteristic, they present no ingestion hazard to sea turtles.

In addition to expendable target use, MK-58 marine markers or LUU-2B/B flares are used which produce chemical flames and surface smoke. They are used in training exercises to mark a surface position to simulate divers, vessels, and points of contact on the surface of the ocean. The smoke dissipates in the air and has little effect on the marine environment. The marker burns similar to a flare, producing a flame until all burn components have been used. While the light generated from the marker is bright enough to be seen up to 3 mi (4.8 km) away in ideal conditions, the light either reflects off the water's surface or enters the water and attenuates in brightness over depth. Because they spend only three to six percent of time on the sea surface, it would be extremely unlikely that leatherback turtles would be affected by the light from the marker.

In accordance with EO 12114, harm to leatherback turtles from target use in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, use of target-related materials under the No Action Alternative may affect leatherback turtles.

Chaff

As detailed in Section 3.2.1.1, chaff consists of aluminum-coated polymer fibers used as an electronic countermeasure designed to reflect radar waves and obscure aircraft, ships, and other equipment from radar tracking sources. Upon deployment, the chaff fibers are widely dispersed in the air and eventually land in the water and sink to the ocean floor. An extensive review of literature, combined with controlled experiments, revealed that chaff use poses little risk to the environment or animals (U.S. Air Force 1997, Naval Research Laboratory 1999, Arfsten et al. 2002, Farrell and Siciliano 2007). The materials in chaff are generally nontoxic except in quantities significantly larger than those any animal could reasonably be exposed to from normal usage. Particulate tests concluded that the concern about chaff fibers breaking down into respirable particle sizes is not a significant issue. Experiments have shown that animals should not suffer toxic or physical effects from chaff ingestion (U.S. Air Force 1997, Naval Research Laboratory 1999). It is likely that due to the small size of chaff, if ingested, it would pass through the digestive tract and be voided naturally without causing harm, sublethal, or lethal effects. Under the No Action Alternative, ingestion of chaff, although very unlikely, could occur but any effects are likely insignificant and discountable. In accordance with the ESA effects determination language, use of chaff under the No Action Alternative may affect leatherback turtles.

Entanglement

Entanglement in persistent marine debris threatens the survival of sea turtles in the eastern Pacific Ocean (NMFS and USFWS 1998a). Often, sea turtles that become entangled in debris or abandoned fishing gear cannot submerge to feed or surface to breathe. Those that do not starve or drown may lose a limb or attract predators with their struggling. Sea turtles can also become entangled in plastics and other buoyant and persistent synthetic debris discarded into the ocean (Balazs 1995, Carr 1987).

Although entanglement in military expended materials was not cited as a source of injury or mortality for any sea turtle in a large stranding database for Californian waters, there is a potential for sea turtles to become entangled in expended materials.

The greatest risk of entanglement occurs when expendable devices, primarily parachutes, are on or near the surface. Aircraft-launched sonobuoys, flares, and other expendable devices deploy nylon parachutes of varying sizes (e.g., the surface area is 1.5 square ft [ft^2] [0.1 square m {m^2}] to 3.5 ft^2 [0.3 m^2]). At water impact, the parachute lines and assembly is expended and sinks because all of the material is negatively buoyant. Other components of the expendable devices are metallic and will sink rapidly. Entanglement and the eventual drowning of a leatherback turtle in a parachute assembly would be unlikely because such an event would require the parachute to land directly on a leatherback turtle, or the leatherback turtle to swim into the parachute before it sinks. Approximately 56 expendable devices employing parachutes are used annually under the No Action Alternative in the TMAA.

The expended material accumulates on the ocean floor and is covered by sediments over time, reducing the potential for entanglement. If bottom currents are present, the canopy may billow and pose an entanglement threat to sea turtles with bottom-feeding habits. As described in Species Accounts and Life History, leatherback turtles have been recorded as diving to depths in excess of 1,200 m (3,937 ft) (DoN 2006) though spend the majority of time at depths less than 100m (328ft). With the general depth in the TMAA being over 1,000 m (3,281 ft), the probability of a leatherback turtle encountering a submerged parachute assembly is low, and the potential for accidental entanglement in the canopy or suspension lines is therefore discountable.

In accordance with EO 12114, harm to leatherback turtles from entanglement from military expended materials in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, entanglement from military expended materials under the No Action Alternative may affect leatherback turtles.

3.7.2.4 Alternative 1

Under Alternative 1, the level of activities in the TMAA would increase relative to the No Action Alternative. In addition to accommodating an increase in training activities currently conducted, Alternative 1 would also support an introduction of training activities to include training activities associated with ASW training.

Vessel Movements

Under Alternative 1, the number of vessels used in training events would increase from 23 under the No Action Alternative (current conditions) to 27 surface vessels plus 1 submarine; however, vessel movements would be widely dispersed throughout the area. This would be an increase of 17 percent over the No Action Alternative's current conditions. The small increase in number of vessels over current conditions would not measurably increase potential effects to sea turtles. As described for the No Action Alternative, leatherback turtles exposed to the general disturbance associated with a passing Navy vessel could exhibit a short-term behavioral response such as fleeing. In accordance with EO 12114, harm to leatherback turtles from vessel movements in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, vessel movements under Alternative 1 may affect leatherback turtles.

Vessel Collisions

The types of vessel strike impacts to sea turtles under Alternative 1 would be the same as those described for the No Action Alternative. The increase of four surface vessels and one submarine over current conditions would not measurably change effects on sea turtles relative to the No Action Alternative.

In accordance with EO 12114, harm to leatherback turtles from vessel movements in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, vessel collisions under Alternative 1 may affect leatherback turtles.

Aircraft Overflights

Under Alternative 1, overflights associated with 300 sorties would occur above the TMAA annually. This would represent no change from No Action Alternative conditions. In addition there would be 59 training events that may involve helicopter flights conducted over water, an approximate 84 percent increase from the No Action Alternative. As with the other alternatives, most aircraft overflights would occur over the TMAA at elevations in excess of 15,000 ft (915 m). All aircraft overflights between the shore and 12 nm (22 km) from land would occur at altitudes at or above 15,000 ft (915 m).

Exposures to elevated noise levels associated with Alternative 1 would be brief and infrequent, based on the transitory, dispersed nature of the overflights. Sound exposure levels are relatively low because sea turtles spend only three to six percent of the time at the sea surface, and most of the overflights would be above 15,000 ft.

As described for aircraft overflights under the No Action Alternative, sea turtles could exhibit no response, or may exhibit behavioral reactions such as quick diving. Any behavioral avoidance reaction would be short-term and would not permanently displace animals or result in physical harm. Overflights are not expected to result in chronic stress because it is extremely unlikely that individual animals would be repeatedly exposed to low-altitude overflights.

In accordance with EO 12114, harm to leatherback turtles from vessel movements in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, aircraft overflights under Alternative 1 may affect leatherback turtles.

At-Sea Explosions

Under Alternative 1, approximately 72 bomb explosions would occur each year during training activities in the TMAA, which is a 52% increase over the No Action Alternative. There would also be 42 5-in rounds and 14 76mm rounds fired during S-S GUNEX, which is a 167% increase over the No Action Alternative.

In addition, 40 SSQ-110A Improved Extended Echo Ranging (IEER) sonobuoys could be used for the first time in the TMAA under Alternative 1 in association with ASW training. These sonobuoys contain an explosive component and could be used in all areas of the TMAA. In the very rare event that a leatherback sea turtle was in the vicinity of an IEER sonobuoy, remained undetected, and loitered in the vicinity until the 4.4-lb charge was detonated, the leatherback turtle could be exposed to noise and the pressure wave from the detonation. Monitoring and resource protection undertaken prior to any detonation of an IEER would reduce the likelihood of sea turtles being exposed to such detonations. Protective measures that are used during training activities to identify sea turtle presences and suspend detonation activities if a sea turtle should be spotted would make these effects discountable.

An analysis of potential impacts from at-sea explosions under Alternative 1 using acoustic modeling could not conducted for leatherback turtles. There is no data regarding the abundance or distribution in the Pacific (NMFS and USFWS 1998c) and no known density or information available to derive an estimate for the number of leatherback turtles in the GOA or in the TMAA. In analyses undertaken for similar actions at other locations, modeling to predict potential impacts required that the zone of influence resulting from each explosion or detonation be multiplied by the sea turtle density to assess the potential for and number of impacts likely (see Sea Turtle Hearing Section and Section 3.7.2.2 for sea turtle-specific thresholds and Section 3.8, Marine Mammals, for a full description of the modeling and methods). The approach in prior modeling efforts were to model without consideration for reduction in the predicted impact numbers as a result of standard mitigations (regarding standard mitigations, see Current Requirements and Practices Section).

Given the low numbers of leatherback turtles likely present in the TMAA, modeling would likely result in a conclusion that there were no exposures in any event. However, without density information and modeling of potential impacts, there remains a possibility there could be an exposure of a leatherback to at-sea explosions. Based on this possibility, under Alternative 1, the explosions and detonations that would take place in the TMAA may affect leatherback turtles. No sea turtle mortalities would be expected under this alternative. The Navy is working with NMFS through the ESA Section 7 consultation process to ensure that unavoidable significant effects to sea turtles do not result from implementation of the Proposed Action.

In accordance with EO 12114, harm to leatherback turtles from explosive ordnance use in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, use of explosive ordnance in the TMAA under Alternative 1 may affect leatherback turtles.

Expended Materials

Ordnance-Related Materials

Under Alternative 1, a total of 19,101 items of ordnance or related materials would be expended. This is a 17 percent increase over current conditions. As described for the No Action Alternative, leatherback turtles would not be expected to be at risk from ingesting ordnance-related materials because they feed in the water column, not in the benthic environment. Because these materials sink rapidly and are encrusted on the seafloor, the potential to affect leatherbacks would be remote.

In accordance with EO 12114, harm to leatherback turtles from expended materials in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, ordnance-related materials under Alternative 1 may affect leatherback turtles.

Nonexplosive Ordnance Use

Approximately 12,987 nonexplosive ordnance rounds would be used in the TMAA annually under Alternative 1. This is a 20 percent increase from current conditions and includes including inert bombs, missiles, naval gun shells, cannon shells, and small-caliber ammunition. Ordnance is used in all areas of the TMAA. Given the few number of leatherback turtles likely in the TMAA, the large area encompassed by the training activities, and area clearance procedures, the potential for leatherback turtles to be struck by ordnance is very low.

In accordance with EO 12114, harm to leatherback turtles from nonexplosive ordnance use in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, nonexplosive ordnance strikes under the Alternative 1 may affect leatherback turtles.

Target-Related Materials

At-sea targets used in the TMAA could range from high-technology, remotely operated airborne and surface targets (such as airborne drones) to low-technology, floating, at-sea targets (such as inflatable targets) and airborne, towed banners. Many of the targets are designed to be recovered for reuse and are not destroyed during training (i.e., Killer Tomato and BQM-74E). The expendable targets used in the study area under this alternative are the Tactical Air Launched Decoy (TALD), BQM-74E, and Killer Tomato. When not recovered after use, these units are large and remain in large pieces when they sink to the bottom after use. Because of this characteristic, they present no ingestion hazard to sea turtles. Under Alternative 1, there would be 322 target-related materials expended.

As discussed for the No Action Alternative, the smoke and flames produced by the marine markers or flares dissipate in the air, having little effect on the marine environment. While the light generated from the marker is bright enough to be seen up to 3 mi (4.8 km) away in ideal conditions, the light either reflects off the water's surface or enters the water and attenuates in brightness over depth.

In accordance with EO 12114, harm to leatherback turtles from target use in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, use of target-related materials under Alternative 1 may affect leatherback turtles.

Chaff

As detailed in Section 3.2.1.1 chaff consists of aluminum-coated polymer fibers used as an electronic countermeasure designed to reflect radar waves and obscure aircraft, ships, and other equipment from radar tracking sources. Upon deployment, the chaff fibers are widely dispersed in the air and eventually land in the water and sink to the ocean floor. An extensive review of literature, combined with controlled experiments, revealed that chaff use poses little risk to the environment or animals (U.S. Air Force 1997, Naval Research Laboratory 1999, Arfsten et al. 2002, Farrell and Siciliano 2007). The materials in chaff are generally nontoxic except in quantities significantly larger than those any animal could reasonably be exposed to from normal usage. Particulate tests concluded that the concern about chaff fibers breaking down into respirable particle sizes is not a significant issue. Experiments have shown that animals should not suffer toxic or physical effects from chaff ingestion (U.S. Air Force 1997, Naval Research Laboratory 1999). It is likely that due to the small size of chaff, if ingested, it would pass through the digestive tract and be voided naturally without causing harm, sublethal, or lethal effects. Under Alternative 1, ingestion of chaff, although very unlikely, could occur but any effects are likely insignificant and discountable. In accordance with the ESA effects determination language, use of chaff under Alternative 1 may affect leatherback turtles.

Portable Undersea Tracking Range

The PUTR is a self-contained, portable, undersea tracking capability that employs modern technologies to support coordinated undersea warfare training for Forward Deployed Naval Forces (FDNF). PUTR will be available in two variants to support both shallow and deep water remote activities in keeping with Navy requirements to exercise and evaluate weapons systems and crews in the environments that replicate the potential combat area. The system will be capable of tracking submarines, surface ships, weapons, targets, and Unmanned Underwater Vehicles (UUVs) and distribute the data to a data processing and display system, either aboard ship, or at a shore site.

No area supporting a PUTR system has been identified. The transponders are not deployed on sensitive hard-bottom habitat, but rather on soft-bottom habitats. There would be direct impact to soft bottom habitat from the clump weight anchoring the transponder, however, this should have no impact on sea turtles. Cabling between the clump weight and the transponder is under tension and would not present an entanglement hazard to leatherback sea turtles. Upon completion of the exercise, the transponders are recovered, which eliminates any potential impacts associated with hazardous materials such as batteries and electronic components associated with the PUTR system. The clump weight is not recovered, and since it is composed of inert material, it is not a potential source of contaminants. Sediments stirred up by the clump weight anchor should only result in a temporary and localized turbidity. Therefore, use of the PUTR under Alternative 1 is not likely to have impact on sea turtles.

Entanglement

Under Alternative 1, use of parachuted expended devices (sonobuoys, flares, EMATT) would increase by 859 items as compared to the No Action Alternative. Changes in the use of targets and markers that are delivered using parachutes were provided under "Target-Related Materials." The greatest risk of entanglement occurs when expendable devices, primarily parachutes, are on or near the surface. Aircraft-launched sonobuoys, flares, and other expendable devices deploy nylon parachutes of varying sizes. At water impact, the parachute lines and assembly is expended and sinks because all of the material is negatively buoyant. Other components of the expendable devices are metallic and will sink rapidly. Entanglement and the eventual drowning of a leatherback turtle in a parachute assembly would be unlikely because such an event would require the parachute to land directly on a leatherback turtle, or the leatherback turtle to swim into the parachute before it sinks.

In accordance with EO 12114, harm to leatherback turtles from entanglement from military expended materials in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, entanglement from military expended materials under Alternative 1 may affect leatherback turtles.

3.7.2.5 Alternative 2

Under Alternative 2, the level of activities in the TMAA would increase relative to the No Action Alternative and Alternative 1. Implementation of Alternative 2 would generally double the number of activities proposed under Alternative 1. Alternative 2 includes the following activities:

- Conduct one additional separate summertime CSG exercise lasting up to 21 days within the ATA.
- Conduct a SINKEX in each summertime exercise (a maximum of 2) in the TMAA.

Vessel Movements

Under Alternative 2, there may be up to 27 surface vessels and 1 submarine participating in training activities during two training periods. This alternative would increase by 17 percent the number of vessels relative to the No Action Alternative. Vessel movements would be widely dispersed throughout the TMAA. The increase in the number of vessels would not measurably increase potential effects to sea turtles. Sea turtles exposed to the general disturbance associated with a passing Navy vessel could exhibit a short-term behavioral response such as fleeing. In accordance with EO 12114, harm to leatherback turtles from vessel movements in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, vessel disturbance under Alternative 2 may affect leatherback turtles.

Vessel Collisions

The types of vessel strike effects to sea turtles under Alternative 2 would be the same as those described for the No Action Alternative. The 17 percent increase in the number of vessels associated with this alternative would not measurably change effects on sea turtles under Alternative 2 in comparison to the No Action Alternative.

In accordance with EO 12114, harm to leatherback turtles from vessel movements in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, vessel disturbance under Alternative 2 may affect leatherback turtles.

Aircraft Overflights

Under Alternative 2, overflights associated with 600 sorties would occur above the TMAA annually. This would be a 100 percent increase over the number of overflights in the No Action Alternative. In addition there would be 120 training events that may involve helicopter flights conducted over water, an approximate 275 percent increase from the No Action Alternative. As with the other alternatives, most aircraft overflights would occur over the TMAA at elevations in excess of 15,000 ft (915 m). All aircraft overflights between the shore and 12 nm (22 km) from land would occur at altitudes at or above 15,000 ft (915 m).

The increase in potential exposure to visual and noise disturbance that would be associated with the increase in sorties and helicopter flights would not measurably increase effects to sea turtles. Sea turtles could exhibit no response, or may change their behavior to avoid the disturbance. Any behavioral avoidance reaction would be short-term and would not permanently displace animals or result in physical harm. Overflights are not expected to result in chronic stress because it is extremely unlikely that individual animals would be exposed to low-altitude overflights during the short periods of takeoff and landing.

In accordance with EO 12114, harm to leatherback turtles from vessel movements in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, aircraft overflights under Alternative 2 may affect leatherback turtles.

At-Sea Explosions

Under Alternative 2, approximately 144 live bombs may be dropped during BOMBEX and 84 5-in rounds and 28 76mm rounds could be fired during S-S GUNEX. In addition, 80 SSQ-110A explosive sonobuoys would be used during ASW Tracking Exercises (TRACKEXs) under Alternative 2. These events involving the use of at-sea explosions may occur in all areas of the TMAA. As mentioned previously, monitoring and resource protection undertaken prior to any detonation of an IEER would reduce the likelihood of sea turtles being exposed to such detonations. Protective measures that are used during training activities to identify sea turtle presence and suspend detonation activities if a sea turtle should be spotted would make these effects discountable.

In addition to the events noted above, under Alternative 2 the potential to conduct a SINKEX training event during each of the two possible summer exercise periods is also proposed. During a SINKEX, a decommissioned vessel is towed to a deep-water location and sunk using a variety of ordnance containing high explosives that may include missiles, bombs, and gunfire. For each SINKEX, there may be up to 10 non-inert bombs and 400 explosive rounds of 5-inch gunfire used during the event. For modeling purposes it was assumed that approximately one third of the munitions used (one Maverick missile, three bombs, and 120 of the 5-inch rounds) would miss the target and explode in the water (for details, see Appendix D). SINKEX may also include the use of one MK-48 ADCAP torpedo, which can be used at the end of SINKEX if the target is still afloat.

Aspects of the SINKEX event that have potential effects on sea turtles (e.g., vessel movement, aircraft overflights, gunfire firing noise, munitions constituents) have been analyzed separately in previous sections. Other than as a result of a vessel strike, serious injury and/or mortality to individual sea turtles is unlikely. If a sea turtle remained in the immediate vicinity of the SINKEX and ordnance missed the target vessel, injury or mortality could occur. SINKEX under Alternative 2 is, however, not likely to result in impacts to leatherback turtles based on the low number of leatherback turtles likely to be in the TMAA, the assumption that they will not remain in the vicinity of the activities surrounding a SINKEX event, and area clearance procedures (See Section 5.1.7).

An analysis of potential impacts from at-sea explosions under Alternative 2 using acoustic modeling, could not conducted for leatherback turtles. There is no data available regarding the abundance or distribution in the Pacific (NMFS and USFWS 1998c) and no known density or information available to derive an estimate for the number of leatherback turtles in the GOA or in the TMAA. In analyses undertaken for similar actions at other locations, modeling to predict potential impacts required that the zone of influence resulting from each explosion or detonation be multiplied by the sea turtle density to assess the potential for and number of impacts likely (see Sea Turtle Hearing Section and Section 3.7.2.2 for sea turtle-specific thresholds and Section 3.8, Marine Mammals, for a full description of the modeling and methods).

Given the low numbers of leatherback turtles likely present in the TMAA, modeling would likely result in a conclusion that there were no exposures in any event. However, without density information and modeling of potential impacts, there remains a possibility there could be an exposure of a leatherback to at-sea explosions. Based on this assumption, under Alternative 2, the explosions and detonations that would take place in the study area are unlikely to affect leatherback turtles. No sea turtle mortalities would be expected under this alternative. The Navy is working with NMFS through the ESA Section 7 consultation process to address effects to sea turtles for the Preferred Alternative (Alternative 2). NMFS will determine, through issuance of a Biological Opinion, the effect to listed species that may result from implementation of the Proposed Action.

In accordance with EO 12114, harm to leatherback turtles from explosive ordnance use in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, use of explosive ordnance in the TMAA under Alternative 2 may affect leatherback turtles.

Expended Materials

Ordnance-Related Materials

Approximately 39,036 items of ordnance or related materials would be used in the TMAA under Alternative 2; the majority of these are non-explosive rounds, this is a 60 percent increase over current conditions. As discussed for the no Action Alternative and Alternative 1, leatherback turtles would not be expected to be at risk under Alternative 2 from ingesting ordnance-related materials because they feed in the water column, not in the benthic environment. Because these materials sink rapidly and are encrusted on the seafloor, the potential to affect the leatherback would be discountable. In accordance with EO 12114, harm to leatherback turtles from expended materials in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, ordnance-related materials under Alternative 2 may affect leatherback turtles.

Nonexplosive Ordnance Use

Approximately 25,922 nonexplosive ordnance rounds would be used in the TMAA under Alternative 2, an increase of 60 percent over the No Action Alternative. Ordnance could be used in all areas of the TMAA. Given the few number of leatherback turtles likely in the TMAA, the large area encompassed by the training activities, and area clearance procedures, the potential for leatherback turtles to be struck by ordnance is low.

In accordance with EO 12114, harm to leatherback turtles from nonexplosive ordnance use in nonterritorial seas would be possible but very unlikely. In accordance with the ESA effects determination language, nonexplosive ordnance strikes under Alternative 2 may affect leatherback turtles.

Target-Related Materials

At-sea targets used in the TMAA could range from high-technology, remotely operated airborne and surface targets (such as airborne drones) to low-technology, floating, at-sea targets (such as inflatable targets) and airborne, towed banners. A total of 644 targets and target related materials would be used under Alternative 2, an increase of 160% over the No Action Alternative. Many of the targets are designed to be recovered for reuse and are not destroyed during training. The expendable targets used in the study area under this alternative are the Tactical Air Launched Decoy (TALD), BQM-74E, and Killer Tomato. When not recovered after use, these units are large and remain in large pieces when they sink to the bottom after use. Because of this characteristic, they present no ingestion hazard to sea turtles.

As discussed for the No Action Alternative, the smoke and flames produced by marine markers and flares dissipate in the air, having little effect on the marine environment. The light generated from the marker either reflects off the water's surface or enters the water and attenuates in brightness over depth.

In accordance with EO 12114, harm to leatherback turtles from target use in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, use of target-related materials under Alternative 2 may affect leatherback turtles.

Chaff

As detailed in Section 3.2.1.1 chaff consists of aluminum-coated polymer fibers used as an electronic countermeasure designed to reflect radar waves and obscure aircraft, ships, and other equipment from radar tracking sources. Upon deployment, the chaff fibers are widely dispersed in the air and eventually land in the water and sink to the ocean floor. An extensive review of literature, combined with controlled experiments, revealed that chaff use poses little risk to the environment or animals (U.S. Air Force 1997, Naval Research Laboratory 1999, Arfsten et al. 2002, Farrell and Siciliano 2007). The materials in chaff are generally nontoxic except in quantities significantly larger than those any animal could reasonably be exposed to from normal usage. Particulate tests concluded that the concern about chaff fibers breaking down into respirable particle sizes is not a significant issue. Experiments have shown that animals should not suffer toxic or physical effects from chaff ingestion (U.S. Air Force 1997, Naval Research Laboratory 1999). It is likely that due to the small size of chaff, if ingested, it would pass through the digestive tract and be voided naturally without causing harm, sublethal, or lethal effects. Under Alternative 2, although the use of chaff may double as compared to the No Action Alternative, ingestion of chaff remains, although very unlikely, could occur but any effects are likely insignificant and discountable. In accordance with the ESA effects determination language, use of chaff under Alternative 2 may affect leatherback turtles.

Portable Undersea Tracking Range

Under Alternative 2, impacts from the PUTR would be the same as those described for Alternative 1. The use of the PUTR is not likely to have impact on sea turtles.

Entanglement

Under Alternative 2, the use of 1,847 expendable devices using parachutes is proposed. Changes in the use of targets, sonobuoys, and markers that are delivered using parachutes were provided under "Target-Related Materials." The greatest risk of entanglement occurs when expendable devices, primarily parachutes, are on or near the surface. Aircraft-launched sonobuoys, flares, and other expendable devices deploy nylon parachutes of varying sizes. At water impact, the parachute lines and assembly is expended and sinks because all of the material is negatively buoyant. Other components of the expendable devices are metallic and will sink rapidly. Entanglement and the eventual drowning of a leatherback turtle in a parachute assembly would be unlikely because such an event would require the parachute to land directly on a leatherback turtle, or the leatherback turtle to swim into the parachute before it sinks.

In accordance with EO 12114, harm to leatherback turtles from entanglement from military expended materials in nonterritorial seas would be possible but unlikely. In accordance with the ESA effects determination language, entanglement from military expended materials under Alternative 2 may affect leatherback turtles.

3.7.3 Mitigation

Impacts to the leatherback turtle resulting from the alternatives proposed in this EIS/OEIS would be below thresholds that could adversely affect the continued presence of this species in the GOA or the TMAA. The current requirements and practices described in Chapter 5 would continue to be implemented, and no further mitigation measures would be needed to protect leatherback turtles in the TMAA.

3.7.4 Summary of Effects

The presence of sea turtles species other than the leatherback turtle is restricted by cold water temperatures that would otherwise result in thermal shock to those species. There is no data available from which to derive the number or density of leatherback turtles in the TMAA. The presumed low numbers of leatherback turtles based on temperature preference, limited number of stressors from Navy activities, and routine implementation by the Navy of protective measures combine to produce a low potential for effects to leatherback turtles under all the alternatives. Table 3.7-2 summarizes the effects of the No Action Alternative, Alternative 1, and Alternative 2 on leatherback turtles under both NEPA and EO 12114.

Table 3.7-2: Summary of Effects by Alternative

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
No Action Alternative	• Aircraft overflights would occur at altitudes at or above 15,000 ft (915 m) and have no effect on leatherback turtles.	• Activities would have temporary and spatially limited short-term impacts. • No long-term effects would occur. • No Action Alternative may affect ESA-listed leatherback turtles.
Alternative 1	• Aircraft overflights would occur at altitudes at or above 15,000 ft (915 m) and have no effect on leatherback turtles.	• Activities would have temporary and spatially limited short-term impacts. • No long-term effects would occur. • Alternative 1 may affect ESA-listed leatherback turtles.
Alternative 2 (Preferred Alternative)	• Aircraft overflights would occur at altitudes at or above 15,000 ft (915 m) and have no effect on leatherback turtles.	• Activities would have temporary and spatially limited short-term impacts. • No long-term effects would occur. • Alternative 2 may affect ESA-listed leatherback turtles.

3.8 Marine Mammals

3.8.1 Affected Environment

For purposes of this Draft Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the Region of Influence (ROI) for marine mammals is the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA). The TMAA is more than 12 nautical miles (nm) (22 kilometers [km]) from the closest point of land and is therefore outside of United States (U.S.) territorial Seas. Thus, this section provides an overview of the species, distribution, and occurrence of marine mammals that are either resident, are seasonally present, or migratory through the GOA TMAA. This section also presents the information concerning the affected environment of the GOA TMAA as it relates to marine mammals, provides an analysis of the environmental consequences resulting from the Proposed Action, and summarizes mitigation measures as they relate to protections of marine mammals potentially affected by the Proposed Action. The mitigation measures relating to the protection of marine mammals are presented in detail in Section 5.1.7 of Chapter 5, Mitigation Measures, of this EIS/OEIS.

All marine mammals are protected under the Marine Mammal Protection Act (MMPA). In addition, specific “listed species” are protected under the Endangered Species Act (ESA). Both the MMPA and ESA are administered by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS).

Information on species listed under the ESA is presented first, followed by non-ESA listed marine mammals subject to regulation under the Marine Mammal Protection Act (MMPA). These lists are further subdivided by taxonomic Order with the species listed by common name in alphabetical order. Tables are provided to summarize this information where appropriate.

Seven of the marine mammals found in the TMAA are designated “listed species” under the ESA. The ESA has additional requirements when assessing the effect of proposed activities on those species and their critical habitats. Sections 3.8.7.1 and 3.8.7.2 provide further details. All marine mammals are protected under the Marine Mammal Protection Act (MMPA) of 1972, amended in 1994. The MMPA is administered by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS).

Marine mammals that are expected to be present within the TMAA belong to two taxonomic groups:

- *Cetaceans* is the generalized term describing both *Mysticetes* (large whales with baleen) and *odontocetes* (toothed whales, porpoises, and dolphins).
- *Pinnipeds* (seals and sea lions) are divided into eared seals or *otariids* such as Steller sea lions and Northern fur seals, and earless seals or *phocids* such as harbor seals and elephant seals. Although pinnipeds come ashore to rest, molt, breed, and bear young, the waters of the TMAA are locations where they may hunt and feed.

There are 26 species of marine mammals with possible or confirmed occurrence in the waters of the GOA (Carretta et al. 2007, Angliss and Allen 2008, Rone et al. 2009, Stafford 2009), but not all inhabit waters within the TMAA (Table 3.8-1). Six species, the beluga whale (*Delphinapterus leucas*), false killer whale (*Pseudorca crassidens*), northern right whale dolphin (*Lissodelphis borealis*), Risso’s dolphin (*Grampus griseus*), short-finned pilot whale (*Globicephala macrorhynchus*), and sea otter (*Enhydra lutris*), are considered extralimital in the TMAA and not expected to be present given their documented habitat preferences (Department of the Navy [DoN] 2006, Angliss and Outlaw 2007). Since the TMAA is well outside the normal range of these species, they will be discussed briefly and then dismissed from further analysis.

Table 3.8-1: Summary of Marine Mammal Species Found in the GOA

Common Name *Species Name*	Abundance[a] (CV)	Stock	Calculated Density in the TMAA[b] (animals per km^2)	Population Trend	Occurrence in the TMAA (Apr - Dec)	Designated Critical Habitat
ESA Listed Cetaceans						
Blue whale[1,3,4] *Balaenoptera musculus*	1,368 (0.22)	Eastern North Pacific	No Density	May be increasing	Very rare	None in North Pacific
Cook Inlet Beluga Whale[1,3,4] *Delphinapterus leucas*	375[c]	Cook Inlet	NA	Decreasing	Extralimital	None
Fin whale [1,3,4] *Balaenoptera physalus*	2,636 (0.15)	Northeast Pacific	0.010	Increasing 4.8 percent annually	Common	None
Humpback whale[1,3,4] *Megaptera novaeangliae*	4,005 (0.95)	Central North Pacific and Western North Pacific	0.0019	May be increasing	Common	None
North Pacific Right Whale[1,3,4] *Eubalaena robustus*	Unknown (may be < 100 whales)	Eastern North Pacific	No Density	Unknown (may be decreasing)	Very rare	Yes- Outside of the TMAA
Sei whale[1,3,4] *Balaenoptera borealis*	43 (0.61)	Eastern North Pacific	No Density	May be increasing	Very rare	None
Sperm whale[1,3,4] *Physeter macrocephalus*	Unknown	North Pacific	0.0003	Unknown	Rare	None
ESA Listed Pinnipeds						
Steller sea lion [2,3,4] *Eumetopias jubatus*	45,095-55,832	Eastern U.S.	0.0098	Increasing (3.1 percent/year)	Common	Yes- Outside of the TMAA
Steller sea lion [1,3,4] *Eumetopias jubatus*	38,988	Western U.S.	0.0098	Decreasing (5.4 percent/year)	Common	Yes- Outside of the TMAA

Table 3.8-1: Summary of Marine Mammal Species Found in the GOA (continued)

Common Name *Species Name*	**Abundance[a] (CV)**	**Stock**	**Calculated Density in the TMAA[b] (animals per km^2)**	**Population Trend**	**Occurrence in the TMAA (Apr - Dec)**	**Designated Critical Habitat**
ESA listed Mustelid						
Sea otter *Enhydra lutris*	Unknown	South Central, Southeast and South West Alaska[2,3]	NA	Increasing	Extralimital	None
Non-ESA Listed Cetaceans						
Baird's beaked whale *Berardius bairdii*	Unknown	Alaska	0.0005	Unknown	Rare	None
Cuvier's beaked whale *Ziphius cavirostris*	Unknown	Alaska	0.0022	Unknown	Common	None
Dall's porpoise *Phocoenoides dalli*	83,400 (0.097)	Alaska	0.1892	Unknown	Common	None
False killer whale *Pseudorca crassidens*	Unknown	Hawaii	NA	Unknown	Extralimital	None
Gray whale *Eschrichtius robustus*	18,813 (0.069)	Eastern North Pacific	0.0125	Increasing	Common	None
Harbor porpoise[3] *Phocoena phocoena*	41,854 (0.224)	Gulf of Alaska	No Density	Stable	Rare	None
Killer whale- *Orcinus orca* (Multiple stocks that may occur in the TMAA)	249-1,123	Eastern North Pacific Alaska Resident & Northern Resident, Gulf of Alaska, Aleutian Islands and Bering Sea, AT1[3,4], West Coast and Offshore	0.010 (for all killer whales)	Increasing	Common	None
Minke whale *Balaenoptera acutorostrata*	Unknown	Alaska	0.0006	Unknown	Rare	None
Northern right whale dolphin *Lissodelphis borealis*	12,876 (0.30)	California/ Oregon/ Washington	NA	No trend	Extralimital	None

Table 3.8-1: Summary of Marine Mammal Species Found in the GOA (continued)

Common Name *Species Name*	Abundance[a] (CV)	Stock	Calculated Density in the TMAA[b] (animals per km^2)	Population Trend	Occurrence in the TMAA (Apr - Dec)	Designated Critical Habitat
Pacific white-sided dolphin *Lagenorhynchus obliguidens*	26,880 (0.90)	North Pacific	0.0208	Unknown	Common	None
Risso's Dolphin *Grampus griseus*	11,621 (0.17)	California, Oregon, and Washington	NA	Unknown	Extralimital	None
Short-finned pilot whale *Globicephala macrorhynchus*	245 (0.97)	California, Oregon, and Washington	NA	Unknown	Extralimital	None
Stejneger's beaked whale *Mesoplodon stejnegeri*	Unknown	Alaska	Density of Cuvier's beaked whale used as a surrogate[d]	Unknown	Common	None
Non-ESA Listed Pinnipeds						
California sea lion *Zalophus californianus*	238,000	U.S.	No Density	Increasing	Very rare	None
Harbor seal *Phoca vitulina richardii*	45,975 (0.04)	Gulf of Alaska	NA	Stable	Very rare	None
Northern elephant seal *Mirounga angustirostris*	124,000	California Breeding	0.0022	Increasing	Common	None
Northern fur seal[3,4] *Callorhinus ursinus*	665,550	Eastern Pacific	0.1180	Increasing	Common	None

Sources: Barlow and Forney 2007, Angliss and Allen 2008, Carretta et al. 2007, DoN 2007, Dahlheim et al. 2009
Notes: ESA notations: [1]endangered; [2]threatened. MMPA designations: [3]strategic stock; [4]depleted.
[a] Abundance numbers reported are for the entire stock (as listed in the next column) and not representative of the abundance present in the TMAA or GOA.
[b] Densities calculated for summer as discussed in Appendix E
[c] NOAA 2008a; Endangered Status for the Cook Inlet Beluga Whale
[d] No current estimates of abundance for Stejneger's beaked whales are available. Given that sufficient information exists for Cuvier's beaked whale, they are in the same taxonomic family, and the predicted density of Cuvier's beaked whale in the GOA is higher than that of Baird's beaked whales, estimates therefore err on the side of overestimation.
CV = Coefficient of Variation
km^2 = square kilometer
TMAA = temporary Maritime Activities Area
NA = not applicable given species is extralimital to TMAA.

The abundance for each species is specific to that species and varies seasonally in Alaska waters (Table 3.8-1; in simple terms, abundance is the number in a specified area and the density is the number per unit area). For purposes of analysis of environmental effects in this section, the abundance of the marine mammal species has been estimated using the summer months, which is when they are most abundant and when the proposed action would occur. As reflected in Table 3.8-1, many species are listed as common, indicating that they occur routinely, either year-round or during annual migrations into or through the area.

Some species are indicated as "rare" because of sporadic sightings and species listed as "very rare" are very few in number, very few in number in the TMAA, or are unlikely to be present in the TMAA. Those species considered "extralimital" are considered outside their normal habitat range in the TMAA although their past presence may have been documented on a few occasions in GOA. All of the species that occur in the TMAA are either cosmopolitan (occur worldwide), or associated with the temperate and sub-Arctic oceans (Leatherwood et al. 1988). For many species, the TMAA constitutes a small portion of their total range given seasonal migrations to warmer waters where breeding and calving occur. These species, for example, include the humpback whale (*Megaptera noveangliae*) and gray whale (*Eschrichtius robustus*), which both feed in Alaska waters in roughly the May to September timeframe.

The 20 species that occur in the TMAA include 7 species of baleen whales (mysticetes), 8 species of toothed whales/dolphins/porpoises (odontocetes), and 5 species of seals and sea lions (pinnipeds). Tables 3.8-1 and 3.8-2 summarize the available information regarding their density, ESA and MMPA status, population trends, and occurrence in the area.

Table 3.8-2: Summary of Marine Mammal Species, Density, and Information Sources for the TMAA in Summer (April – October)

Species	Density (animal /km^2)	Source
ESA Listed Species		
Fin whale	0.010	Rone et al. (2009)
Humpback whale	0.0019	Rone et al. (2009)
Sperm whale	0.0003	Waite (2003), Mellinger et al. (2004)
Steller sea lion	0.0098	Angliss and Allen (2008), Bonnell and Bowlby (1992)
Non-ESA Listed Species		
Gray whale	0.0125	Moore et al. (2007)
Minke whale	0.0006	Waite (2003)
Baird's beaked whale	0.0005	Waite (2003)
Cuvier's beaked whale	0.0022	Waite (2003)
Dall's porpoise	0.1892	Waite (2003)
Killer whale	0.0100	Zerbini et al. (2007)
Pacific white-sided dolphin	0.0208	Waite (2003)
Northern elephant seal	0.0022	Carretta et al., 2009
Northern fur seal	0.1180	Carretta et al., 2009

Notes: ESA = Endangered Species Act, km^2 = squared kilometers

Information presented in Tables 3.8-1 and 3.8-2 was compiled mainly from NMFS Stock Assessment Reports (Angliss and Outlaw 2007, Angliss and Allen 2008, Carretta et al. 2008) and supporting literature as referenced. Life history and habitat information for these species in the GOA was previously detailed in the Marine Resources Assessment for the GOA Operating Area (DoN 2006). Much of the species-specific information in that comprehensive assessment has been brought forward into this section of the Draft EIS/OEIS in summary or verbatim for the convenience of the reader.

Much of the analysis in this section deals with potential consequences resulting from exposure to underwater sound associated with Navy training activities. Behavioral responses to sound are greatly influenced by the context of the exposure and the individual animal's experience, motivation, and conditioning (Southall et al. 2007). While this leads to great variance in potential responses to a given sound, measurements of marine mammal sound production and hearing capabilities provide some basis for assessment of whether exposure to a particular sound source (its frequency and sound level) may affect a marine mammal behaviorally or potentially result in direct injury. Table 3.8-3 provides a summary of sound production and hearing capabilities for marine mammal species in the TMAA.

Table 3.8-3: Sound Production and Hearing Capabilities of Marine Mammals in the TMAA

Common Name	Sound Production		Hearing Ability
	Frequency Range (kHz)	Source Level Sound (dB re 1 µPa @ 1 m)	Frequency Range (kHz)
Baleen whales			
Blue whale	0.012 - 0.4	188 (maximum)	Not Available
Fin whale	0.010 - 0.75	155 - 186	Not Available
Gray whale	0.020 - 20	142 - 185	<2
Humpback whale	0.020 - 10	144 - 192	0.7 - 10 (predicted)
Minke whale	0.060 - 20	150 - 175	Not Available
North Pacific right whale	0.050 - 0.6	137 - 192	0.010 - 22 (predicted)
Sei whale	0.433 (+/- 0.192) - 3.5	156 +/- 3.6	Not Available
Toothed whales			
Baird's beaked whale	4 - 42	Not Available	Not Available
Cuvier's beaked whale	0.3 - 135	214 (maximum)	Not Available
Dall's porpoise	0.04 - 160	120 - 175	Not Available
Harbor porpoise	0.04 - 160	135 - 177	16 - 140
Killer whale	0.1 - 35	137 - 224	<0.5 - 105
Pacific white-sided dolphin	0.002 - 80	170 (peak amplitude)	0.075 - 150
Stejneger's beaked whale	Not Available	Not Available	Not Available
Sperm whale	0.1 - 30	140 - 236	5 - 20 (measured from 1 neonatal sperm whale)
Pinnipeds			
Harbor seal	0.1 - 150	Not Available	1 - 180
Northern elephant seal	0.2 - 1	Not Available	0.075 - 45
Northern fur seal	Not Available	Not Available	0.5 - 60
Steller sea lion	0.03 - 3 (female calls only)	Not Available	1 - 25
California sea lion	0.25 - 6	Not Available	1 - 40

Notes::Information presented in this table was compiled from numerous literature and technical sources, which are identified in each species profile.dB re 1 µPa @ 1 m = decibels referenced to 1 micropascal at 1 meter, kHz = kilohertz, TMAA = Temporary Maritime Activities Area

3.8.1.1 Marine Mammal Species Excluded from Further Analysis

Cook Inlet Beluga Whales

Only 28 sightings of beluga in the GOA have been reported from 1936 to 2000 (Laidre et al. 2000). The nearest beluga whales to the TMAA are in Cook Inlet with an abundance estimate of 375 whales in the Cook Inlet stock as of 2008 (NOAA 2008a). Cook Inlet beluga whales were listed as endangered on 22 October 2008 and have been previously designated as depleted under the MMPA (NOAA 2008a). Cook Inlet beluga whales do not leave the waters of Cook Inlet (NOAA 2007a, 2008a). Cook Inlet is approximately 70 nm (129.6 km) from the nearest edge of the TMAA. Based on this information, and the regulatory definition of the stock as those beluga whales confined to the waters of Cook Inlet, this stock of beluga whales will not be present in the TMAA, so this species will not be considered in greater detail in the remainder of this analysis.

False Killer Whale

False killer whales should not occur in the TMAA. False killer whales are found in tropical and temperate waters, generally between 50°S and 50°N latitude (Baird et al. 1989, Odell and McClune 1999). The southernmost point boundary of the TMAA is well north of 55°N latitude. There have been records of false killer whale sightings as far north as the Aleutian Islands and Prince William Sound in the past (Leatherwood et al. 1988). A solitary false killer whale was sighted in May 2003 near Juneau, but this was considered to be far north of its normal range (DoN 2006). There are no abundance estimates available for this species in the NMFS stock assessment report for this area of the Pacific. In summary, false killer whales are considered extralimital to the TMAA and will not be considered further in this analysis.

Northern Right Whale Dolphin

Northern right whale dolphins (*Lissodelphis borealis*) should not occur in the TMAA. This species occurs in North Pacific oceanic waters and along the outer continental shelf and slope in cool temperate waters colder than 20°C. This species is distributed approximately from 30°N to 55°N and 145°W to 118°E (both south and east of the TMAA). There are two records of northern right whale dolphins in the GOA (one just south of Kodiak Island), but these are considered extremely rare (DoN 2006). There are no abundance estimates available for this species in the NMFS stock assessment report for this area of the Pacific. In summary, northern right whale dolphins are considered extralimital to the TMAA and will not be considered further in this analysis.

Risso's Dolphin

The Risso's dolphin is distributed worldwide in tropical to warm-temperate waters, roughly between 60°N and 60°S, where surface water temperature is usually greater than 50°F (10°C) (Kruse et al. 1999). The average sea surface temperature for the GOA is reported to be approximately 49.3°F (9.6°C) and has undergone a warming trend since 1957 (Aquarone and Adams 2008). The average summer temperature within the upper 328 ft (100 m) of the TMAA is approximately 52°F (11°C) based on data as presented in the modeling analysis undertaken. In the eastern Pacific, Risso's dolphins range from the GOA to Chile (Leatherwood et al. 1980, Reimchen 1980, Braham 1983, Olavarria et al. 2001). Water temperature appears to be a factor that affects the distribution of Risso's dolphins in the Pacific (Leatherwood et al. 1980, Kruse et al. 1999). Risso's dolphins are expected to be extralimital in the TMAA. They prefer tropical to warm-temperate waters and have been seldom sighted in the cold waters of the GOA. There are a few records of this species near the TMAA. Risso's dolphins have been sighted near Chirikof Island (southwest of Kodiak Island) and offshore in the GOA, just south of the TMAA boundary (Consiglieri et al. 1980, Braham 1983). Based on the above information, there is a very low likelihood of Risso's dolphins being present in the action area, so this species will not be considered in greater detail in the remainder this analysis.

Short-finned Pilot Whale

Short-finned pilot whales should not occur in the TMAA. This species is found in tropical to warm-temperate seas, generally in deep offshore areas and they do not usually range north of 50°N (DoN 2006). There are two records of this species in Alaskan waters. A short-finned pilot whale was taken near Katanak on the Alaska Peninsula in 1937 and a group of five short-finned pilot whales were sighted just southeast of Kodiak Island in May 1977 (DoN 2006). There are no abundance estimates available for this species in the NMFS stock assessment report for this area of the Pacific. In summary, short-finned pilot whales are considered extralimital to the TMAA and will not be considered further in this analysis.

Sea Otter

On 16 December 2008, the USFWS proposed to designate critical habitat for the Southwest Alaska stock of the northern sea otter (*Enhydra lutris kenyoni*) under the ESA (Department of the Interior [DOI] 2008). This critical habitat designation was effective as of 9 November 2009. This species is under the federal jurisdiction of the USFWS.

Sea otters occupy and use shorelines and coastal nearshore habitat well outside the boundaries of the TMAA. Sea otters are primarily found within 1-2 km (0.5-1.1 nm) of the shore and/or the 30 fathom (55 m) isobath (DOI 2008, NMFS 2005a). Critical habitat map units boundaries for "Unit 5" in the Kodiak Island area are for nearshore waters within approximately 328 ft (100 m) from the mean high tide line. The closest point from the critical habitat to the TMAA is, therefore, located more than 24 nm (44 km) from the western corner of the TMAA. Sea otters are considered extralimital to the TMAA and none were encountered within the TMAA during the April 2009 GOALS survey (Rone et al. 2009).

3.8.2 Estimated Marine Mammal Densities and Distribution

Marine mammal species occurring in the GOA include baleen whales (mysticetes), toothed whales, dolphins, and porpoises (odontocetes), and seals and sea lions (commonly referred to as pinnipeds). Baleen and toothed whales as well as dolphins and porpoises, collectively known as cetaceans, spend their entire lives in the water and spend most of the time (>90 percent for most species) entirely submerged below the surface. When at the surface, cetacean bodies are almost entirely below the water's surface, with only the blowhole exposed to allow breathing. This makes cetaceans difficult to locate visually and also exposes them to underwater noise, both natural and anthropogenic, essentially 100 percent of the time because their ears are nearly always below the water's surface. Seals and sea lions (pinnipeds) spend significant amounts of time out of the water during breeding, molting and hauling out periods. In the water, pinnipeds spend varying amounts of time underwater, as some species regularly undertake long, deep dives (e.g., elephant seals) and others are known to rest at the surface in large groups for long amounts of time (e.g., California sea lions). Sea lions often forage in bouts and then rest at the surface therefore their overall time underwater is much less than a cetacean. When not actively diving, pinnipeds at the surface often hold their heads above the water surface. Consequently, pinnipeds may not be exposed to underwater sounds to the same extent as cetaceans.

For the purposes of this analysis, the Navy has adopted a conservative approach to modeling underwater noise exposure to marine mammals, in that it will tend to overestimate exposures as follows:

- *Cetaceans – assume 100 percent of time is spent underwater and therefore exposed to noise.*
- *Pinnipeds – adjust densities to account for time periods spent at breeding areas, haulouts, etc.; but for those animals in the water, assume 100 percent of time is spent underwater and therefore exposed to noise.*

3.8.2.1 Derivation of Marine Mammal Density Estimates for TMAA

Recent survey data for marine mammals in the GOA was limited and most survey efforts were localized and extremely near shore. In addition to the visual surveys, there is evidence of occurrence of several species based on acoustic studies, but these do not provide measurements of abundance (e.g., Stafford 2009).

In April 2009, the Navy funded and NMFS conducted the Gulf of Alaska Line-Transect Survey (GOALS) to address the data needs for this analysis (Rone et al. 2009). Line-transect survey visual data to support distance sampling statistics and acoustic data were collected over a 10-day period both within and outside the TMAA. This survey resulted in sightings of several species and allowed for the derivation of densities for fin and humpback whale (Rone et al. 2009). In addition to this latest survey, two previous vessel surveys conducted in the near shore region of the TMAA were also used to derive the majority of the density data used in acoustic modeling for this analysis. The methods used to derive density estimates for all remaining species in the TMAA are detailed in Appendix E and summarized below.

Zerbini et al. (2006) conducted dedicated vessel surveys for large whales in summer 2001-2003 from Resurrection Bay on the Kenai Peninsula to Amchitka Island in the Aleutian Islands. Survey effort near the TMAA was nearshore (within approximately 46 nm [85 km] of shore), and is delineated as “Block 1” in the original paper. Densities for this region were published for fin and humpback whales.

Waite (2003) conducted vessel surveys for cetaceans near Kenai Peninsula, within Prince William Sound and around Kodiak Island, during acoustic-trawl surveys for pollock in summer 2003. Surveys extended offshore to the 1,000 meter (3,280 feet [ft]) isobath and therefore overlapped with some of the TMAA. Waite (2003) did not calculate densities, but did provide some of the elements necessary for calculating density (see Appendix E).

Mysticetes occurring in the GOA include blue, fin, gray, humpback, minke, North Pacific right, and sei whales which have been sighted in the GOA (Angliss and Allen 2008, Rone et al. 2009). Blue, North Pacific right, and sei whales are considered rare, are too few in number to allow for quantitative analysis, and are included here only for discussion purposes given they are endangered species.

Gray whale density was calculated from data obtained from feeding studies near shore in the GOA. Gray whales are found almost exclusively in near shore areas; therefore, they would not be expected to be found in the majority of the TMAA (>50 nm [93 km] offshore and >5,997 ft [1,828 m] depth). (DoN 2006) The recent 2009 survey encountered one group of two gray whales on the shelf within the western edge of the TMAA and two groups well outside the TMAA near shore at Kodiak Island (Rone et al. 2009).

Odontocetes occurring regularly include sperm whale, Cuvier’s, Baird’s, and Stejneger’s beaked whales, killer whale, Pacific white-sided dolphin, and Dall’s porpoise (Angliss and Allen 2008, Rone et al. 2009). In Alaskan waters, harbor porpoises inhabit nearshore areas and are common in bays, estuaries, and tidal channels. In the GOA, harbor porpoise inhabit coastal waters where depths are less than 328 ft (100 m) in depth (DoN 2006, Angliss and Allen 2008). The majority of the TMAA is well offshore of the normal habitat range for harbor porpoise. There is no density data available for this species in the nearshore fraction of the TMAA overlapping the harbor porpoise range. An estimated quantification of impacts for harbor porpoise was, however, undertaken as is described in Section 3.8.4.6.

Pinnipeds occurring regularly include Steller sea lion, northern fur seal, and northern elephant seal. California sea lion range extends as far north as the Pribilof Islands in the Bering Sea. Tagging data indicate that most northern fur seal forage and migration takes place to the west of the TMAA (Ream et al. 2005), although the derived density for this species assumed the population would be present in the area for modeling purposes. Harbor seals are primarily a coastal species and are rarely found more than 12 miles (mi) (20 km) from shore (DoN 2006). Harbor seals should be very rare in the TMAA and there was no attempt to model for this species.

Pinniped at-sea density is not often available because pinniped abundance is obtained via shore counts of animals at known rookeries and haulouts. Lacking any other available means of quantification, densities of pinnipeds were derived using shore counts. Several parameters were identified for pinnipeds from the literature, including area of stock occurrence, number of animals (which may vary seasonally) and season, and those parameters were then used to calculate density. Once density per “pinniped season” was determined, those values were prorated to fit the warm water (June-October) and cold water (November-May) seasons. Determining density in this manner is risky as the parameters used usually contain error (e.g., geographic range is not exactly known and needs to be estimated and abundance estimates usually have large variances). As is true of all density estimates, they assume that animals are always distributed evenly within an area which is likely never true. Table 3.8-2 presents all available densities of species for the TMAA and pertinent references.

Additional information on all species can be found in the Marine Resources Assessment for the GOA Operating Area (DoN 2006). The Marine Resource Assessment listed 6 mysticetes, 12 odontocetes, and 5 pinnipeds as occurring or possibly occurring in the GOA region (DoN 2006; Table 3.8-1). However, several of the species listed are extralimital to the TMAA. Only species for which densities are available are included in Table 3.8-2.

3.8.2.2 Depth Distribution

There is limited depth distribution data for most marine mammals. There are a few different methodologies/techniques that can be used to determine depth distribution percentages, but by far the most widely used technique currently is the time-depth recorder. These instruments are attached to the animal for a fairly short period of time (several hours to a few days) via a suction cup or glue, and then retrieved immediately after detachment or when the animal returns to the beach. Depth information can also be collected via satellite tags, sonic tags, digital tags, and, for sperm whales, via acoustic tracking of sounds produced by the animal itself.

There are somewhat suitable depth distribution data for a few marine mammal species. Sample sizes are usually extremely small, nearly always fewer than 10 animals total and often only 1 or 2 animals. Depth distribution information often must be interpreted from other dive and/or preferred prey characteristics. Depth distributions for species for which no data are available are extrapolated from surrogate species (example in Section 3.8.4.9).

3.8.2.3 Density and Depth Distribution Combined

Marine mammal density is nearly always reported for an area as animals per square kilometer (km^2). Analyses of survey results using Distance Sampling techniques include correction factors for animals at the surface but not seen, as well as animals below the surface and not seen. Therefore, although the area (e.g., km^2) appears to represent only the surface of the water (two-dimensional [2-D]), density actually implicitly includes animals anywhere within the water column under that surface area. Density assumes that animals are uniformly distributed within the prescribed area, even though this is likely rarely true. Marine mammals are usually clumped in areas of greater importance, for example, areas of high productivity, lower predation, safe calving, etc. Density can occasionally be calculated for smaller areas that are used regularly by marine mammals, but more often than not there is insufficient data to calculate density for small areas. Therefore, assuming an even distribution within the prescribed area remains the norm.

The ever-expanding database of marine mammal behavioral and physiological parameters obtained through tagging and other technologies has demonstrated that marine mammals use the water column in various ways, with some species capable of regular deep dives (<2,625 ft [<800 m]) and others regularly diving to <656 ft (<200 m), regardless of the bottom depth. Assuming that all species are evenly distributed from surface to bottom is almost never appropriate and can present a distorted view of marine mammal distribution in any region.

By combining marine mammal density with depth distribution information, a more accurate three-dimensional (3-D) density estimate is possible. These 3-D estimates allow more accurate modeling of potential marine mammal exposures from specific noise sources. See Appendix D for additional modeling information.

3.8.3 ESA Species

3.8.3.1 Blue Whale

Stock

Eastern North Pacific

Regulatory Status

Blue whales (*Balaenoptera musculus*) are listed as endangered under the ESA and a recovery plan has been prepared (NMFS 1998b). The Eastern North Pacific (ENP) stock is designated depleted and classified as strategic under the MMPA.

Habitat Preferences & Critical Habitat

Blue whales inhabit both coastal and oceanic waters in temperate and tropical areas (Yochem and Leatherwood 1985). Important foraging areas include the edges of continental shelves and upwelling regions (Reilly and Thayer 1990, Schoenherr 1991). There is an absence of information available for blue whales in Alaska waters. Feeding grounds have been identified in coastal upwelling zones off the coast of California (Croll et al. 1998, Fiedler et al. 1998, Burtenshaw et al. 2004) and Baja California, Mexico (Reilly and Thayer 1990). Blue whales off the coast of southern California appear to feed exclusively on dense schools of krill between 328 and 656 ft (100 and 200 m; Croll et al. 1998, Fiedler et al. 1998). These concentrations form downstream from upwelling centers in close proximity to regions of steep topographic relief off the continental shelf break (Croll et al. 1999). Migratory movements of blue whales in California probably reflect seasonal patterns and productivity (Croll et al. 2005). Blue whales also feed in cool, offshore, upwelling-modified waters in the eastern tropical and equatorial Pacific (Reilly and Thayer 1990, Palacios 1999). Moore et al. (2002) determined that blue whale call locations in the western north Pacific were associated with relatively cold, productive waters and fronts. Stafford et al. (2007), however, reports that the distribution of northeastern Pacific blue whales was not correlated to sea surface temperature.

Critical habitat has not been designated for blue whales.

Population Size and Trends

Two stocks are recognized within U.S. North Pacific waters: the Western North Pacific stock (Hawaiian) and the ENP (NMFS 2006c). The ENP stock includes animals found from the northern GOA to the eastern tropical pacific. There is a minimum population estimate of 1,368 (Coefficient of Variation [CV] = 0.22) individuals in the ENP blue whale stock (Carretta et al. 2007) but no estimates for blue whales are available for the Alaska Stock Assessment (Angliss and Allen 2008). There are insufficient numbers of individuals of this species present in the TMAA to allow for acoustic impact modeling given they are rare.

While it is expected that the north Pacific population of blue whales has increased since being given protected status in 1966, there is no clear information on the population structure or population trend of species. The abundance of blue whales along the California coast has clearly been increasing (Calambokidis et al. 1990, Barlow 1994, Calambokidis 1995). However, the scarcity of blue whales in areas of former abundance (e.g., GOA near the Aleutian Islands) suggests that the potential increasing trend does not apply to the species' entire range in the eastern north Pacific (Calambokidis et al. 1990).

Distribution

Blue whales are distributed from the ice edges to the tropics in both hemispheres. In the North Pacific Ocean, blue whales are sighted from Kamchatka (Russia) to southern Japan in the west, and from the GOA south to at least Costa Rica in the east. Historical areas of concentrations include the eastern GOA, the eastern Aleutians, and the far western Aleutians (DoN 2006).

Blue whales as a species are thought to summer in high latitudes and move into the subtropics and tropics during the winter. A discovery tag on a blue whale by whalers off Vancouver Island in May 1963 was recovered a year later in June 1964 just south of Kodiak Island and a blue whale photoidentified south of Prince William Sound was identified five times between 1995 and 1998 off southern California. These occurrences support the hypothesis that blue whales seasonally migrate to and from feeding areas in the GOA (DoN 2006). Data from both the Pacific and Indian Oceans, however, indicate that some individuals may remain year-round in low latitudes, such as over the Costa Rican Dome. The productivity of the Costa Rican Dome may allow blue whales to feed during their winter calving/breeding season and not fast, like humpback whales are believed to do.

In the GOA, three blue whales were sighted in the summer of 2004 during survey work (Calambokidis et al. 2008). Blue whale calls, with a strong seasonal pattern, have been acoustically detected in the GOA in mid-July to mid-December with the peak occurrence from August through November (Moore et al. 2006, DoN 2006). The area of primary occurrence is seaward of the shelf break, with waters over the shelf area of a secondary occurrence (DoN 2006).

Life History

The eastern North Pacific stock of blue whales feeds in waters from California to Alaska in summer and fall and migrates south to the waters of Mexico to Costa Rica in winter (National Marine Fisheries Service 2006e) for breeding and to give birth (Mate et al. 1999).

Reproduction/Breeding

Calving occurs primarily during the winter (Yochem and Leatherwood 1985) and blue whales move south from feeding areas to give birth. There are no known areas used by blue whales for reproduction or calving in the TMAA.

Diving Behavior

Blue whales spend more than 94 percent of their time below the water's surface (Lagerquist et al. 2000). Croll et al. (2001) determined that blue whales dived to an average of 462 ft (141 m) and for 7.8 minutes (min) when foraging and to 222 ft (68 m) and for 4.9 min when not foraging. Calambokidis et al. (2003) deployed tags on blue whales and collected data on dives as deep as about 984 ft (300 m).

Acoustics

In 1994 off the coast of California, blue whale vocalizations at 17 hertz (Hz) were estimated to have source levels in the range of 195 decibels (dB) referenced to 1 micropascals at a distance of 1 meter (dB re 1 µPa @ 1 m) (Aburto et al. 1997). Blue whale vocalizations are long, patterned low-frequency sounds with durations up to 36 seconds repeated every 1 to 2 min. Their frequency range is 12 to 400 Hz, with dominant energy in the infrasonic range at 12 to 25 Hz (see Table 3.8-3) (Ketten 1998, Mellinger and Clark 2003). Vocalizations of blue whales in Alaska appear be of two distinct types suggestive of separate populations consisting of western Pacific and northeastern Pacific types (Moore et al. 2006). While no data on hearing ability for this species are available, it is hypothesized that mysticetes have excellent low frequency hearing (Ketten 1997).

Impacts of Human Activity

Historic Whaling

Blue whales were occasionally hunted by the sailing-vessel whalers of the 19th century (Carretta et al. 2008). The introduction of steam power in the second half of that century made it possible for boats to overtake large, fast-swimming blue whales and other rorquals. From the turn of the century until the mid-1960s, blue whales from various stocks were intensely hunted in all the world's oceans (NMFS 1998b). Blue whales were protected in portions of the Southern Hemisphere beginning in 1939, but were not fully protected in the Antarctic until 1965. In 1966, they were given complete protection in the North Pacific under the International Convention for the Regulation of Whaling (Gambell 1979, Best 1993). Some illegal whaling by the Union of Soviet Socialist Republics have occurred in the north Pacific (Yablokov 1994); it is likely that blue whales were among the species taken by these operations, but the extent of the catches is not known. Since gaining complete legal protection from commercial whaling in 1966, some populations have shown signs of recovery, while others have not been adequately monitored to determine their status (NMFS 1998b). Removal of this threat has allowed increased recruitment in the population, and therefore, the blue whale population in the eastern north Pacific is expected to have grown.

The blue whale population was severely depleted by commercial whaling in the twentieth century (NMFS 1998b). In the North Pacific, pre-exploitation population size is speculated to be approximately 4,900 blue whales, and the current population estimate is a minimum of 3,300 blue whales (Wade and Gerrodette 1993, NMFS 2006c).

Fisheries Interactions

Because little evidence of entanglement in fishing gear exists and large whales such as the blue whale may often die later and drift further offshore, it is difficult to estimate the numbers of blue whales killed and injured by gear entanglements. The offshore drift gillnet fishery is the only fishery that is likely to take blue whales from this stock, but no fishery mortalities or serious injuries have been observed. In addition, the injury or mortality of large whales due to interactions or entanglements in fisheries may go unobserved because large whales swim away with a portion of the net or gear. Fishermen have reported that large whales tend to swim through their nets without entangling and causing little damage to nets. (Carretta et al. 2008)

Ship Strikes

There is no record of any ship strike involving a blue whale in Alaska waters (Jensen and Silber 2004). According to NMFS, the average number of blue whale mortalities in California attributed to ship strikes was 0.6 whales per year for 2002-2006 (Carretta et al. 2008). As recently as September 2007, commercial vessels were implicated in the deaths of three blue whales in the Santa Barbara Channel off southern California. Additional mortality from ship strikes probably goes unreported because the whales do not strand, or if they do, they do not always have obvious signs of trauma. However, several blue whales have been photographed in California with large gashes in their dorsum that appear to be from ship strikes. (Carretta et al. 2008)

3.8.3.2 Fin Whale

Stock

Northeast Pacific

Regulatory Status

Fin whales (*Balaenoptera physalus*) are listed as endangered under the ESA. The Northeast Pacific stock is designated as depleted and classified as strategic under the MMPA. A draft species recovery plan for fin whales has been prepared (NMFS 2006b).

Habitat Preferences & Critical Habitat

Fin whales are found in continental shelf, slope, and oceanic waters (Gregr and Trites 2001, Reeves et al. 2002). Globally, this species tends to be aggregated in locations where populations of prey are most plentiful, irrespective of water depth, although those locations may shift seasonally or annually (Payne et al. 1986, 1990; Kenney et al. 1997; Notarbartolo-di-Sciara et al. 2003). Littaye et al. (2004) determined that fin whale distribution in the Mediterranean Sea was linked to frontal areas and upwelling within large zooplankton patches. Fin whales in the north Pacific spend the summer feeding along the cold eastern boundary currents and appear to prefer krill and large copepods, but also eat schooling fish such as Pacific herring (*Clupea harengus pallasi*), walleye pollock (*Theragra chalcogramma*), and capelin (*Mallotus villosus*) (Nemoto and Kawamura 1977, Perry et al. 1999). Critical habitat has not been designated for fin whales.

Population Size and Trends

In the north Pacific, the total pre-exploitation population size of fin whales is estimated at 42,000 to 45,000 whales (Ohsumi and Wada 1974). From whaling records, fin whales that were marked in winter 1962 to 1970 off southern California were later taken in commercial whaling operations between central California and the GOA in summer (Mizroch et al. 1984). In summer 2003, a cetacean survey in the Shelikof Strait (north of Kodiak), Cook Inlet, Prince William Sound and on the shelf between Kodiak and Montague Island detected 165 fin whales along the shelf break and having an average group size of 2.9 observed over 57 sightings (Waite 2003). The April 2009 GOALS survey in the TMAA had 24 visual observations of fin whale groups totaling 64 individuals during a 10-day period (Rone et al. 2009).

Currently there are no reliable estimates of current or historical abundance numbers for the Northeast Pacific fin whale stock. Fin whales have a worldwide distribution, with three distinct stocks recognized in the Pacific: (1) Alaska (Northeast Pacific), (2) California/Washington/ Oregon, and (3) Hawaii. Provisional estimates for the Northeastern Pacific based on surveys in 1999 and 2000 are 3,368 (CV = 0.18) for the central-eastern Bering Sea and 683 (CV = 0.32) for the eastern Bering Sea. (Angliss and Allen 2008)

The population trend for this species estimated for 1987 to 2003 is reported as growing at 4.8 percent annually, which is consistent with estimated the growth rates of other large whales (Angliss and Allen 2008). For purposes of acoustic impact modeling, a density of 0.010 individuals per km^2 was used for fin whales in the TMAA as provided by Rone et al. (2009) and described in detail in Appendix E.

Distribution

Fin whales are broadly distributed throughout the world's oceans, usually in temperate to polar latitudes and less commonly in the tropics (Reeves et al. 2002). Single fin whales are most common, but they gather in groups, especially when good sources of prey are aggregated.

Fin whales in the North Pacific spend the summer feeding along the cold eastern boundary currents and have been observed as far north as the Chukchi and Bering Seas (Gambell 1985, Perry et al. 1999, DoN 2006, Angliss and Allen 2008). However, although fewer in number, fin whales have also been sighted in the Bering Sea all winter (Mizroch et al. 1999). Acoustic signals from fin whales are detected year-round in the GOA with most calls from August through February (Moore et al. 2006, Mizroch et al. 2009). Around Kodiak Island (in the vicinity of the TMAA) fin whales have been observed year-round with most sightings from April to September (DoN 2006).

Life History

Natural sources and rates of mortality are largely unknown, but Aguilar and Lockyer (1987) suggest annual natural mortality rates may range from 0.04 to 0.06 (based on studies of northeast Atlantic fin whales). The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure in fin whales and may be preventing some fin whale stocks from recovering from whaling (Lambertsen 1992). Killer whale or shark attacks may result in serious injury or death in very young and sick whales (Perry et al. 1999).

Reproduction/Breeding

Fin whales become sexually mature between 6 to 10 years of age, depending on density-dependent factors (Gambell 1985). Reproductive activities for fin whales occur primarily in the winter. Gestation lasts about 12 months and nursing occurs for 6 to 11 months (Perry et al. 1999). Although fin whales are present in GOA in the winter, there are no known calving areas in GOA (Mizroch et al. 2009) Peak calving is in October through January (Hain et al. 1992) and fin whales likely move south from feeding areas to give birth. There are no known areas used by fin whales for reproduction or calving in the TMAA.

Diving Behavior

Details of diving behavior and the derivation of parameters used in the acoustic modeling are presented in Appendix D. Kopelman and Sadove (1995) found significant differences in blow intervals, dive times, and blows per hour between surface feeding and nonsurface-feeding fin whales. Various researchers have reported foraging fin whales have dive durations of approximately 4 to 15 min and to depths between approximately 200 and 500 ft (61 and 152 m) (DoN 2006). Dives are followed by sequences of four to five blows at 10- to 20-second (sec) intervals (Cetacean and Turtle Assessment Program [CETAP] 1982, Stone et al. 1992, Lafortuna et al. 2003).

Acoustics

Fin whales produce calls with the lowest frequency and highest source levels of all mysticetes. Fin whales produce a variety of sounds with a frequency range from 15 to 750 Hz (see Table 3.8-3). The long-patterned 15- to 30-Hz vocal sequence 1 second in duration with a source level of 184 to 200 dB re 1 Pa @ 1 m is most typically recorded (Richardson et al. 1995, Charif et al. 2002). Only males are known to produce infrasonic pulses, suggesting they may function as a male breeding display (Croll et al. 2002, Moore et al. 2006). Although data on hearing ability for fin whales are unavailable, it is hypothesized that based on their anatomy and vocalizations, fin whales have acute infrasonic hearing (Ketten, 1997).

Impacts of Human Activity

Historic Whaling

Between 1947 and 1987, approximately 46,000 fin whales were taken from the North Pacific by commercial whalers. In addition, approximately 3,800 were taken off the west coast of North America between 1919 and 1929. In 1976 Fin whales in the North Pacific were given protected status by the IWC. (Carretta et al. 2008)

Fisheries Interactions

The incidental take of fin whales in fisheries is extremely rare. In the California/Oregon drift gillnet fishery, observers recorded the entanglement and mortality of one fin whale, in 1999, off southern California (NMFS 2000). Based on a worst-case scenario, NMFS estimates that a maximum of six fin whales (based on calculations that adjusted the fin whale observed entangled and killed in 1999 by the number of sets per year) could be captured and killed in a given year by the California-Oregon drift gillnet fleet (NMFS 2000). Anecdotal observations from fishermen suggest that large whales swim through their nets rather than get caught in them (NMFS 2000). Because of their size and strength, fin whales probably swim through fishing nets, which might explain why these whales are rarely reported as having become entangled in fishing gear. NMFS has no records of fin whales being killed or injured by commercial fisheries operating in the North Pacific (Ferrero et al., 2000).

Vessel Collisions

Worldwide historical records indicate fin whales were the most likely species to be struck by vessels (Laist et al. 2001). For Alaska waters, the available whale-vessel collision data has been presented in an unpublished preliminary summary of opportunistically collected reports involving 62 whale-vessel collisions between 1978 and 2006 (Gabriele et al., manuscript on file). Recognizing that this report is likely biased toward near shore reports and inland waters of Southeast Alaska where the authors were located and where nearshore vessels and a population of humpback whales overlap, there have been no recorded vessel collisions with fin whales in Alaska waters.

3.8.3.3 Humpback Whale

Stock

Central and Western North Pacific

Regulatory Status

Humpback whales are listed as endangered under the ESA. They are designated as depleted throughout their range under the MMPA and the Western North Pacific stock is classified as strategic. A final species recovery plan has been prepared (NMFS 1991).

In addition to being listing as endangered, there are regulations that have been issued governing the approach to humpback whales in Alaska waters, “within 200 miles of the coast” (NOAA 2001b). These regulations were issued to manage the threat caused by whale watching activities by: (1) prohibiting approach to within 100 yards (yd) (91.4 m) of humpback whales; (2) implementation of a “slow safe speed” in proximity to humpbacks, and (3) creating exemptions for some vessels including military vessels engaged in “official duty” (training).

Habitat Preferences & Critical Habitat

Although humpback whales typically travel over deep, oceanic waters during migration, their feeding and breeding habitats are mostly in shallow, coastal waters over continental shelves (Clapham and Mead 1999). Shallow banks or ledges with high sea-floor relief characterize feeding grounds (Payne et al. 1990, Hamazaki 2002). The habitat requirements of wintering humpbacks appear to be determined by the conditions necessary for calving and breeding consisting mainly of relatively shallow or protected areas around and between islands, over banks, and along continental coasts. Critical habitat has not been designated for humpback whales in the North Pacific.

Population Size and Trends

Three Pacific stocks of humpback whales are recognized in the Pacific Ocean and include the Western North Pacific stock, Central North Pacific stock, and ENP stock (Calambokidis et al. 1997, Baker et al. 1998). In the entire North Pacific Ocean basin prior to 1905, it is estimated that there were 15,000 humpback whales basin-wide (Rice 1978). Whaling in the North Pacific continued until 1976 by the Japanese and Soviet pelagic whaling fleets. After the end of commercial whaling, approximate humpback numbers were estimated to be between 1,200 to 1,400 whales (Calambokidis et al. 2008), although it is unclear if estimates were for the entire north Pacific or just the eastern north Pacific. The population of humpbacks in the Pacific is increasing and has undergone substantial recovery since the end of whaling. The Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific (SPLASH) study suggested the current (2008) best estimate for the overall abundance in the North Pacific is 18,302 (Calambokidis et al., 2008).

It has been recently estimated there are 3,000 to 5,000 humpback whales are in the GOA area (Calambokidis et al. 2008). The best abundance estimate for the Central North Pacific Stock, is 4,005 (CV = 0.095) individuals (Angliss and Allen 2008). In summer 2003, a survey in the Shelikof Strait (north of Kodiak), Cook Inlet, Prince William Sound and between Kodiak and Montague Island detected 128 humpbacks whales along the shelf break and having an average group size of 2.7 (Waite 2003). An April 2009 survey in the TMAA had 11 visual observations of humpback groups totaling 20 individuals during a 10-day period (Rone et al. 2009). Density for the entire TMAA was 0.0019/km^2 (Table 9, Rone et al. 2009) for the April-December timeframe (Table 3.8-2) as described in detail in Appendix E. As the humback whales tend to prefer shallow water and are concentrated nearshore over the shelf, this is likely an overestimate for humpback density in the TMAA.

Distribution

Humpback whales live in all major ocean basins from equatorial to subpolar latitudes, migrating from tropical breeding areas to polar or subpolar feeding areas (Jefferson et al. 1993, NMFS 2006c). North Pacific humpback whales are distributed primarily in four more-or-less distinct wintering areas: the Ryukyu and Ogasawara (Bonin) Islands (south of Japan), the Hawaiian Islands, the Revillagigedo Islands off Mexico, and along the coast of mainland Mexico (Calambokidis et al. 2008). There is known to be some interchange of whales among different wintering grounds, and matches between Hawaii and Japan and Hawaii and Mexico have been found (Calambokidis et al. 2008). However, it appears that the overlap is relatively small between the western north Pacific humpback whale population and Central North Pacific and ENP populations (Calambokidis et al. 2008).

Humpbacks in the Pacific are generally found during the summer on high-latitude feeding grounds in a nearly continuous band from southern California to the Aleutian Islands, Kamchatka Peninsula, and the Bering and Chukchi seas (Calambokidis et al. 2001). The U.S./Canada border is an approximate geographic boundary between the California and Alaska feeding groups (Carretta et al. 2006). There is much interchange of whales among different feeding grounds, although some site fidelity occurs.

During the winter, humpbacks generally migrate to the tropics and subtropics where they can be found around islands, over shallow banks, and along continental coasts, where calving and breeding occur. Humpbacks have one of the longest migrations known for any mammal with individuals traveling nearly 4,320 nm (8,000 km) between feeding and breeding areas (Clapham and Mead 1999). Most humpback whale sightings are in nearshore and continental shelf waters; however, humpback whales frequently travel through deep water during migrations such as the route to and from the Hawaiian Islands (Clapham and Mattila 1990, Calambokidis et al. 2001). Migratory transits between the Hawaiian Islands and southeastern Alaska have been documented to take as little as 36 to 39 days (Gabriele et al. 1996, Calambokidis et al. 2001).

In the GOA, peak abundance occurs in late November and early December and slowly declines in January as humpback whales migrate to southerly breeding grounds (Consiglieri et al. 1982, Straley 1990, DoN 2006). Humpback whales that have migrated south begin to return to Alaskan feeding grounds in April (Consiglieri et al. 1982).

Identifications made between feeding areas and wintering areas indicate that the majority of humpbacks in the GOA winter in Hawaii (about 57 percent of the population) with the remainder wintering in Mexican waters around the Revillagigedo Islands, Baja, and the Mexican mainland (Calambokidis et al. 2008). Whales from Southeast Alaskan waters almost exclusively go to Hawaii. However, approximately 15 to 17 percent of the whales identified in the Western GOA could not be matched to known wintering areas, suggesting the existence of undocumented humpback wintering area(s) (Calambokidis et al. 2008). As noted previously, a small number of humpbacks humpback whales occur in the GOA year-round (DoN 2006).

Life History

Humpbacks primarily feed on small schooling fish and krill (Angliss and Allen 2008). The whales primarily feed along the shelf break and continental slope (Green et al. 1992, Tynan et al. 2005).

Reproduction/Breeding

Humpback whales migrate to calving/breeding grounds (e.g. Hawaii and Central America) in the lower latitudes each winter (Calambokidis et al. 2008). There are no known areas used by humpback whales for reproduction or calving in the TMAA.

Diving Behavior

Details of diving behavior and the derivation of parameters used in the acoustic modeling are presented in Appendix D. Humpback whale diving behavior depends on the time of year (Clapham and Mead 1999). In summer, most dives last less than 5 min; those exceeding 10 min are atypical. Although humpback whales have been recorded to dive as deep as about 1,638 ft (500 m) (Dietz et al. 2002), on the feeding grounds they spend the majority of their time in the upper 400 ft (120 m) of the water column (Dolphin 1987, Dietz et al. 2002). In winter, dives average 10 to 15 min; dives of greater than 30 min have been recorded (Clapham and Mead 1999) and with recorded dives to 577 ft (176 m) (Baird et al. 2000).

Acoustics

Humpback whales produce three classes of vocalizations: (1) “songs” in the late fall, winter, and spring by solitary males primarily on wintering grounds and much less frequently on northern feeding grounds; (2) sounds made within groups on the wintering (calving) grounds; and (3) social sounds made on the feeding grounds (Thomson and Richardson 1995). The best-known types of sounds produced by humpback whales are songs, which are thought to be breeding displays used only by adult males (Helweg et al. 1992). Singing is most common on breeding grounds during the winter and spring, but is occasionally heard on feeding grounds outside breeding areas and season (Matilla et al. 1987, Clark and Clapham 2004). There is geographical variation in humpback whale song, with different populations singing different songs, and all members of a population using the same basic song. The song evolves over the course of a breeding season, but remains nearly unchanged from the end of one season to the start of the next (Payne et al. 1983). Social calls are from 50 Hz to over 10 kilohertz (kHz), with the highest energy below 3 kHz (Silber, 1986).

Female humpback whale vocalizations appear to be simple: Simão and Moreira (2005) noted little complexity. The male song, however, is complex and changes between seasons. Components of the song range from under 20 Hz to 4 kHz and occasionally 8 kHz, at source levels of 144 to 174 dB re 1 µPa @ 1 m, with a mean of 155 dB re 1 µPa @ 1 m. The main energy lies between 0.2 and 3.0 kHz, with frequency peaks at 4.7 kHz (Table 3.8-3). Au et al. (2001) reported source levels (between 171 and 189 dB re 1 µPa @ 1 m) of humpback whale songs.

No tests of humpback whale hearing have been made. Houser et al. (2001) constructed a humpback audiogram using a mathematical model based on the internal structure of the ear. The predicted audiogram indicates sensitivity to frequencies from 700 Hz to 10 kHz, with maximum relative sensitivity between 2 kHz and 6 kHz. Au et al. (2006) took recordings of whales off Hawaii and found high-frequency harmonics of songs extending beyond 24 kHz, which may indicate that they can hear at least as high as this frequency. A single study suggested that humpback whales responded to mid-frequency active (MFA) sonar (3.1 to 3.6 kHz) sound (Maybaum 1989). The hand-held sonar system had a sound artifact below 1,000 Hz which caused a response to the control playback (a blank tape) and may have affected the response to sonar (i.e., the humpback whale responded to the low-frequency artifact rather than the MFA sonar sound).

Impacts of Human Activity

Historic Whaling

Commercial whaling, the single most significant population impact on humpback whales, ceased operation in the Pacific Ocean in 1966. Intensive commercial whaling removed more than 28,000 animals from the North Pacific during the 20th century. From 1961 to 1971, an additional 6,793 humpback whales were killed illegally by the former Soviet Union. Many animals during this time were taken from the GOA and Bering Sea; however, catches occurred across the North Pacific, from the Kuril Islands to the Queen Charlottes, and additional illegal catches in earlier years may have gone unrecorded. (Angliss and Allen 2008)

Fisheries Interactions

Entanglement in fishing gear poses a threat to individual humpback whales throughout the Pacific. A number of fisheries based out of West Coast ports may incidentally take the ENP stock of humpback whales, and documented interactions are summarized in the U.S. Pacific Marine Mammal Stock Assessments: 2006 (Carretta et al. 2007). The estimated impact of fisheries on the ENP humpback whale stock is probably underestimated; the serious injury or mortality of large whales from entanglement in gear may go unobserved because whales swim away with a portion of the net, line, buoys, or pots. In 1996 and again in 2001, gear traced to fishing activities in Alaska were removed from two entangled humpback whales in Hawaii. According to the NMFS Pacific Islands Region Marine Mammal Response Network Activity Update (dated July 2007 [NMFS 2007]), there were reports of 26 distressed marine mammals in Hawaii found entangled in fishing gear for the 6-month period, November to April 2007.

NMFS estimates that between 2002 and 2006, there were incidental serious injuries to 0.2 humpback annually in the Bering Sea/Aleutian Islands sablefish longline fishery. This estimation is not considered reliable. Observers have not been assigned to a number of fisheries known to interact with the Central and Western North Pacific stocks of humpback whale. In addition, the Canadian observation program is also limited and uncertain. (Angliss and Allen 2008)

Ship Strikes

Humpback whales, especially calves and juveniles, are highly vulnerable to ship strikes and other interactions with nonfishing vessels. Younger whales spend more time at the surface, are less visible, and are found closer to shore (Herman et al. 1980, Mobley et al. 1999), thereby making them more susceptible to collisions. Nine ship strikes were implicated in mortality or serious injuries of humpback whales between 2001 and 2005. Seven of these ship strikes occurred in Southeast Alaska and two occurred in the northern portion of the Central North Pacific's range (Angliss and Allen 2008). Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not have obvious signs of trauma.

Whale-watching tours are becoming increasingly popular, and ship strikes have risen in recent years. Regulations governing the approach to humpback whales in Alaska were promulgated in 2001 to manage the threat caused by whale watching activities (NOAA 2001b). Two whale watch vessel strikes in Alaska waters have also involved humpback whales (Jensen and Siber, 2004). Available whale-vessel collision data presented in an unpublished preliminary summary indicates that most of the 62 recorded collisions between vessels and whales in Alaska waters involve humpback whales (Gabriele et al., manuscript on file).

As noted previously, many of the humpbacks feeding in GOA winter in Hawaii. In the Hawaiian Islands, ship strikes of the humpback whale are of particular concern. According to the NMFS Pacific Islands Region Marine Mammal Response Network Activity Update (dated January 2007 [NMFS 2007]), there were nine reported collisions with humpback whales in 2006 (none involved the Navy).

Whale Watching Disturbance

Whale-watching boats and scientific research vessels specifically direct their activities toward whales, and may have direct or indirect impacts on humpback whales. The growth of the whale-watching industry has not increased as rapidly for the ENP stock of humpback whales as it has for the Central North Pacific stock (wintering grounds in Hawaii and summering grounds in Alaska), but whale-watching activities do occur throughout the ENP stock's range. There is concern regarding the impacts of close vessel approaches to large whales because harassment may occur, preferred habitats may be abandoned, and fitness and survivability may be compromised if disturbance levels are too high. While a 1996 study in Hawaii measured the acoustic noise of different whale-watching boats (Au and Green 2000) and determined that the sound levels were unlikely to produce grave effects on the humpback whale auditory system, the potential direct and indirect effects of harassment due to vessels cannot be discounted. Several investigators have suggested that shipping noise may have caused humpback whales to avoid or leave feeding or nursery areas (Jurasz and Jurasz 1979, Dean et al. 1985), while others have suggested that humpback whales may become habituated to vessel traffic and its associated noise. Still other researchers suggest that humpback whales may become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle et al. 1993, Wiley et al. 1995).

Other Threats

Humpback whales are potentially affected by a resumption of commercial whaling, loss of habitat, loss of prey (for a variety of reasons including climate variability), underwater noise, and pollutants. Very little is known about the effects of organochlorine pesticides, heavy metals, polychlorinated biphenyls, and other toxins on baleen whales, although the impacts may be less than higher trophic level odontocetes due to baleen whales' lower levels of bioaccumulation from prey (Angliss and Allen 2008).

Anthropogenic noise may also affect humpback whales, because humpback whales seem to respond to moving sound sources, such as whale-watching, fishing, and recreational vessels and low-flying aircraft (Richardson et al. 1995). Their responses to noise are variable and affected by the context of the exposure and the animal's experience, motivation, and conditioning (Wartzok et al. 2003, Southall et al. 2007).

3.8.3.4 North Pacific Right Whale

Stock

Eastern North Pacific

Regulatory Status

North Pacific right whales (*Eubalaena robustus*) are classified as endangered under the ESA and are considered one of the world's most endangered large whale species. The right whale is designated as depleted and the ENP stock is classified as strategic under the MMPA. (DoN 2006)

Habitat Preferences & Critical Habitat

Feeding habitat for right whales is defined by the presence of sufficiently high densities of prey, especially zooplankton (calanoid copepods). Development of those patches is essentially a function of oceanic conditions, such as stratification, bottom topography, and currents which concentrate zooplankton, and concentration is probably enhanced by the behavior of the organisms themselves. The apparent shift in Bering Sea right whale occurrences from deep waters in the mid-twentieth century to the mid-shelf region in the late 1900s was attributed to changes in the availability of optimal zooplankton patches, possibly relating to climatic forcing (variability in oceanic conditions caused by changes in atmospheric patterns). Sightings in the Bering Sea have been clustered in relatively shallow water (waters with a bottom depth of 164 to 262 ft (50 to 80 m). Information from a tagged individual documented movement between the middle and outer portions of the continental shelf in the Bering Sea, which is consistent with historical distribution patterns. Additionally, sightings of some other right whale individuals during the 2004 survey were made on the outer continental shelf. (DoN 2006)

North Pacific right whales in locations other than Alaska waters have been sighted in even deeper depths, as evidenced by a sighting off California with a bottom depth as deep as 5,577 ft (1,700 m). The International Whaling Commission (IWC) noted a surprising absence of evidence for coastal calving grounds, since right whales in the North Atlantic and in the Southern Hemisphere have calving grounds located in shallow bays, lagoons, or in waters over the continental shelf. (DoN 2006)

Sightings of North Pacific right whales in 1996 during an Alaska Fisheries Science Center groundfish assessment cruise led to intense photoidentification and vessel surveys from 1998 to 2004 in the south-eastern Bering Sea. According to Moore et al. (2006), the sighting locations indicated that right whales preferred the relatively shallow waters of the southeastern Bering Sea middle shelf, which are approximately 230 ft (70 m) in depth. Also determined during these surveys was that right whale calls occurred from May through November, with the greatest number of calls recorded in September and October. (Moore et al. 2006)

In July 1998, a lone North Pacific right whale was sighted among humpback whales during an aerial survey southeast of Kodiak Island. Acoustic surveys of this area produced very few north Pacific right whale calls; however, unambiguous right whale calls were detected in August and early September in western GOA. In addition calls were recorded from locations where right whales were formerly abundant but have not been seen in recent decades. (Moore et al. 2006)

In August 2004, a NMFS researcher observed a single right whale among a group of humpbacks. In August 2005, a NMFS researcher reported yet another sighting of a right whale within 820 to 1,640 ft (250 to 500 m) of groups of humpback and fin whales. (Angliss and Allen 2008) There were no right whales detected acoustically or visually during the April 2009 survey of the TMAA (Rone et al. 2009).

In May 2008, NMFS issued a final rule designating two areas as North Pacific right whale critical habitat, one in the GOA and one in the Bering Sea. The location of the critical habitat for North Pacific right whales in the GOA is shown on Figure 3.8-1. This area is located beyond approximately 16 nm (30 km) west of the southwest corner of the TMAA. The final rule for this critical habitat designation cites consistent sightings of right whales—both single individuals and pairs—in specific areas in spring and summer over an extended period as an indicator of primary constituent element (dense concentrations of prey) in a feeding area. While sightings of right whales are fewer in number in the GOA than in the Bering Sea, just prior to the final rule three individuals were sighted in the critical habitat area in the GOA. (Angliss and Allen 2008)

Population Size and Trends

There are no reliable estimates of current abundance or trends for right whales in the North Pacific, and the population may only number at least in the low hundreds (Angliss and Allen 2008). The population in the eastern north Pacific is considered to be very small, perhaps only in the tens of animals. An analysis of both photoidentification and biopsy efforts in 2004 in the Bering Sea revealed 17 individuals. However, of 13 individual animals photographed during aerial surveys in 1998, 1999, and 2000, 2 have already been rephotographed. This photographic recapture rate is consistent with a very small population size (Angliss and Outlaw 2006). Over the past 40 years, most sightings in the eastern north Pacific have been of single whales. However, during the last few years, small groups of right whales have been sighted (such as the group of 17 documented in 2004; Angliss and Allen 2008). Observers in 2002 and 2004 reported one confirmed calf sighting and two probable calves (Angliss and Allen 2008). There are not sufficient numbers of individuals of this species present in the TMAA to allow for acoustic impact modeling, given they are rare.

Distribution

Right whales occur in subpolar to temperate waters. They are generally migratory, with at least a portion of the population moving between summer feeding grounds in temperate or high latitudes and winter calving areas in warmer waters (DoN 2006). However, Right whale calls have been detected as early as May and as late as November in southeast Bering Sea region (Munger et al. 2008).

Current distribution patterns and migration routes of North Pacific right whales are not known. Historical whaling records provide virtually the only information on North Pacific right whale distribution. North Pacific right whales historically occurred across the Pacific Ocean north of 35°N, with concentrations in the GOA south of Kodiak Island, the eastern Aleutian Islands, south-central Bering Sea, Okhotsk Sea, and the Sea of Japan. Presently, sightings are extremely rare, occurring primarily in the Okhotsk Sea and the eastern Bering Sea in roughly the same location. There is evidence that the GOA was used as a feeding ground, and recent surveys suggest that some individuals continue to use the shelf east of Kodiak as a feeding area, which has now been designated as critical habitat. It is not known whether there is an interchange between the Bering Sea and GOA areas; for example, an individual right whale that was photographed off Kodiak Island did not match to any photographs of individuals seen in the Bering Sea (DoN 2006, Moore et al. 2006).

The area of densest concentration of North Pacific right whales in the GOA is roughly east from 170°W to 150°W and south to 52°N. (DoN 2006). In GOA off Kodiak Island, sightings of a single lone right whale have occurred in 1998, 2004, 2005, and 2006 (Angliss and Allen 2008). Many of the recent sightings of right whales in GOA are individuals seen in association with humpback whales.

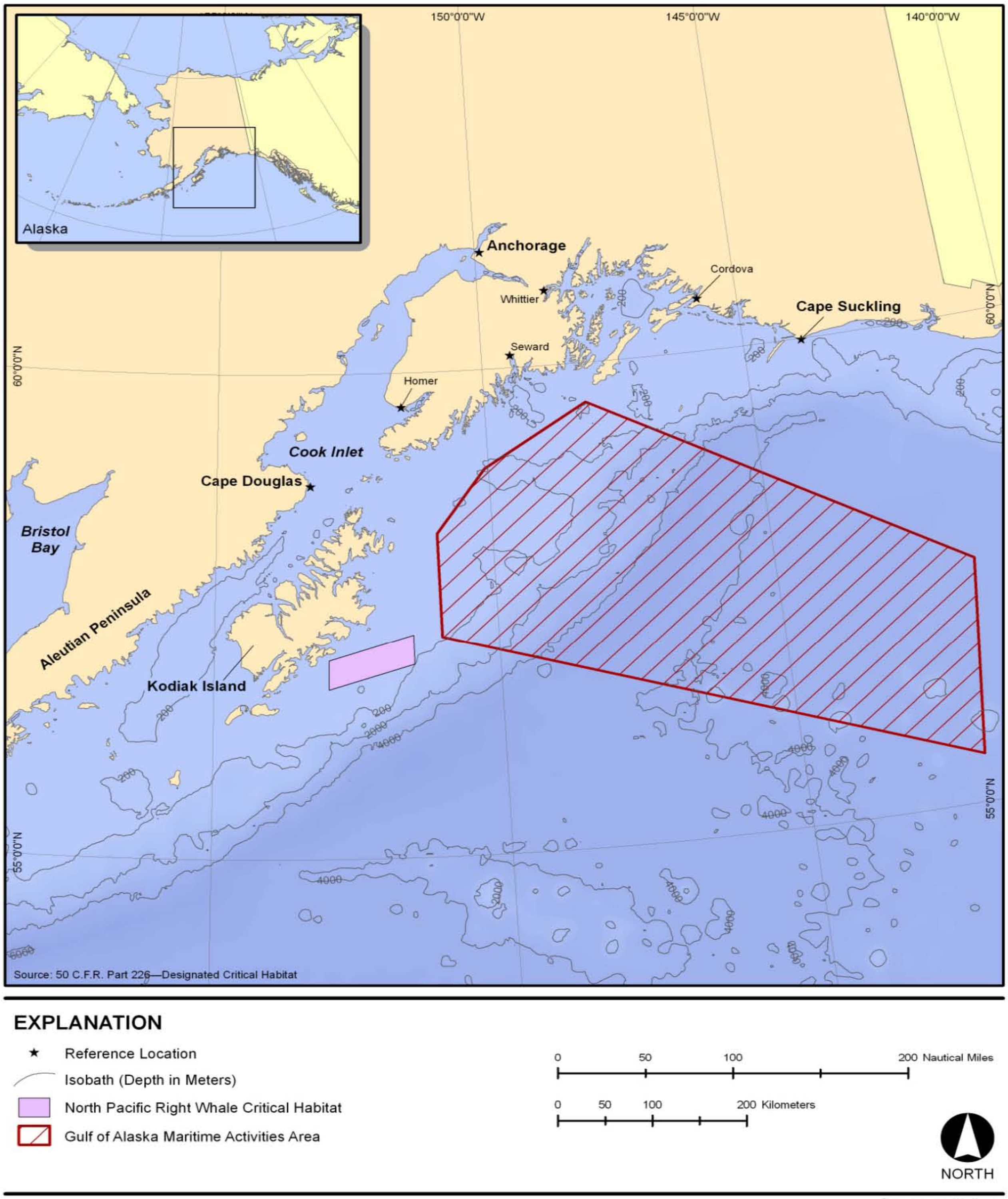


Figure 3.8-1: Right Whale Critical Habitat in the Vicinity of the TMAA

There have since been 10 acoustic detections of probable right whale calls off the continental shelf near Kodiak Island (Moore et al. 2006).

The highly endangered status of North Pacific right whales necessitates an extremely conservative determination of this species' occurrence in the GOA. Right whales will be rare in the TMAA due to the small number in population. There is sparse survey effort during the winter, and this species is believed to be largely absent in Alaska waters during December through April. It is assumed right whales would be on their breeding grounds, which are likely located further south, although the location of the breeding grounds is unknown. (DoN 2006)

Life History

Feeding habitat for right whales is defined by the presence of sufficiently high densities of prey, especially calanoid copepods. Development of those patches is essentially a function of oceanic conditions, such as stratification, bottom topography, and currents which concentrate zooplankton, and concentration is probably enhanced by the behavior of the organisms themselves. The apparent shift in Bering Sea right whale occurrences from deep waters in the mid-twentieth century to the mid-shelf region in the late 1900s was attributed to changes in the availability of optimal zooplankton patches, possibly relating to climatic forcing (variability in oceanic conditions caused by changes in atmospheric patterns). Sightings in the Bering Sea are clustered in relatively shallow water (waters with a bottom depth of 50 m to 80 m [164 to 262 ft]). Recently, however, a tagged individual moved between the middle and outer portions of the continental shelf in the Bering Sea, which is consistent with historical distribution patterns. Additionally, sightings of some other right whale individuals during the 2004 survey were made on the outer continental shelf. In other locations, North Pacific right whales have been sighted in even deeper waters, as evidenced by a sighting off California in waters with a bottom depth as deep as 1,700 m (5,577 ft). The IWC noted a surprising absence of evidence for coastal calving grounds, since right whales in the North Atlantic and in the Southern Hemisphere have calving grounds located in shallow bays, lagoons, or in waters over the continental shelf. (Department of the Navy 2006)

Reproduction/Breeding

The location of calving grounds for the eastern North Pacific population is unknown. There were no records in the last 100 years of newborn or very young calves in the eastern North pacific until 2004 when the presence of at least two calves was documented in the eastern Bering Sea. (Department of the Navy 2006) There are no known areas used by right whales for reproduction or calving in the TMAA.

Diving Behavior

There is almost nothing known of North Pacific right whale diving abilities. Dives of 5 to 15 min or even longer have been reported for North Atlantic right whales. Observations of North Atlantic right whales found that the average depth dive was strongly correlated with both the average depth of peak copepod abundance and the average depth of the bottom mixed layer's upper surface. North Atlantic right whale feeding dives are characterized by a rapid descent from the surface to a particular depth between 262 and 574 ft (80 and 175 m), remarkable fidelity to that depth for 5 to 14 min, and then rapid ascent back to the surface. Longer surface intervals have been observed for reproductively active females and their calves. (DoN 2006)

Acoustics

North Pacific right whale calls are classified into five categories: (1) up, (2) down-up, (3) down, (4) constant, and (5) unclassified. The "up" call is the predominant type and is typically a signal sweeping from about 90 to 150 Hz in 0.7 sec. Right whales commonly produce calls in a series of 10 to 15 calls lasting 5 to 10 min, followed by silence lasting an hour or more. Some individuals do not call for periods of at least 4 hours. Morphometric analyses of the inner ear of right whales resulted in an estimated hearing frequency range of approximately 0.01 to 22 kHz, based on established marine mammal models (see Table 3.8-3).

Nowacek et al. (2004, 2007) documented observations of the behavioral response of North Atlantic right whales exposed to alert stimuli (containing mid-frequency components) in an experiment to help develop a potential ship strike avoidance tool. To assess risk factors involved use of the tool, a multisensor acoustic tag was used to measure the responses of whales to passing ships and experimentally tested their responses to the controlled exposures to various alert stimuli sounds, which included recordings of ship noise, the social sounds of conspecifics, and a signal designed to alert the whales. The alert signal was 18 min of exposure consisting of three 2-min signals played sequentially three times over. The three signals had a 60-percent duty cycle and consisted of (1) alternating 1-sec pure tones at 500 Hz and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 Hz to 500 Hz; and (3) a pair of low (1,500 Hz) to high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1-sec long. The purposes of the alert signal were (1) to provoke an action from the whales via the auditory system with disharmonic signals that cover the whales' estimated hearing range, (2) to maximize the signal to noise ratio (obtain the largest difference between background noise), and (3) to provide localization cues for the whale.

At maximum received levels ranging from 133 to 148 dB re 1µPa/√Hz, five out of six whales reacted to the signal designed to elicit a behavioral reaction. The reaction documented, however, was that the whales ceased feeding and came to the surface, which is not a desired effect given the purpose for the exposure was meant as an alert signal to prevent whale/ship interactions.

Impacts of Human Activity

Historic Whaling

Since right whales are considered large, slow-swimming whales and have a thick layer of blubber which results in their floating when killed, they were an easy and profitable species for early (pre-modern) whalers. It has been estimated that between 26,500 and 37,000 right whales were killed during the period from 1839 to 1909. From 1900 to 1999, a total of 742 North Pacific right whales were killed by whaling; of those, 331 were killed in the western North Pacific and 411 in the eastern north Pacific. This includes 372 whales killed illegally by the former U.S.S.R. in the period from 1963 to 1967, primarily in the GOA and Bering Sea (Angliss and Allen 2008).

Fisheries Interactions

Gillnets were implicated in the death of a right whale off the Kamchatka Peninsula (Russia) in October of 1989. No other incidental takes of right whales are known to have occurred in the North Pacific. Based on the available records, the estimated annual mortality rate incidental to U.S. commercial fisheries approaches zero whales per year from this stock. Therefore, the annual human-caused mortality level is considered to be insignificant and approaching a zero mortality and serious injury rate (Angliss and Outlaw 2006).

Ship Strikes

In the North Pacific, ship strikes and entanglements may pose a threat to right whales but information is lacking. Using what is known for the North Atlantic right whale, the species seems generally unresponsive to vessel sounds and given they are slow moving, they are susceptible to vessel collisions (Nowacek et al. 2004). In contrast to conditions for the North Atlantic right whale, however, ship strikes and entanglement impacts to the North Pacific right whale population may pose less of a threat because of their rare occurrence and scattered distribution in the GOA (NMFS 2007). Thus, the estimated annual rate of human-caused mortality and serious injury appears minimal (Angliss and Outlaw 2006).

3.8.3.5 Sei Whale

Stock

Eastern North Pacific

Regulatory Status

Sei whales (*Balaenoptera borealis*) are listed as endangered under the ESA. A species recovery plan has not been prepared. The ENP stock is considered a "depleted" and "strategic" stock under the MMPA.

Habitat Preferences & Critical Habitat

Sei whales are most often found in deep, oceanic waters of the cool temperate zone. They appear to prefer regions of steep bathymetric relief, such as the continental shelf break, canyons, or basins situated between banks and ledges. These areas are often the location of persistent hydrographic features, which may be important factors in concentrating zooplankton, especially copepods. On the feeding grounds, the distribution is largely associated with oceanic frontal systems. In the north Pacific, sei whales are found feeding particularly along the cold eastern currents. Characteristics of preferred breeding grounds are unknown. In the north Pacific, sei whales particularly feed along the cold eastern currents. In the north Pacific, prey includes calanoid copepods, krill, fish, and squid. (DoN 2006). Critical habitat has not been designated for the ENP stock of sei whales.

Population Size and Trends

The IWC groups all sei whales in the North Pacific Ocean into one stock (Donovan 1991). Mark-recapture, catch distribution, and morphological research, however, indicated that more than one stock exists: one between 175°W and 155°W longitude, and another to the east of 155°W longitude (Masaki 1976, 1977). In the U.S. Pacific Exclusive Economic Zone (EEZ), only the ENP Stock is recognized. Worldwide, sei whales were severely depleted by commercial whaling activities. In the north Pacific, the pre-exploitation population estimate for sei whales is 42,000 whales, and the most current population estimate for sei whales in the entire north Pacific (from 1977) is 9,110 (NMFS 2006c).

Application of various models to whaling catch and effort data suggests that the total population of adult sei whales in the north Pacific declined from about 42,000 to 8,600 between 1963 and 1974 (Tillman 1977). Since 500 to 600 sei whales per year were killed off Japan from 1910 to the late 1950s, the stock size presumably was already, by 1963, below its carrying capacity level (Tillman 1977). Currently, the best estimate for the ENP stock is 43 (CV = 0.61) individuals (Carretta et al. 2007b). There are not sufficient numbers of individuals of this species present in the TMAA to allow for acoustic impact modeling, given they are few in number.

Distribution

Sei whales have a worldwide distribution and are currently found primarily in cold temperate north Pacific (north of 40°N) to subpolar latitudes (as far south as 20°N), rather than in the tropics or near the poles. Sei whales range as far south as Baja California, Mexico, Hawaii, and Guam in the Northern Marianas Islands. Whaling data suggest that the northern limit for this species was about 55°N. Sei whales are usually observed singly or in small groups of 2 to 5 animals, but are occasionally found in larger (30 to 50) loose aggregations (DoN 2006).

Sei whales are also known for occasional irruptive occurrences in areas followed by disappearances for sometimes decades. Currently in the Alaskan waters, sei whales are thought to occur mainly south of the Aleutian Islands. Whaling records from the 1900s indicate there were high densities of sei whales in the northwestern and northeastern portions (i.e., near Portlock Bank) of the GOA during May through

August. (DoN 2006) There were no sei whales detected during the April 2009 survey of the TMAA (although there were sightings of 38 unidentified large whales; Rone et al. 2009).

Life History

In the North Pacific, sei whales particularly feed along the cold eastern currents (Perry et al. 1999). In the North Pacific, prey includes calanoid copepods, krill, fish, and squid (Nemoto and Kawamura 1977). The dominant food for sei whales off California during June through August is the northern anchovy, while in September and October they eat mainly krill (Rice 1977). The location of winter breeding areas and characteristics of preferred breeding grounds are unknown (Rice 1998, Perry et al. 1999).

Reproduction/Breeding

No breeding areas have been determined but calving is thought to occur from September to March (Rice 1977) and sei whales likely move south for breeding/calving. Their reproductive cycle is about 2 years (Gambell 1985). There are no known areas used by sei whales for reproduction or calving in the TMAA.

Diving Behavior

There are no reported diving depths or durations for sei whales. Sei whales are capable of diving 5 to 20 min to opportunistically feed on plankton (e.g., copepods and krill), small schooling fish, and cephalopods (e.g., squid) by both gulping and skimming. (DoN 2006)

Acoustics

Sei whale vocalizations have been recorded on a few occasions. In the North Atlantic off Canada, recorded sounds from sei whales consisted of 10 to 20 short duration frequency-modulated sweeps between 1.5 and 3.5 kHz; source level unknown (Richardson et al. 1995). Sei whales were also recorded in the Antarctic having produced broadband “growls” and “whooshes” at an average frequency of 433 Hz (see Table 3.8-3) and source level of approximately 156 dB re 1 µPa @ 1 m (McDonald et al. 2005). While no data on hearing ability for this species are available, it has been hypothesized that mysticetes have acute infrasonic hearing (DoN 2006).

Impact of Human Activity

Historic Whaling

Several hundred sei whales in the North Pacific were taken each year by whalers based at shore stations in Japan and Korea between 1910 and the start of World War II (Committee for Whaling Statistics 1942). Small numbers were taken sporadically at shore stations in British Columbia from the early 1900s until the 1950s, when their importance began to increase (Pike and MacAskie 1969). More than 2,000 were killed in British Columbia waters between 1962 and 1967, when the last whaling station in western Canada closed (Pike and MacAskie 1969). Small numbers were taken by shore whalers in Washington (Scheffer and Slipp 1948) and California (Clapham et al. 1997) in the early 20th century, and California shore whalers took 386 from 1957 to 1971 (Rice 1977). Perry et al. (1999) reports that from 1910 to 1975, approximately 74,215 sei whales were caught in the entire North Pacific Ocean. Tillman (1977) reported that heavy exploitation by pelagic whalers began in the early 1960s, with total catches throughout the North Pacific averaging 3,643 per year from 1963 to 1974 (total 43,719; annual range 1,280-6,053), while Barlow et al. (1997) reported the capture of sei whales in the North Pacific was 61,500 between 1947 and 1987.

A major area of discussion in recent years has been IWC member nations issuing permits to kill whales for scientific purposes. Since the moratorium on commercial whaling came into effect Japan, Norway, and Iceland have issued scientific permits as part of their research programs. For the last 5 years, only Japan has issued permits to harvest sei whales although Iceland asked for a proposal to be reviewed by the

IWC Scientific Committee in 2003. The Government of Japan has issued scientific permits in recent years to capture minke, Bryde's, and sperm whales in the North Pacific, known as JARPA II and JARPN II programmes. The Government of Japan extended the captures to include 50 sei whales from pelagic areas of the western North Pacific. (Carretta et al. 2007)

Fisheries Interactions

Sei whales, because of their offshore distribution and relative scarcity in U.S. Atlantic and Pacific waters, probably have a lower incidence of entrapment and entanglement than fin whales. Data on entanglement and entrapment in non-U.S. waters are not reported systematically. Heyning and Lewis (1990) made a crude estimate of about 73 rorquals killed/year in the southern California offshore drift gillnet fishery during the 1980s. Some of these may have been fin whales instead of sei whales. Some balaenopterids, particularly fin whales, may also be taken in the drift gillnet fisheries for sharks and swordfish along the Pacific coast of Baja California, Mexico (Barlow et al. 1997). Heyning and Lewis (1990) suggested that most whales killed by offshore fishing gear do not drift far enough to strand on beaches or to be detected floating in the nearshore corridor where most whale-watching and other types of boat traffic occur. Thus, the small amount of documentation may not mean that entanglement in fishing gear is an insignificant cause of mortality. Observer coverage in the Pacific offshore fisheries has been too low for any confident assessment of species-specific entanglement rates (Barlow et al. 1997). The offshore drift gillnet fishery is the only fishery that is likely to take sei whales from this stock, but no fishery mortalities or serious injuries to sei whales have been observed. Sei whales, like other large whales, may break through or carry away fishing gear. Whales carrying gear may die later, become debilitated or seriously injured, or have normal functions impaired, but with no evidence recorded.

Ship Strikes

The decomposing carcass of a sei whale was found on the bow of a container ship in Boston harbor, suggesting that sei whales, like fin whales, are killed at least occasionally by ship strikes (Waring et al. 1997). Sei whales are observed from whale-watching vessels in eastern North America only occasionally (Edds et al. 1984) or in years when exceptional foraging conditions arise (Weinrich et al. 1986, Schilling et al. 1992). There is no comparable evidence available for evaluating the possibility that sei whales experience significant disturbance from vessel traffic. During 2000-2004, there were an additional five injuries and three mortalities of unidentified large whales attributed to ship strikes. Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not always have obvious signs of trauma. (DoN 2006)

Other Threats

No major habitat concerns have been identified for sei whales in either the North Atlantic or the North Pacific. Sei whales have a preference for copepods and euphausiids (i.e., low trophic level organisms), and may be less susceptible to the bioaccumulation of organochlorine and metal contaminants than, fin, humpback, and minke whales, all of which seem to feed more regularly on fish and euphausiids (O'Shea and Brownell 1994). Sei whales off California often feed on pelagic fish as well as invertebrates (Rice 1977). There is no evidence that levels of organochlorines, organotins, or heavy metals in baleen whales generally (including fin and sei whales) are high enough to cause toxic or other damaging effects (O'Shea and Brownell 1994). However, very little is known about the possible long-term and trans-generational effects of exposure to pollutants.

3.8.3.6 Sperm Whale

Stock

North Pacific

Regulatory Status

Sperm whales (*Physeter macrocephalus*) are listed as endangered under the ESA and designated as depleted under MMPA. The North Pacific stock is classified as strategic. A draft species recovery plan has been prepared (NMFS 2006a).

Habitat Preferences & Critical Habitat

Sperm whales show a strong preference for deep waters (Rice 1989), especially in areas with high sea floor relief. Recent research at the Azores Seamounts off Portugal did not, however, demonstrate association of sperm whales with seamounts (Morato et al. 2008). Globally, sperm whale distribution is associated with waters over the continental shelf break, over the continental slope, and into deeper waters (Hain et al. 1985). However, in some areas, such as off New England, on the southwestern and eastern Scotian Shelf, or the northern Gulf of California, adult males are reported to use waters with bottom depths less than 328 ft (100 m) and as shallow as 131 ft (40 m) (Whitehead et al. 1992, Scott and Sadove 1997, Croll et al. 1999, Garrigue and Greaves 2001, Waring et al. 2002). Worldwide, females rarely enter the shallow waters over the continental shelf (Whitehead 2003). In GOA the primary occurrence for the sperm whales is seaward of the 1640 ft (500 m) isobath (DoN 2006).

Sperm whales have a highly diverse diet. Prey includes large mesopelagic squid and other cephalopods, fish, and occasionally benthic invertebrates (Fiscus and Rice 1974, Rice 1989, Clarke 1996).

Critical habitat has not been designated for sperm whales.

Population Size and Trends

Current estimates of population abundance, status, and trends for the North Pacific stock in Alaska of sperm whales are not available. For the North Pacific, sperm whales have been divided into three separate stocks based on where they are found, designated as (1) Alaska (North Pacific stock), (2) California/Oregon/Washington, and (3) Hawaii. (Angliss and Allen 2008)

Estimates of pre-whaling abundance in the North Pacific are considered somewhat unreliable, but sperm whales may have totaled 1,260,000 individuals (Angliss and Allen 2008). Approximately 258,000 sperm whales in the North Pacific were harvested by commercial whalers between 1947 and 1987 (Hill and DeMaster 1999). However, this number may be negatively biased by as much as 60 percent because of under-reporting by Soviet whalers (Brownell et al. 1998). In particular, the Bering Sea population of sperm whales (consisting mostly of males) was severely depleted (Perry et al. 1999). Catches in the north Pacific continued to climb until 1968, when 16,357 sperm whales were harvested. Catches declined after 1968, in part through limits imposed by the IWC (Rice 1989).

The following has been estimated for other stocks in the Pacific:

- California/Oregon/Washington 2,853 (CV = 0.25); Carretta et al. (2008)
- Hawaii 7,082 (CV = 0.30); Carretta et al. (2008)
- North Pacific 102,112 (CV = 0.15); Angliss and Allen (2008)

From 26 June to 15 July 2003, a survey in the Shelikof Strait (north of Kodiak), Cook Inlet, Prince William Sound and between Kodiak and Montague Island detected six sperm whales along the shelf break, with an average group size of 1.2 (Waite 2003). Data from this survey yielded a density of 0.0003/km^2, which is applicable year-round for sperm whales in the TMAA as described in detail in Appendix E. This density was based on only two "on effect" sightings, so confidence in the value is low, but it is the only data from which to derive a density that exists at this time for the region. The April 2009 survey in the TMAA recorded sperm whales acoustically in both the inshore and offshore strata but no sperm whales were detected visually (Rone et al. 2009).

Distribution

Sperm whales occur throughout all ocean basins from equatorial to polar waters, including the entire North Atlantic, North Pacific, northern Indian Ocean, and the southern oceans. Sperm whales are found throughout the North Pacific and are distributed broadly from tropical and temperate waters to the Bering Sea as far north as Cape Navarin. Male sperm whales are found from tropical to polar waters in all oceans of the world, between approximately 70°N and 70°S (Rice 1998). In the North Pacific, the distribution of females and young sperm whales is more limited year-round and generally corresponds to tropical and temperate waters approximately to 50°N latitude (at least 6 degrees south of the TMAA; Whitehead 2003). Summer surveys in the coastal waters around the central and western Aleutian Islands have found sperm whales to be the most frequently sighted large cetacean (Angliss and Allen 2008). Acoustic surveys have detected the presence of sperm whales year-round in the GOA although about twice as many are present in summer as in winter (Mellinger et al. 2004, Moore et al. 2006). Fewer detections in winter are reflected by the documented seasonal movement of whales from Canada and Japan to the GOA/Bering Sea/Aleutian Islands region (Angliss and Allen 2008).

Life History

Female sperm whales become sexually mature at about 9 years of age (Kasuya 1991). Male sperm whales take between 9 and 20 years to become sexually mature, but will require another 10 years to become large enough to successfully compete for breeding rights (Kasuya 1991). The age distribution of the sperm whale population is unknown, but sperm whales are believed to live at least 60 years (Rice 1978). Estimated annual mortality rates of sperm whales are thought to vary by age, but previous estimates of mortality rate for juveniles and adults are now considered unreliable (International Whaling Commission 1980).

Reproduction/Breeding

Calving generally occurs in the summer at lower latitudes and the tropics (Department of the Navy 2005). Adult females give birth after about 15 months gestation and nurse their calves for 2 to 3 years. The calving interval is estimated to be about 4 to 6 years (Kasuya 1991). There are no known areas used by sperm whales for reproduction or calving in the TMAA.

Diving Behavior

Details regarding the relatively extensive dive behavior information for sperm whales are presented in Appendix D. In general, sperm whales forage during deep dives that routinely exceed a depth of 1,312 ft (400 m) and 30 min duration (Watkins et al. 2002). Sperm whales can dive to depths of over 6,562 ft (2,000 m) with durations of over 60 min (Watkins et al. 1993). Sperm whales spend up to 83 percent of daylight hours underwater (Jaquet et al. 2000, Amano and Yoshioka 2003). Males do not spend extensive periods at the surface (Jaquet et al. 2000). In contrast, females spend prolonged periods at the surface (1 to 5 hours daily) without foraging (Whitehead and Weilgart 1991, Amano and Yoshioka 2003). The average swimming speed is estimated to be 2.3 ft/sec (0.7 m/sec) (Watkins et al. 2002). Dive descents averaged 11 min at a rate of 5.0 ft/sec (1.52 m/sec), and ascents averaged 11.8 min at a rate of 4.6 ft/sec (1.4 m/sec) (Watkins et al. 2002).

Acoustics

Sperm whales produce short-duration (generally less than 3 sec), broadband clicks. These clicks range in frequency from 100 Hz to 30 kHz (Weilgart and Whitehead, 1993, 1997; Goold and Jones 1995; Thode et al. 2002), with dominant energy in two bands (2 to 4 kHz and 10 to 16 kHz). The source levels can be up to 236 dB re 1 µPa @ 1 m (Møhl et al. 2003). Thode et al. (2002) suggested that the acoustic directivity (angular beam pattern) from sperm whales must range between 10 and 30 dB in the 5- to 20-kHz region. The clicks of neonate sperm whales are very different from the usual clicks of adults, in that they are of low directionality, long duration, and low frequency (centroid frequency between 300 and 1,700 Hz) with estimated source levels between 140 and 162 dB re 1 µPa @ 1 m (Madsen et al. 2003). Clicks are heard most frequently when sperm whales are engaged in diving and foraging behavior (Whitehead and Weilgart 1991, Miller et al. 2004, Zimmer et al. 2005). These may be echolocation clicks used in feeding, contact calls (for communication), and orientation during dives. When sperm whales socialize, they tend to repeat series of clicks (codas), which follow a precise rhythm and may last for hours (Watkins and Schevill 1977). Codas are shared between individuals of a social unit, and are considered to be primarily for intragroup communication (Weilgart and Whitehead 1997, Rendell and Whitehead 2004).

The anatomy of the sperm whale's ear indicates that it hears high-frequency sounds (Ketten 1992). Anatomical studies also suggest that sperm whales have some ultrasonic hearing, but at a lower maximum frequency than many other odontocetes (Ketten 1992). Sperm whales may also possess better low-frequency hearing than some other odontocetes, although not as extraordinarily low as many baleen whales (Ketten 1992). Auditory brainstem response in a neonatal sperm whale indicated highest sensitivity to frequencies between 5 and 20 kHz (Ridgway and Carder 2001; Table 3.8-3).

Impacts of Human Activity

Historic Whaling

In 2000, the Japanese Whaling Association announced that it planned to kill 10 sperm whales and harvest 5 sperm whales. Japanese whalers took another 31 sperm whales between 2001 and 2005 (Angliss and Allen 2008). The consequence of these deaths on the status and trend of sperm whales remains uncertain, given the lack of information concerning sperm whale abundance. (Institute of Cetacean Research undated)

Fisheries Interactions

In U.S. waters in the Pacific, sperm whales have been incidentally taken only in drift gillnet operations, which killed or seriously injured an average of nine sperm whales per year from 1991-1995 (Barlow et al. 1997). Of the eight sperm whales taken by the California/Oregon drift gillnet fishery, three were released alive and uninjured (37.5 percent), one was released injured (12.5 percent), and four (50 percent) were killed (NMFS 2000). Therefore, approximately 63 percent of captured sperm whales could be killed accidentally or injured, based on the mortality and injury rate of sperm whales observed taken by the U.S. fleet from 1990 to 2000. Based on past fishery performance, sperm whales were not observed taken in every year; they were observed to be taken in 4 out of 10 years (NMFS 2000). During the 3 years the Pacific Coast Take Reduction Plan has been in place, a sperm whale was taken only once, in a set that did not comply with the Take Reduction Plan (NMFS 2000).

Interactions between sperm whales and longline fisheries in the GOA have been reported since 1995 and are increasing in frequency (Rice 1989, Hill and Mitchell 1998, Hill and DeMaster 1999). Between 2002 and 2006, there were three observed serious injuries (considered mortalities) to sperm whales in the GOA from the sablefish longline fishery (Angliss and Allen 2008). Sperm whales have also been observed in GOA feeding off longline gear (for sablefish and halibut) at 38 of the surveyed stations (Angliss and Allen 2008). Recent findings suggest sperm whales in Alaska may have learned that fishing vessel propeller cavitations (as gear is retrieved) are an indicator that longline gear with fish is present as a predation opportunity (Thode et al. 2007).

Berzin (1972) noted that there were “many” reports of sperm whales of different age classes being struck by vessels, including passenger ships and tug boats. Sperm whales spend long periods (typically up to 10 min) at the surface between deep dives (Jacquet et al. 1998). This behavior could make sperm whales more vulnerable to ship strikes. There is record of one collision between a fishing vessel and a sperm whale within the TMAA (Gabriele et al., manuscript on file).

3.8.3.7 Steller Sea Lion

The Steller sea lion’s (*Eumetopias jubatus*) range includes portions of the TMAA. The boundary between the Western U.S stock and the Eastern U.S. stock approximately bisects the TMAA, although the TMAA is located offshore of the main habitat/foraging areas.

Stock

Eastern and Western United States

Regulatory Status

In 1997, NMFS reclassified Steller sea lions into two distinct subpopulations, based on genetics and population trends (Loughlin 1997, Angliss and Outlaw 2005). The Western U.S. stock was designated as endangered and includes animals at and west of Cape Suckling, Alaska (144°W; NMFS 1997c). The Eastern U.S. stock remained designated as threatened and includes animals east of Cape Suckling (NMFS 1997c, Loughlin 2002, Angliss and Outlaw 2005) that extend into southeastern Alaska, and Canada. Rookeries of the Eastern U.S. stock occur along the coasts of Oregon and California (NMFS 2008c). The Steller sea lion is designated as depleted under MMPA. A final revised species recovery plan addresses both the Eastern U.S. and Western U.S. stocks (NMFS 2008c).

Habitat Preferences & Critical Habitat

Steller sea lions are opportunistic predators, feeding primarily on fishes (including walleye pollock, cod, mackerel, and herring), invertebrates, and cephalopods (octopus and squid), with diet varying geographically and seasonally (Merrick et al. 1997, Loughlin 2002, DoN 2006). For the GOA, foraging habitat is primarily shallow, nearshore and continental shelf waters 8 to 24 km (4.3 to 13 nm) offshore with a secondary occurrence inshore of the 1,000 m isobath, and a rare occurrence seaward of the 1,000 m isobath.

Steller sea lions form large rookeries during late spring when adult males arrive and establish territories (Pitcher and Calkins 1981), so the rookeries would normally be occupied during the likely time-period for the annual Northern Edge exercise.

In 1993, NMFS published a final rule to designate critical habitat for Steller sea lions (NMFS 2008). There is no Critical Habitat for Steller sea lions in the TMAA. The areas designated as critical habitat were based on land use patterns, the extent of foraging trips, and the availability of prey items with particular importance given to the haul out areas where animals rest, pup, nurse, mate, and molt. Two kinds of marine habitat were designated as critical: “aquatic zones” around rookeries and haulouts and three special aquatic feeding areas in Alaska. The special aquatic foraging areas were chosen, “based on 1) at-sea observations indicating that sea lions commonly used these areas for foraging, 2) records of animals killed incidentally in fisheries in the 1980s, 3) knowledge of sea lion prey and their life histories and distributions, and 4) foraging studies” (NMFS 2008).

For the Eastern U.S. stock, the Critical Habitat aquatic zones (located east of 144°W longitude) extend 3,000 ft (0.9 km) seaward in state and federally managed waters from the baseline or basepoint of each major rookery. None of this Critical Habitat is in the vicinity of the TMAA.

For the Western U.S. stock, Critical Habitat for aquatic zones located (west of 144°W longitude) extend 20 nm (37 km) seaward in state and federally managed waters. None of the aquatic zones are located within the boundaries of the TMAA. Critical Habitat for the Western U.S. stock in the vicinity of the TMAA is depicted in Figure 3.8-2 (NMFS 2008).

Population Size and Trends

The minimum abundance estimate for Western U.S. stock Steller sea lions is 38,988 individuals, and the Eastern stock is estimated at 45,095 to 55,832 (Angliss and Allen 2008). Given the wide dispersal of individuals, both the Western U.S. and Eastern U.S. stock may occur in the GOA (DoN 2006, Angliss and Outlaw 2007, NMFS 2008), with about 70 percent of the population living in Alaskan waters. Between 2000 and 2004, the Western U.S. stock increased at a rate of approximately 3 percent per year (Fritz and Stinchcomb 2005). The Eastern U.S. stock has increased at an annual rate of approximately 3 percent since at least the late 1970s (Pitcher et al. 2007) and may be a candidate for removal from the list of threatened and endangered species (NMFS 2008). Despite incomplete surveys conducted in 2006 and 2007, the available data indicate that the western Steller sea lion population (non-pups) was stable since 2004 (when the last complete assessment was done). The revised Steller Sea Lion Recovery Plan (NMFS 2008) contains recovery criteria to change the listing of the Western U.S. stock from endangered to threatened ("down-listing") and to remove it from the list of species requiring ESA protection (delist).

For purposes of acoustic impact modeling, a density of $0.0098/km^2$ was derived for Steller sea lions in the TMAA as described in detail in Appendix E.

Distribution

Steller sea lions do not migrate, but they often disperse widely outside of the breeding season (Loughlin 2002). Steller sea lions are gregarious animals that often travel or haul out in large groups of up to 45 individuals (Keple 2002). At sea, groups usually consist of females and subadult males; adult males are usually solitary while at sea (Loughlin 2002). An area of high occurrence extends from the shore to the 273-fathom (500-m) depth. For the GOA, foraging habitat is primarily shallow, nearshore, and continental shelf waters 4.3 to 13 nm (8 to 24 km) offshore with a secondary occurrence inshore of the 3,280 ft (1,000 m) isobath, and a rare occurrence seaward of the 3,280 ft (1,000 m) isobath. Steller sea lions have been sighted foraging in the middle of the GOA (DoN 2006). The April 2009 survey in the TMAA encountered two groups of Steller sea lions (Rone et al. 2009).

Life History

Foraging habitat is primarily shallow, nearshore and continental shelf waters, and some Steller sea lions feed in freshwater rivers (Reeves et al. 1992, Robson 2002). They also are known to feed in deep waters past the continental shelf break (Department of the Navy 2006). Haulout and rookery sites are located on isolated islands, rocky shorelines, and jetties. Steller sea lions are opportunistic predators, feeding primarily on fish and cephalopods, and their diet varies geographically and seasonally (Merrick et al. 1997). They feed near land or in relatively shallow water (Pitcher and Calkins 1981).

Steller sea lions form large rookeries during late spring when adult males arrive and establish territories. Large males aggressively defend territories while non-breeding males remain at peripheral sites or haulouts. Females arrive soon after and give birth to pups. Females reach sexual maturity at 4 to 5 years of age. (Pitcher and Calkins 1981)

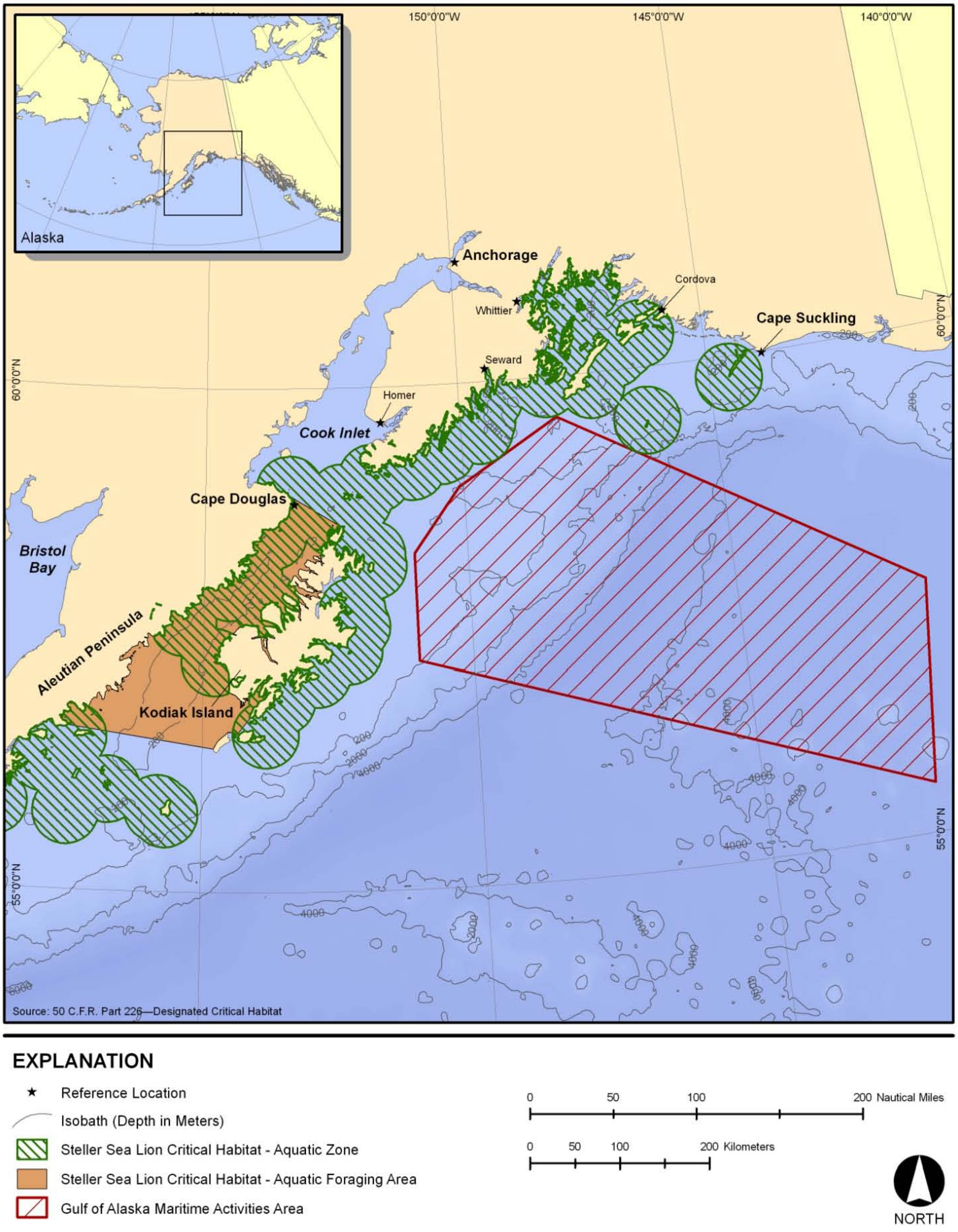


Figure 3.8-2: Steller Sea Lion Western U.S. Stock Critical Habitat in the Vicinity of the TMAA

Natural mortality in Steller sea lions is thought to result primarily from killer whale predation, diseases and parasites, and habitat loss (National Marine Fisheries Service 2008b). The carrying capacity of the North Pacific for Steller sea lions also likely fluctuates in response to changes in the environment.

Reproduction/Breeding

Most births occur from mid-May through mid-July at rookeries outside the boundaries of the MAA, and breeding takes place shortly thereafter (Pitcher and Calkins 1981). Rookeries of the Eastern stock occur along the coasts of Oregon and California (National Marine Fisheries Service 2008c). There are no known areas used by Steller sea lions for reproduction or calving in the TMAA.

Diving Behavior

Details regarding the characterization of diving behavior for input into acoustic impact modeling for Steller sea lions are provided in Appendix D. Diving and foraging activity varies by sex, age, and season. During the breeding season, females with pups feed mostly at night, while territorial males eat little or no food (Loughlin 2002). In the winter, females make long trips of around 81 mi (130 km) and dive deeply to locate prey (Merrick and Loughlin 1997, Loughlin 2002). In the summer, trip length is about 11 mi (17 km) and dives are shallower (Loughlin 2002). Females usually go to sea to feed and return to nurse their pups in 24- to 48-hour cycles (NRC 2003). Steller sea lions tend to make shallow dives of less than 820 ft (250 m) but are capable of deeper dives (NMFS 2003).

Acoustics

On land, territorial male Steller sea lions usually produce low frequency roars (Schusterman et al. 1970, Loughlin et al. 1987). The calls of females range from 30 Hz to 3 kHz (see Table 3.8-3), with peak frequencies from 150 Hz to 1 kHz; typical duration is 1.0 to 1.5 sec (Campbell et al. 2002). Pups produce bleating sounds. Underwater sounds are similar to those produced on land (Loughlin et al. 1987).

When the underwater hearing sensitivity of two Steller sea lions was tested, the hearing threshold of the male was significantly different from than that of the female. The range of best hearing for the male was from 1 to 16 kHz, with maximum sensitivity (77 dB re 1 µPa @ 1 m) at 1 kHz. The range of best hearing for the female was from 16 kHz to above 25 kHz, with maximum sensitivity (73 dB re 1 µPa @ 1 m) at 25 kHz. However, because of the small number of animals tested, the findings could not be attributed to individual differences in sensitivity or sexual dimorphism (Kastelein et al. 2005).

Impacts of Human Activity

Major sources of induced (anthropogenic) mortality include harvesting by Alaska Natives, fisheries interactions (e.g., entanglements) and food shortages as a result of fishing pressure on prey items, and environmental contamination (NMFS 2008).

Hunting

Historically, the Eastern U.S. stock was subjected to substantial mortality by humans, primarily due to commercial exploitation and both sanctioned and unsanctioned predator control (NMFS 2008c). Alaska Natives are exempted from the MMPA and ESA and continue taking seals for subsistence and/or handicraft purposes. The mean annual harvest of Steller sea lions by Alaska Natives between 2000 and 2004 was estimated approximately 190 animals with the majority of these harvests having involved the Western U.S. stock (NMFS 2000). The mean annual take for subsistence harvest between 2002 and 2006 is estimated to have been 198 animals in the Western U.S. stock (Angliss and Allen 2008).

State-sanctioned commercial harvest of Steller sea lions ended in 1972 with the advent of the MMPA. Although not well documented, there is little doubt that numbers of Steller sea lions were greatly reduced in many locations by these activities (NMFS 2008c). Commercial hunting and predator control activities have been discontinued and no longer affect the Eastern U.S. stock. In contrast to the Western U.S. stock, which is experiencing potential human-related threats from competition with fisheries (potentially high), incidental take by fisheries (low), and toxic substances (medium) no threats to continued recovery were identified for the Eastern U.S. stock. Although several factors affecting the Western U.S. stock also affect the Eastern U.S. stock (e.g., environmental variability, killer whale predation, toxic substances, disturbance, shooting), these threats do not appear to be at a level sufficient to keep the Eastern U.S. stock from continuing to recover, given the long-term sustained growth of the population as a whole (NMFS 2008c).

Fisheries Interactions

Lethal deterrence of seals from fishing activities ended in 1990 when Steller sea lions were listed under the ESA. Incidental take by fisheries has been assessed as having a low potential threat for the Western U.S. stock with an estimated approximate 30 lethal entanglements annually and 3.6 lethal entanglements (estimated in 2005) for the Eastern U.S. stock (NMFS 2008, Angliss and Allen 2008). Entanglement in marine debris is assessed as a minor threat to the Steller sea lions (NMFS 2008).

Both climate shift and fisheries induced changes in prey communities may have affected the condition of Steller sea lions over the last 40 years, but the relative importance of each is a matter of considerable debate (NMFS 2008c). There are two fishery-related theories about what may have contributed most to decline of Steller sea lions through reductions in prey biomass and quality, which resulted in nutritional stress (proximate cause) and subsequent decreases in vital rates (Trites et al. 2006a). In one case, nutritional stress stems from climate-induced changes in the species composition, distribution or nutritional quality of the sea lion prey base. In the other, fishery-induced reductions in localized or overall prey abundance cause nutritional stress (Braham et al. 1980; NMFS 1998a, 2000).

What may have been unusual about the decline in sea lions observed through 2000 is the introduction of large-scale commercial fisheries on sea lion prey. While large-scale groundfish fisheries began in the 1960s, their potential for competitive overlap with Steller sea lions (e.g., catches within what would be designated as critical habitat) increased markedly in the 1980s. Overall and localized fisheries removals of prey could have exacerbated natural changes in carrying capacity, possibly in nonlinear and unpredictable ways (Goodman et al. 2002). Reductions in carrying capacity may have contributed to declines in Steller sea lion fatality that are believed to have occurred at some rookeries through at least 2002 despite shifts to potentially more favorable environmental conditions that may have occurred in 1989 and 1998 (NMFS 2008c).

3.8.4 Non-ESA Cetacean Species

3.8.4.1 Baird’s Beaked Whale

<u>Stock</u>

Alaska

<u>Regulatory Status</u>

Baird’s beaked whales (*Berardius bairdii*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The Alaska stock of Baird’s beaked whales is not classified as strategic.

<u>Habitat Preferences</u>

Baird’s beaked whales appear to occur mainly in cold deep waters (3,300 ft [1,000 m] or greater) over the continental slope, oceanic seamounts, and in areas with submarine escarpments. They may also occur occasionally near shore along narrow continental shelves. The range for the Alaska stock of Baird’s beaked whale extends from Cape Navarin (63°N) and the central Sea of Okhotsk (57°N) to St. Matthew Island, the Pribilof Islands in the Bering Sea, and the northern GOA. (Angliss and Allen 2008, DoN 2006)

Population Size and Trends

There is no reliable population estimate for the Alaska stock of Baird's beaked whale (Angliss and Allen 2008). For purposes of acoustic impact modeling, a density of $0.0005/km^2$ was derived for Baird's beaked whales in the TMAA as described in detail in Appendix E.

Distribution

Baird's beaked whales are found only in the North Pacific and the adjacent seas (Bering Sea, Okhotsk Sea, Sea of Japan, and the Gulf of California), mainly north of 34°N in the west and 28°N in the east. The best-known populations occur in the coastal waters around Japan since whaling takes place there. Along the U.S. west coast, Baird's beaked whales are seen primarily along the continental slope from late spring to early fall. British Columbia whalers commented that Baird's beaked whales were most often sighted during May through September, with most catches occurring during August. Baird's beaked whales are seen less frequently and are presumed to be further offshore during the colder water months of November through April. (DoN 2006)

Within the GOA, the area of primary occurrence for Baird's beaked whales during both summer and winter is between the depths of 1,640 and 9,842 ft (500 and 3,000 m). There is no evidence of seasonal movements by this species that would affect these predicted occurrence patterns. There is a secondary occurrence between the 656 and 1,640 ft (200 and 500 m) isobaths, as well as seaward of the 9,842 ft (3,000 m) isobath. There is a rare occurrence in waters shallower than the 656 ft (200 m) isobath. In 2003, Waite (2003) reported a group of four Baird's beaked whales was sighted at the shelf break to the east of the TMAA. There were no beaked whales detected acoustically or visually (although two groups of unidentified small whale were sighted) during the April 2009 survey of the TMAA (Rone et al. 2009).

Life History

Baird's beaked whales occur in relatively large groups of 6 to 30, and groups of 50 or more sometimes are seen (Balcomb 1989). Baird's beaked whales in Japan prey primarily on deepwater gadiform fishes and cephalopods, indicating that they feed primarily at depths ranging from 800 to 1,200 m (Walker et al. 2002, Ohizumi et al. 2003). Sexual maturity occurs at about 8 to 10 years, and the calving peak is in March and April (Balcomb 1989).

Reproduction/Breeding

Mating generally occurs in October and November but little else is known of their reproductive behavior (Balcomb 1989). There are no known areas used by Baird's beaked whales for reproduction or calving in the TMAA.

Diving Behavior

Details regarding the characterization of diving behavior for input into acoustic impact modeling for Baird's beaked whales is provided in Appendix D. Analysis of stomach contents from captured and stranded individuals suggests that beaked whales are deep-diving animals, feeding by suction (Heyning and Mead 1996). The overall dive behavior of Baird's beaked whales is not known; therefore the diving behavior of a related species, Blainville's beaked whale, is used to provide diving behavior information. Baird et al. (2006) reported on the diving behavior of four Blainville's beaked whales (a similar species) off the west coast of Hawaii. The Blainville's beaked whales foraged in deep ocean areas (2,270-9,855 ft [691-3,003 m]) with a maximum dive to 4,619 ft (1,407 m). Dives ranged from at least 13 min (lost dive recorder during the dive) to a maximum of 68 min (Baird et al. 2006).

Acoustics

Sounds recorded from beaked whales are divided into two categories: whistles and pulsed sounds (clicks), with whistles likely serving a communicative function, and pulsed sounds being important in foraging and/or navigation (Johnson et al. 2004, Madsen et al. 2005, MacLeod and D'Amico 2006). Both whistles and clicks have been recorded from Baird's beaked whales in the eastern north Pacific. Whistles had fundamental frequencies between 4 and 8 kHz, with two to three strong harmonics within the recording bandwidth. Clicks had a dominant frequency around 23 kHz, with a second frequency peak at around 42 kHz (see Table 3.8-3) and, unlike species that echolocate, were most often emitted in irregular series of very few clicks. (DoN 2006)

There is no information on the hearing abilities of Baird's beaked whale. In fact, there is no direct information available on the exact hearing abilities of most beaked whales, except for recent information from a live stranded juvenile Gervais' beaked whales (*Mesoplodon europaeus*); another whale in the same taxonomic family. Auditory evoked potential tests on this beaked whale found its hearing to be most sensitive to high-frequency signals between 40 and 80 kHz but it also perceiving mid-frequency sound down to 5 kHz although resulting in smaller evoked potentials (Cook et al. 2006).

It has been previously postulated, based on the occurrence of beaked whale strandings associated with ASW training events, that the species in general may be more sensitive than other cetaceans to sonar (Southall et al. 2007). In contrast and based on recent field experiments with tagged beaked whales, it has been suggested that beaked whales may be "particularly sensitive to anthropogenic sounds, but there is no evidence that they have a special sensitivity to sonar compared with other signals" (Tyack 2009). These beaked whales' reactions to three different sound stimulus consisted of the animals stopping their clicking, producing fewer foraging buzzes than normal, and ending their dives in a long and unusually slow ascent while moving away from the sound source (Tyack 2009).

Impacts of Human Activity

While beaked whale strandings have been reported since the 1800s, several mass strandings since have been associated with naval operations that may have included mid-frequency sonar (Cox et al. 2006). As Cox et al. (2006) concluded, the state of science can not yet determine if a sound source such as mid-frequency sonar alone causes beaked whale strandings, or if other factors (acoustic, biological, or environmental) must co-occur in conjunction with a sound source. Recent evidence from the experimental sonar exposure to tagged beaked whales seems to suggest there is no general beaked whale sensitivity to Navy sonar (Tyack 2009).

For Alaska waters this is important given that between 27 June and 19 July 2004, five beaked whales were discovered stranded at various locations along 1,600 mi (2,625 km) of the Alaskan coastline and one was found floating (dead) at sea; These whales included three Baird's beaked whales. As described in Appendix F in greater detail, questions were raised soon after the strandings as to whether they were the result of Navy sonar use, although sonar training events had not been part of an exercise which took place in that general timeframe. While records of Baird's beaked whale strandings are uncommon in Alaska waters, they are not unknown. Between 1975 and 1987, eight Baird's beaked whales were found stranded as far north as the area between Cape Pierce and Cape Newenham, to the east near Kodiak, and along the Aleutian Islands (Zimmerman, 1991). In Alaska there has been on average, including more recent data, between zero and three beaked whale strandings documented per year (Jensen 2008).

3.8.4.2 Cuvier's Beaked Whale

Stock

Alaska

Regulatory Status

Cuvier's beaked whales (*Ziphius cavirostris*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The Alaska stock of Cuvier's beaked whales is not classified as strategic.

Habitat Preferences

World-wide, beaked whales normally inhabit continental slope (656-6,562 ft [200-2,000 m]) and deep oceanic waters (>6,562 ft [>2,000 m]), and only rarely stray over the continental shelf (Pitman 2002). Beaked whales are only occasionally reported in waters over the continental shelf. Cuvier's beaked whales generally are sighted in waters with a bottom depth greater than 656 ft (200 m) and are frequently recorded at depths of 3,280 ft (1,000 m) or more. Forney and Brownell (1996) made one sighting of Cuvier's beaked whales during surveys in the Aleutian Islands during 1994 in waters with a bottom depth of 13,123 to 16,404 ft (4,000 to 5,000 m). Rice and Wolman (1982) observed a group of six Cuvier's beaked whales in about 17,716 ft (5,400 m) of water southeast of Kodiak Island. Waite (2003) reported one sighting of a group of four Cuvier's beaked whales at the shelf break within the TMAA. There were no beaked whales detected acoustically or visually (although two groups of unidentified small whale were sighted) during the April 2009 survey of the TMAA (Rone et al. 2009).

Population Size and Trends

There is no population estimate for the Alaska stock of Cuvier's beaked whales (Angliss and Allen 2008). For purposes of acoustic impact modeling, a density of $0.0022/km^2$ was derived for Cuvier's beaked whales in the TMAA as described in detail in Appendix E.

Distribution

The general distribution of Cuvier's beaked whales is primarily derived from strandings, which indicated that they are the most widely distributed of the beaked whales. They occur in all three major oceans and most seas. In the north Pacific, they range north to the northern GOA, the Aleutian Islands, and the Commander Islands and as far south as Hawaii. Cuvier's beaked whales generally are sighted in waters with a bottom depth greater than 656 ft (200 m) and are frequently recorded in areas with depths of 3,281 ft (1,000 m) or more. Occurrence has been linked to physical features such as the continental slope, canyons, escarpments, and oceanic islands. (Angliss and Outlaw 2005)

Life History

Little is known of the feeding preferences of Cuvier's beaked whale. They may be mid-water and bottom feeders (Baird et al. 2005b) on cephalopods and, rarely, fish (MacLeod et al. 2003).

Reproduction/Breeding

Little is known of Cuvier's beaked whale reproductive behavior. There are no known areas used by Cuvier's beaked whales for reproduction or calving in the TMAA.

Diving Behavior

Recent research has provided considerable information regarding the complex patterns associated with the diving behavior of this species. Details regarding dive behavior information and how it was used in deriving parameters for input to the acoustic modeling are provided in Appendix D. In general, Cuvier's beaked whales feed on deep sea fish and squid and tend to dive for an hour or more to considerable depths to forage. Tagged Cuvier's beaked whale dive durations have been recorded for as long as 87 min and dive depths of up to 6,529 ft (1,990 m). (Baird et al. 2006)

Acoustics

MacLeod (1999) suggested that beaked whales use frequencies of between 300 Hz and 129 kHz for echolocation, and between 2 and 10 kHz, and possibly up to 16 kHz, for social communication. Blainville's beaked whales echolocation clicks were recorded at frequencies from 20 to 40 kHz (Johnson et al. 2004) and Cuvier's beaked whales at frequencies from 20 to 70 kHz (Zimmer et al. 2005). Soto et al. (2006) reported changes in vocalizations during diving on close approaches of large cargo ships which may have masked their vocalizations. Cuvier's beaked whales only echolocated below 200 m (656 ft) (Tyack et al. 2006a). Echolocation clicks are produced in trains (interclick intervals near 0.4 second) and individual clicks are frequency modulated pulses with durations of 200-300 microsecond; the center frequency was around 40 kHz with no energy below 20 kHz (Tyack et al. 2006a).

Impacts of Human Activity

Fisheries Interactions

From 1990 to 2002, six different commercial fisheries operating within the range of the Alaska stock of Cuvier's beaked whales were monitored for incidental take. These fisheries included Bering Sea (and Aleutian Islands) ground fish trawl, longline, and pot fisheries and GOA ground fish trawl, longline, and pot fisheries. No Cuvier's beaked whale mortalities were observed. (Angliss and Outlaw 2007)

Strandings

As noted previously for Baird's beaked whales, mass strandings associated with naval training that may have included mid-frequency sonar is a concern for all beaked whales. Between 27 June and 19 July 2004, five beaked whales were discovered stranded at various locations along 1,600 mi (2,575 km) of the Alaskan coastline and one was found floating (dead) at sea. These whales included two Cuvier's beaked whales. As described in Appendix F in greater detail, these strandings were not associated with sonar use by the Navy. Additionally, prior to the Navy conducting the exercise (before 27 June), two Cuvier's beaked whales were discovered stranded at two separate locations along the Alaskan coastline (February 26 at Yakutat and June 1 at Nuka Bay).

Zimmerman (1991) reported that between 1975 and 1987, 19 Cuvier's beaked whales were found stranded from the eastern GOA to the western Aleutians. As noted previously, on average in Alaska there has been on average between zero and three beaked whale strandings documented per year (Jensen 2008).

3.8.4.3 Dall's Porpoise

Stock

Alaska

Regulatory Status

Dall's porpoises (*Phocoenoides dalli*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The Alaska stock of Dall's porpoise is not classified as strategic.

Habitat Preferences

Dall's porpoises are a cool- temperate to subarctic deepwater species found only in the North Pacific and adjacent seas. Cool water temperature (<63 degrees Fahrenheit [°F], 17 degrees Celsius [°C]) is characteristic of their primary habitat. Dall's porpoises are common along the shelf break, slope, and in offshore waters (Consiglieri et al. 1982, Calkins 1986). The waters of the TMAA are an area of primary occurrence.

Population Size and Trends

Numerous studies have documented the occurrence of Dall's porpoises in the Aleutian Islands and western GOA as well as in the Bering Sea. Using a population estimate based on vessel surveys during 1987–1991, and correcting for the tendency of this species to approach vessels, which has been suggested to result in inflated abundance estimates, perhaps by as much as five times, reported a minimum population estimate of 83,400 (CV=0.097) for the Alaska stock of Dall's porpoise. (Angliss and Outlaw 2008) Based on the derived density of 0.1892/km^2 for acoustic impact modeling (Appendix E), Dall's porpoises are the most common cetacean in the TMAA.

Distribution

Dall's porpoises are found from northern Baja California, Mexico, north to the northern Bering Sea and south to southern Japan (Jefferson et al. 1993). The species is only common between 32°N and 62°N in the eastern north Pacific (Morejohn 1979; Houck and Jefferson 1999). Dall's porpoises shift their distribution southward during cooler-water periods (Forney and Barlow 1998). Norris and Prescott (1961) reported finding Dall's porpoises in southern California waters only in the winter, generally when the water temperature was less than 59°F (15°C). Inshore/offshore movements off southern California have also been reported, with individuals remaining inshore in fall and moving offshore in the late spring (Norris and Prescott 1961, Houck and Jefferson 1999, Lagomarsino and Price 2001). Seasonal movements have also been noted off Oregon and Washington, where higher densities of Dall's porpoises were sighted offshore in winter and spring and inshore in summer and fall (Green et al. 1992).

Fiscus et al. (1976) suggested that Dall's porpoise is probably the most common cetacean from the northeast GOA to Kodiak Island. Dall's porpoises are regularly found throughout the GOA year-round. Sightings indicate a general seasonal shift in distribution in the GOA from east in April to west in May and south in June. Dall's porpoises are common along the shelf break, slope, and in offshore waters. Dall's porpoises are primarily found seaward of the 328 ft (100 m) isobaths in the GOA throughout the year. (Angliss and Outlaw 2008, DoN 2006). The April 2009 survey in the TMAA encountered 10 groups of Dall's porpoise totaling 59 individuals in both inshore and offshore strata (Rone et al. 2009).

Life History

Dall's porpoises feed primarily on small fish and squid (Houck and Jefferson 1999). Groups of Dall's porpoises generally include fewer than 10 individuals and are fluid, probably aggregating for feeding (Jefferson 1990, 1991; Houck and Jefferson 1999). There is a strong summer calving peak from June through August, and a smaller peak in March (Jefferson 1989). Animals reach sexual maturity at 3.5 to 8 years (Houck and Jefferson 1999).

Reproduction/Breeding

Calving for Dall's porpoise occurs in the north Pacific from early June through late July (Ferrero and Walker 1999). There are no known areas used by Dall's propoise for reproduction or calving in the TMAA.

Diving Behavior

Details regarding the characterization of diving behavior for input into acoustic impact modeling for Dall's porpoises are provided in Appendix D. Dall's porpoises feed on small fish and squid. In the GOA, Dall's porpoises primarily feed on lanternfish (myctophids). Hanson and Baird (1998) provided the first data on diving behavior for this species: an individual tagged for 41 min dove to a mean depth of 109.6 ft

(33.4 m; Standard Deviation [S.D.] = ±23.9 m) for a mean duration of 1.29 min (S.D. = ±0.84 min). (DoN 2006)

Acoustics

Only short-duration pulsed sounds have been recorded from Dall's porpoises; this species apparently does not whistle often. Dall's porpoises produce short-duration (50 to 1,500 microsesond [μs]), high-frequency, narrow-band clicks, with peak energies between 120 and 160 kHz. There are no published data on hearing abilities of this species. However, based on the morphology of the cochlea, it is estimated that the upper hearing threshold is about 170 to 200 kHz (see Table 3.8-3). (DoN 2006)

Impacts of Human Activity

Fisheries Interactions

The Alaska Peninsula and Aleutian Island salmon driftnet fishery was monitored in 1990. One Dall's porpoise mortality was observed which extrapolated to an annual (total) incidental mortality rate of 28 Dall's porpoise. In addition, over a 5-year period (2000-2004), observations of the Bering Sea/Aleutian Islands pollock trawl fishery resulted in a mean annual mortality of 5.9 Dall's porpoises. This results in an estimated annual incidental kill rate in observed fisheries of 33.9 Dall's porpoises per year for the Alaska stock. (Angliss and Outlaw 2008)

3.8.4.4 Gray Whale

Stock

Eastern North Pacific

Regulatory Status

The ENP stock of gray whales was delisted given an increase in population so it was no longer considered "endangered" or "threatened" under the ESA. Subsequent review determined that the stock was neither in danger of extinction, nor likely to become endangered within the foreseeable future. The ENP stock is not classified as a "strategic" stock by NMFS. (Angliss and Allen 2008)

Habitat Preferences

Gray whales primarily occur in shallow waters over the continental shelf. Their feeding grounds are generally less than 223 ft (68 m) deep and most of the ENP stock can be found in summer feeding grounds north of the Aleutian Islands. During migration through the GOA en route from subtropical breeding grounds, gray whales' primary occurrence extends seaward 15 nm (28 km) from the shoreline within a narrow margin of the TMAA's northern boundary. A rare occurrence is expected seaward of the shelf break. (DoN 2006)

Population Size and Trends

Systematic counts of gray whales migrating south along the central California coast have been conducted most years since 1967, documenting the population increasing over the past several decades. The minimum population estimates for the ENP stock of gray whales using the mean of the 2000/01 and 2001/02 abundance estimates is 17,752 and the best estimate of 18,813 whales (CV = 0.07; Angliss and Allen 2008). For purposes of acoustic impact modeling, a density was estimated at 0.0125/km^2, and is applicable only for the farthest north area of the TMAA (2.75 percent of the area) as described in detail in Appendix E.

Distribution

Gray whales are found only in the North Pacific. The ENP population is found from the upper Gulf of California, south to the tip of Baja California, and up the Pacific coast of North America to the Chukchi and Beaufort seas. This stock is known to summer in the shallow waters of the northern Bering Sea, Chukchi Sea, and western Beaufort Sea, but some individuals spend the summer feeding along the Pacific coast from southeastern Alaska to central California. Beginning in October, the whales migrate south to calving and breeding grounds on the west coast of Baja California and the southeastern Gulf of California. Some gray whales are known to deviate from the typical migration path/seasons; for example, gray whale calls have been documented off Barrow, Alaska, in the winter. (DoN 2006, Angliss and Allen 2008)

Gray whales are found along the shore in the northern GOA during migrations between breeding and feeding grounds. Individuals are expected to occur along the northern coast of the GOA between March and November; peak abundance is expected from April through May and in November and December. The southbound migration begins in early October, when gray whales move from the Bering Sea through the Unimak Pass and along the coast of the GOA. The southbound migration continues into the winter season between October and January. Migration of gray whales past Kodiak Island peaks in mid-December. During the northbound migration, the peak of migration in the GOA is in mid-April. Although most gray whales migrate to the Bering Sea to feed, some whales do not complete the migration north but feed in coastal waters in the GOA and the Pacific Northwest. (DoN 2006)

Most gray whales follow the coast during migration and stay within 1.2 mi (2 km) of the shoreline, except when crossing major bays, straits, and inlets from southeastern Alaska to the eastern Bering Sea. However, gray whales are known to move further offshore between the entrance to Prince William Sound and Kodiak Island and between Kodiak Island and the southern part of the Alaska Peninsula. Gray whales use the nearshore areas of the Alaska Peninsula during the spring and fall migrations and are often found within the bays and lagoons, primarily north of the peninsula, during the summer. (DoN 2006) The April 2009 survey encountered one group of two gray whales within the western edge of the TMAA and two groups well outside the TMAA nearshore at Kodiak Island (Rone et al. 2009).

Life History

Most of the gray whales in the Eastern North Pacific stock spend the summer feeding in the northern Bering and Chukchi Seas. However, gray whales have been seen feeding in the summer off of Southeast Alaska, British Columbia, Washington, Oregon, and California. Each fall, the whales migrate south from Alaska to Baja California, in Mexico. The stock winters primarily in certain shallow, nearly landlocked lagoons and bays along the west coast of Baja California. Calves are born from early January to mid-February. The northbound migration begins in mid-February and continues through May, with cows and newborn calves migrating northward primarily between March and June along the U.S. west coast. (Angliss and Outlaw 2007)

Reproduction/Breeding

The winter breeding grounds consist of subtropical lagoons that are protected from the open ocean (Jones and Swartz 2002). There are no known areas used by gray whales for reproduction or calving in the TMAA.

Diving Behavior

Details regarding the characterization of diving behavior for input into acoustic impact modeling for gray whales are provided in Appendix D. When foraging, gray whales typically dive to 164 to 196 ft (50 to 60 m) for 5 min to about 8 min. When migrating, gray whales may remain submerged near the surface for 7 to 10 min and travel 1,640 ft (500 m) or more before resurfacing to breathe. Migrating gray whales sometimes exhibit a unique "snorkeling" behavior in which they surface cautiously, exposing only the area around the blow hole, exhale quietly without a visible blow, and sink silently beneath the surface. The maximum known dive depth is 557 ft (170 m) (DoN 2006, Jones and Swartz 2002).

Acoustics

Gray whales produce broadband signals ranging from 0.1 to 4 kHz (and up to 12 kHz). The most common sounds on the breeding and feeding grounds are knocks, which are broadband pulses from about 0.1 to 2 kHz (dominant frequency range: 0.327 to 0.825 kHz; see Table 3.8-3). The source level for knocks is approximately 142 dB re 1 µPa @ 1 m. During migration, individuals most often produce low-frequency (predominantly below 1.5 kHz) bonging sounds and moans. (DoN 2006)

The structure of the gray whale ear is evolved for low-frequency hearing. The ability of gray whales to hear frequencies below 2 kHz (as low as 0.8 kHz) has been demonstrated in playback studies and in their responsiveness to underwater noise associated with oil and gas activities. Gray whale responses to noise in these studies include startle responses (i.e., water disturbances, tail-lobbing); changes in swimming speed and direction to move away from the sound source; abrupt behavioral changes from feeding to avoidance, with a resumption of feeding after exposure; changes in calling rates and call structure; and changes in surface behavior, usually from traveling to milling. It was determined the threshold for inducing feeding interruptions from air gun noise was a received level of 173 dB re 1 ìPa @ 1 m, and for continuous industrial noise, the threshold for inducing avoidance was a received level of approximately 120 dB re 1 ìPa @ 1 m. (DoN 2006)

Impacts of Human Activity

Subsistence Interactions

Subsistence hunters in Alaska and Russia have traditionally harvested whales from the ENP stock of gray whales. Based upon reported taking of whales by subsistence hunters from 1995 to 1997 along with an agreement reached between the United States and Russia that the average annual harvest of gray whales would be 124, the annual subsistence take of gray whales averaged 122 whales during a 5-year period from 1999 to 2003. (Angliss and Allen 2008)

Vessel Collisions

The nearshore migration route used by gray whales makes ships strike a potential source of mortality. Between 1999 and 2003, the California stranding network reported four serious injuries or mortalities of gray whales caused by ship strikes. One ship strike was reported in Alaska in 1997. Additional mortality from ship strikes probably goes unreported because the whales either do not strand or do not have obvious signs of trauma. (Angliss and Allen 2008)

3.8.4.5 Harbor Porpoise

Stock

Gulf of Alaska

Regulatory Status

Harbor porpoise (*Phocoena phocoena*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The Gulf of Alaska stock of harbor porpoise is classified as strategic.

Habitat Preferences

Harbor porpoises are generally found in cool temperate to subarctic waters over the continental shelf. This species is seldom found in waters warmer than 62°F (17°C). In Alaskan waters, harbor porpoises inhabit nearshore areas and are common in bays, estuaries, and tidal channels. Harbor porpoises are often found in coastal waters and in the GOA and Southeast Alaska; they occur most frequently in waters less than 328 ft (100 m) in depth. (DoN 2006, Angliss and Allen 2008) Waite (2003) reports a single sighting (two individuals) 27 nm (50 km) offshore, but within the 328 ft (100 m) isobath. The majority of the TMAA is well offshore of the normal habitat range for harbor porpoise. The April 2009 survey encountered 30 groups of harbor porpoise totaling 89 individuals but only one of these groups was located within the TMAA (Rone et al. 2009).

Population Size and Trends

Two of the nine stocks of harbor porpoises recognized along the U.S. Pacific coast are found near the TMAA: the Gulf of Alaska, and Southeast Alaska stocks. The boundaries of the Gulf of Alaska stock are Cape Suckling to Unimak Pass in the Aleutian Islands. The boundaries of the Southeast Alaska stock are northern border of British Columbia to Cape Suckling, Alaska (Angliss and Outlaw 2008). Given the distance from shore and the depth of the waters, individuals from the Southeast Alaska stock should not be present in the TMAA. Individuals from the Gulf of Alaska stock may rarely occur in the northern portion of the TMAA. There is a minimum population estimate of 41,854 for the Gulf of Alaska stock. There are not sufficient numbers of harbor porpoise present in the TMAA to allow for acoustic impact modeling given they are rare.

To derive an estimate for the number of harbor porpoise that may be exposed to potential MMPA Level B harassment (behavioral disturbance), an analysis of the approximate distribution of harbor porpoise in the Gulf of Alaska stock (occurring from Unimak Pass to Cape Suckling as presented in the stock assessment; Angliss and Outlaw 2006) was undertaken as a first step. The stock assessment information indicates an area for the GOA stock of approximately 69,829 nm^2 (239,597 km^2) with an abundance of 41,854 animals, resulting in the second highest density for a marine mammal species in the GOA (0.5993/nm^2 or 0.1747/km^2). The nearshore portion of the TMAA overlaps this approximate distribution by an area of 4,538 nm^2 (15,565 km^2). If an even distribution of harbor porpoise in the Gulf of Alaska stock is assumed, there would be 2,719 harbor porpoise in the portion of the TMAA that overlaps the distribution as presented in the stock assessment. While this is likely an overestimate for the number of animals present in the area given the TMAA is outside harbor porpoise habitat preferences, it will be assumed for purposes of this analysis that 2,719 harbor porpoise would be exposed to a sound level at or above 120 dB Sound Pressure Level (SPL) resulting in MMPA Level B behavioral harassment during one summer training event.

Distribution

Harbor porpoises are generally found in cool temperate to subarctic waters over the continental shelf in both the North Atlantic and North Pacific. Harbor porpoises regularly occur in the GOA year-round. They are common in nearshore waters of the northeast GOA and south of Kodiak Island on Albatross and Portlock banks. They also regularly occur in Kachemak Bay, Prince William Sound, Yakutat Bay, and southeast Alaska, particularly between April and September. Based on aerial surveys in coastal and offshore waters from Bristol Bay (eastern Bering Sea) to Dixon Entrance (southeast Alaska), harbor porpoises are abundant in Bristol Bay and between Prince William Sound and Dixon Entrance. Lower abundance estimates were calculated for Cook Inlet, Kodiak Island, and the south side of the Alaska Peninsula. (DoN 2006, Angliss and Allen 2008)

Life History

Harbor porpoises are not known to form stable social groupings, which is the typical situation for species in the porpoise family. In most areas, harbor porpoises are found in small groups consisting of just a few individuals. (Department of the Navy 2006)

Reproduction/Breeding

They mature at an earlier age, reproduce more frequently, and live for shorter periods than other toothed whales (Read and Hohn 1995). Calves are born in late spring (Read 1990, Read and Hohn 1995). Dall's and harbor porpoises appear to hybridize relatively frequently in the Puget Sound area (Willis et al. 2004). There are no known areas used by Harbor porpoises for reproduction or calving in the TMAA.

Diving Behavior

Harbor porpoises make brief dives, generally lasting less than 5 min. Tagged harbor porpoise individuals spend 3 to 7 percent of their time at the surface and 33 to 60 percent in the upper 7 ft (2 m) of the water column. Average dive depths range from 46 to 135 ft (14 to 41 m), with a maximum known dive of 741 ft (226 m), and average dive durations ranging from 44 to 103 sec. (DoN 2006)

Acoustics

Harbor porpoise vocalizations include clicks and pulses, as well as whistle-like signals. The dominant frequency range is 110 to 150 kHz, with source levels of 135 to 177 dB re 1 µPa @ 1 m. Echolocation signals include one or two low-frequency components in the 1.4 to 2.5 kHz range. (DoN 2006).

A behavioral audiogram of a harbor porpoise indicated the range of best sensitivity is 8 to 32 kHz at levels between 45 and 50 dB re 1 µPa @ 1 m; however, auditory-evoked potential studies showed a much higher frequency of approximately 125 to 130 kHz with two frequency ranges of best sensitivity. More recent psycho-acoustic studies found the range of best hearing to be 16 to 140 kHz (see Table 3.8-3), with a reduced sensitivity around 64 kHz and maximum sensitivity between 100 and 140 kHz. (DoN 2006)

Impacts of Human Activity

Fisheries Interactions

The Pacific cod longline, Pacific halibut longline, rockfish longline, and sablefish longline fisheries were monitored for incidental mortality by fishery observers from 2000 to 2004. No mortalities were observed for the Southeast Alaska or Gulf of Alaska stock of the harbor porpoise. However, monitoring in Prince William Sound (1990-1991), Cook Inlet (1999 and 2000), and Kodiak Island (2002) of salmon drift and set gillnet fisheries resulted in the observation of incidental mortalities. These mortalities extrapolated to an estimated mortality level of 71 animals per year for the Gulf of Alaska stock of harbor porpoise.

3.8.4.6 Killer Whale

There are at least three killer whale (*Orcinus orca*) ecotypes in the eastern north Pacific: "residents," "transients," and "offshore" killer whales. Resident animals often differ from both transient and offshore individuals by having a dorsal fin that is more curved and rounded at the tip, especially among mature females. Residents also exhibit five patterns of saddle patch pigmentation, two of which are shared with transients. Transients have more pointed dorsal fins, and closed saddle patches that extend further forward. Offshores are thought to be slightly smaller in body size than residents and transients and have dorsal fins and saddle patches resembling those of residents. (DoN 2006)

Stock

Eastern North Pacific Alaska Resident, Eastern North Pacific Northern Resident, Eastern North Pacific Offshore, Gulf of Alaska, Aleutian Island, and Bering Sea Transient, AT1 Transient; and West Coast Transient

Regulatory Status

The ENP Alaska Resident, ENP Northern Resident, ENP Offshore, GOA, Aleutian Islands, and Bering Sea transient, and West Coast Transient stocks of killer whales are not listed as threatened or endangered under the ESA or classified as depleted or strategic under the MMPA. In June 2004, NMFS designated the AT1 Transient stock of killer whales as a “depleted” stock under the MMPA and therefore classified as strategic. (Angliss and Allen 2008). In the past, the AT1 Transient stock was one of the most frequently encountered and was sighted year-round in Prince William Sound in the 1980s. However, since the 1989 Exxon Valdez oil spill, the size of the AT1 Transient stock has been reduced by half. The AT1 Transient stock is not currently listed as threatened or endangered.

Habitat Preferences

Killer whales have the most ubiquitous distribution of any species of marine mammal, observed in virtually every marine habitat from the tropics to the poles and from shallow, inshore waters (and even rivers) to deep, oceanic regions. Although reported in tropical and offshore waters, killer whales occur in higher densities in colder and more productive waters of both hemispheres, with the greatest densities found at high latitudes. In the eastern north Pacific, including Alaskan waters, killer whales are found in protected inshore waters, as well as offshore waters. (DoN 2006)

Population Size and Trends

Killer whales are segregated socially, genetically, and ecologically into three distinct eco-type groups: residents, transients, and offshore animals. Resident killer whales primarily feed on fish. “Transient” stocks of killer whales feed on other marine mammals, including other whales, pinnipeds (e.g., London 2006) and sea otters (e.g., Estes et al. 1998) and do not have known schedules and locations as resident whales do. Offshore whales do not appear to mix with the other types of killer whales (Black et al. 1997, Dahlheim et al. 1997). Most cetacean taxonomists agree that multiple killer whale species or subspecies occur worldwide (DoN 2006).

ENP Alaskan Resident stock individuals are found from southeastern Alaska to the Aleutian Islands and Bering Sea; intermixing has been documented among these three areas (Angliss and Outlaw 2007). The ENP Northern Resident stock occurs from British Columbia through part of southeastern Alaska. There are about 656 and 216 photoidentified individuals in the ENP Alaska Resident and ENP Northern Resident stocks, respectively (Angliss and Allen 2008).

The minimum population estimate for the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock is 314 individuals based on photoidentification work. There is a minimum population estimate of 320 individuals in the West Coast Transient stock including about 225 in Washington State and British Columbia, and southeastern Alaska, and 105 off California. The population estimate for the ENP Stock of transient killer whales is 346. The minimum population estimate for the AT1 Transient stock is seven individuals based on photographs from recent years. (Angliss and Allen 2008)

The minimum population estimate for the ENP Offshore stock of killer whales is 1,214 individuals (Carretta et al. 2007). The total number of known Offshore killer whales is 211 individuals, but the proportion of time this transboundary stock spends in U.S. waters is unknown (Carretta et al. 2006). For purposes of acoustic impact modeling, a density of 0.010/km^2 was derived as representative for all killer whales in the TMAA as described in detail in Appendix E.

Distribution

Movement data on ENP Alaska Resident stock individuals have been documented based on photographic matches. Southeast Alaskan killer whale pods have been seen in Prince William Sound and in the GOA. Prince William Sound pods have been seen near Kodiak Island, but have never been observed in southeastern Alaska. Recent studies have documented very limited movements between the Bering Sea and GOA. (Angliss and Allen 2008, DoN 2006)

Transient killer whales in the eastern north Pacific spend most of their time along the outer coast, but visit Hood Canal and Puget Sound in search of harbor seals, sea lions, and other prey. Transient occurrence in inland waters appears to peak during August and September, which is the peak time for harbor seal pupping, weaning, and post-weaning. Offshore killer whales usually occur 9 mi (15 km) or more offshore but also visit coastal waters and occasionally enter protected inshore waters. Along the Pacific coast of North America, killer whales are found along the entire Alaskan coast, and are seen frequently in southeast Alaska and the area between Prince William Sound and Kodiak Island. (Angliss and Allen 2008; DoN 2006)

GOA, Aleutian Islands, and Bering Sea transients are seen throughout the GOA, including occasional sightings in Prince William Sound. Wade et al. (2003) noted that transients were more frequently seen from Shumagin Islands to the eastern Aleutian Islands. The AT1 Transient stock is primarily seen in Prince William Sound and in the Kenai Fjords region. At present, there is no information available to determine if this group regularly uses the TMAA. West coast transients are found from California to northern southeast Alaska. Some individual killer whales have been documented to move between the waters of southeast Alaska and central California. (Angliss and Allen 2008, DoN 2006)

The known range of the ENP Northern Resident stock includes Canadian waters from approximately Mid-Vancouver Island and throughout most of southeastern Alaskan waters. They have also been frequently seen in Washington state waters. (Angliss and Allen 2008, DoN 2006)

In Alaska, sightings of killer whales are widely distributed, mostly occurring in waters over the continental shelf, but also quite frequently in offshore waters. The Resident population is suspected to pass through the TMAA regularly during the summer based on limited satellite tagging data. The sympatric Gulf of Alaska, Aleutian Island, and Bering Sea transient population is suspected to spend considerable time in offshore waters, due to the infrequency of nearshore sightings; however, it is not certain how much time these killer whales spend in the TMAA. Members of the Offshore population have been seen only irregularly adjacent to the TMAA, and although it is likely they pass through it there is not data to document this. (Angliss and Allen 2008, DoN 2006)

There is no known seasonal component to the killer whale's occurrence in the TMAA. Resident, AT1 transient, and Gulf of Alaska, Aleutian Island, and Bering Sea transient populations all remain in the general area during the winter, however, there is no data that specifically places these whales in the TMAA due to lack of substantial research effort offshore and in winter. (Angliss and Allen 2008, DoN 2006)

The April 2009 GOALS survey visually detected six groups of killer whales totaling 119 individuals within the TMAA although there were additional acoustic detections as well (Rone et al. 2009). Analysis of photos taken for identification has not yet been completed and, at present, the specific eco-types for some of these detected killer whales have not been determined.

Life History

Diet in the eastern North Pacific is specific to the type of killer whale. The offshore ecotype appears to eat mostly fish (Bigg 1982, Morton 1990, Heise et al. 2003, Herman et al. 2005). Few details are known about the biology of offshore killer whales, but they commonly occur in groups of 20 to 75 individuals (Wiles 2004).

Transient killer whales show greater variability in habitat use, with some groups spending most of their time foraging in shallow waters close to shore while others hunt almost entirely in open water (Heimlich-Boran 1988, Felleman et al. 1991, Baird and Dill 1995, Matkin and Saulitis 1997). Transient killer whales feed on marine mammals and some seabirds, but apparently no fish (Morton 1990, Baird and Dill 1996, Ford et al. 1998, Ford and Ellis 1999, Ford et al. 2005). Transient killer whales travel in small, matrilineal groups, but they typically contain fewer than 10 animals and their social organization generally is more flexible than in residents (Morton 1990, Ford and Ellis 1999). These differences in social organization probably relate to differences in foraging (Baird and Whitehead 2000).

Reproduction/Breeding

There is no information on the reproductive behavior of killer whales in this area. Among resident killer whales in the northeastern Pacific, births occur largely from October to March, although births can occur year-round (Olesiuk et al. 1990, Stacey and Baird 1997).

While there is a lack of data on the reproduction/breeding activities of transient killer whales, it is thought that calving occurs year-round, but tends to peak in fall through spring. (Angliss and Outlaw 2007) There are no known areas used by killer whales for reproduction or calving in the TMAA.

Diving Behavior

The maximum depth recorded for free-ranging killer whales diving off British Columbia is 866 ft (264 m) (Baird et al. 2005a). On average, however, for seven tagged individuals, less than one percent of all dives examined were to depths greater than 98 ft (30 m). A trained killer whale dove to a maximum of 853 ft (260 m) (Baird et al. 2003). The longest duration of a recorded dive from a radio-tagged killer whale was 17 min (DoN 2006). Details regarding the diving behavior as characterized for acoustic modeling input are provided in Appendix D.

Acoustics

Killer whales produce a wide-variety of clicks and whistles, but most of this species' social sounds are pulsed, with frequencies ranging from 0.5 to 25 kHz (dominant frequency range: 1 to 6 kHz). Echolocation clicks recorded for this species indicate source levels ranging from 195 to 224 dB re: 1 ìPa @ 1 m peak-to-peak (see Table 3.8-3), dominant frequencies ranging from 20 to 60 kHz, and durations of 80 to 120 microseconds (ìsec). Source levels associated with social sounds have been calculated to range from 131 to 168 dB re 1 ìPa @ 1 m and have been demonstrated to vary with vocalization type (e.g., whistles: average source level of 140.2 dB re 1 ìPa @ 1 m, variable calls: average source level of 146.6 dB re 1 ìPa @ 1 m, and stereotyped calls: average source level 152.6 dB re 1 ìPa @ 1 m). Additionally, killer whales modify their vocalizations depending on social context or ecological function (i.e., short-range vocalizations [<5.4 nm {10 km} range]) are typically associated with social and resting behaviors and long-range vocalizations [5.4 to 8.6 nm {10 to 16 km} range] associated with travel and foraging). (DoN 2006)

Resident killer whales are very vocal, making calls during all types of behavioral states. Acoustic studies of resident killer whales in the Pacific Northwest have found that there are dialects in their highly stereotyped, repetitive discrete calls, which are group-specific and shared by all group members. These dialects likely are used to maintain group identity and cohesion, and may serve as indicators of relatedness that help in the avoidance of inbreeding between closely related whales. Dialects have been documented in northern Norway and southern Alaskan killer whale populations and are likely to occur in other regions as well. Residents do not need to alter their sounds (i.e., frequency or amplitude) when hunting fishes, since most of their prey (i.e., salmonids) are not capable of hearing in this frequency range (i.e., >20 kHz).

Transient killer whales, conversely, appear to use passive listening as a primary means of locating prey, call less often, and frequently vocalize or use high-amplitude vocalizations only when socializing (i.e., not hunting), trying to communicate over long distances, or after a successful attack, as a result of their prey's ability (i.e., primarily other marine mammal species) to hear or "eavesdrop" on their sounds. Discrete pulsed calls were recently identified in the vocal repertoire of the AT1 transients and for transients off southern Alaska, indicating that transients may maintain reproductive and socially isolated subpopulations using distinct vocalizations as well. (DoN 2006)

Both behavioral and auditory brainstem response (ABR) techniques indicate killer whales can hear a frequency range of 1 to 100 kHz and are most sensitive at 20 kHz, which is one the lowest maximum-sensitivity frequency known among toothed whales (DoN 2006).

Impacts of Human Activity

Fisheries Interactions

Three commercial fisheries in Alaska have caused serious injuries or mortalities of killer whales (any stock) between 2000 and 2004: the Bering Sea and Aleutian Islands flatfish trawl, the Bering Sea and Aleutian Islands pollock trawl and the Bering Sea and Aleutian Islands pacific cod longline. Recently observers have collected tissue samples of many of the killer whales which were killed incidental to commercial fisheries. Genetics analysis have indicated that the mortalities incidental to the Bering Sea and Aleutian Islands flatfish trawl and the Bering Sea and Aleutian Islands Pacific cod fisheries are of the "resident" type, and mortalities incidental to the Bering Sea and Aleutian Islands pollock trawl fisheries are of the "transient" type. The estimated minimum mortality rate for resident killer whales incidental to U.S. commercial fisheries recently monitored is 1.5 animals per year, based completed on observer data. The estimated minimum mortality rate for transient killer whales incidental to U.S. commercial fisheries recently monitored is 0.4 animals per year, based completely on observer data. (Angliss and Allen 2008)

Other Mortality

During the 1992 killer whale surveys conducted in the Bering Sea and western GOA, 9 of 182 individual whales in 7 of the 12 pods encountered had evidence of bullet wounds. The relationship between wounding due to shooting and survival is unknown. There have been no obvious bullet wounds observed on killer whales during recent surveys in the Bering Sea and western GOA. However, researchers have reported that killer whale pods in certain areas exhibit vessel avoidance behavior, which may indicate that shootings occur in some places. (Angliss and Allen 2008)

3.8.4.7 Minke Whale

Stock

Alaska

Regulatory Status

Minke whales (*Balaenoptera acutorostrata*) are not listed as threatened or endangered under the ESA or designated as depleted under the MMPA. Because minke whales are considered common in the waters off Alaska, the Alaska stock is not considered a strategic stock.

Habitat Preferences

Minke whales typically occupy waters over the continental shelf, including inshore bays and some estuaries. In the eastern north Pacific, minke whales are found feeding off California and Washington State in waters over the continental shelf. Based on whaling catches and surveys worldwide, there is also a deep-ocean component to the minke whale's distribution. In the western North Pacific, minke whales occur extensively in deep waters. Most sightings of minke whales in the central-eastern Bering Sea occur along the upper slope in waters with a bottom depth of 328 to 656 ft (100 to 200 m). Minke whales are relatively common in the Bering and Chukchi Seas and in the inshore areas of the GOA. (DoN 2006)

Population Size and Trends

The NMFS recognizes three stocks of minke whales within the Pacific U.S. EEZ: a California/Oregon/Washington stock, an Alaskan stock, and a Hawaiian stock (Carretta et al. 2006). There are no current estimates of abundance are available for minke whales in Alaskan waters (Angliss and Allen 2008). For purposes of acoustic impact modeling, a density of 0.0006/km^2 was derived for minke whales in the TMAA as described in detail in Appendix E.

Distribution

Minke whales are distributed in polar, temperate, and tropical waters (Jefferson et al. 1993); they are less common in the tropics than in cooler waters. Minke whales are present in the North Pacific from near the equator to the Arctic. The number of sightings of minke whales in the GOA is generally sparse. The summer range extends to the Chukchi Sea. In the winter, minke whales are found south to within 2° of the equator. The distribution of minke whale vocalizations (specifically, "boings") suggests that the winter breeding grounds are the offshore tropical waters of the North Pacific Ocean. In the northern part of their range, minke whales are believed to be migratory, although there is no obvious migration from low-latitude, winter breeding grounds to high-latitude, summer feeding locations in the western North Pacific as there is in the North Atlantic. However, there are some monthly changes in densities in both high and low latitudes. Minke whales are seen in several locations year-round in the eastern north Pacific. (Angliss and Allen 2008)

It is believed that minke whales are more abundant in the nearshore waters of the Aleutian Islands than in the waters of the TMAA. Minke whales are known to be a migratory species; however, the patterns are not as well-known or defined as for some other species, such as gray and humpback whales. There are no winter sightings of this species in this area. (DoN 2006)

The number of sightings of minke whales in the GOA is generally sparse (DoN 2006). Large numbers of minke whales were reported at Portlock Bank (in the TMAA) and Albatross bank (west of the TMAA) during May 1976; however, subsequent NMFS surveys encountered none at those locations (Fiscus et al. 1976). Six sightings in shallow water (<656 ft [200 m]) and two in deep water (>3,281 ft [1,000 m]) were reported in 1987. Waite (2003) reported three sightings at or inshore of the shelf break in the northern margin of the TMAA. Two encounters totaling three individual minke whales occurred on the shelf during the April 2009 survey although only one of these encounters (at Portlock Bank) was within the TMAA (Rone et al. 2009.

Life History

Although minke whales are distributed in polar, temperate, and tropical waters (Jefferson et al. 1993), there is no obvious migration from low-latitude, winter breeding grounds to high-latitude, summer feeding locations in the western North Pacific (Horwood 1990).

Reproduction/Breeding

Stewart and Leatherwood (1985) suggested that mating occurs in winter or early spring although it had never been observed. There are no known areas used by minke whales for reproduction or calving in the TMAA.

Diving Behavior

Details of minke whale dive behavior as characterized for acoustic modeling are provided in Appendix D. A general surfacing pattern of minke whales consisting of about four surfacings interspersed by short-duration dives averaging 38 sec have been recorded. After the fourth surfacing, there was a longer duration dive ranging from approximately 2 to 6 min. Minke whales are lunge-feeding "gulpers," like most other rorquals. (DoN 2006)

Acoustics

Recordings of minke whale sounds indicate the production of both high- and low-frequency sounds (range: 0.06 to 20 kHz, see Table 3.8-3). Minke whale sounds have a dominant frequency range of 0.06 kHz to greater than 12 kHz, depending on sound type. There are two basic forms of pulse trains: a "speed-up" pulse train (dominant frequency range: 0.2 to 0.4 kHz) with individual pulses lasting 40 to 60 milliseconds (ms), and a less common "slow-down" pulse train (dominant frequency range: 50 to 0.35 kHz) lasting for 70 to 140 ms. Source levels for this species have been estimated to range from 151 to 175 dB re 1 ìPa @ 1 m. Source levels for some minke whale sounds have been calculated to range from 150 to 165 dB re 1 ìPa @ 1 m. In the Southern Hemisphere a complex and stereotyped sound sequence ("star-wars vocalization") was recorded. This sound sequence spanned a frequency range of 50 Hz to 9.4 kHz. Broadband source levels between 150 and 165 dB re 1 ìPa @ 1 m were calculated. "Boings" recorded in the North Pacific have many striking similarities to the star-wars vocalization in both structure and acoustic behavior. "Boings," recently confirmed to be produced by minke whales and suggested to be a breeding display, consist of a brief pulse at 1.3 kHz followed by an amplitude-modulated call with greatest energy at 1.4 kHz, with slight frequency modulation over a duration of 2.5 sec. (DoN 2006) While no empirical data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes are most adapted to hear low to infrasonic frequencies.

Impacts of Human Activity

Fisheries Interactions

Six different commercial fisheries operating in Alaska waters within the range of the Alaska minke whale stock were monitored for incidental take by NMFS observers during 2000-2004: Bering Sea and Aleutian Islands groundfish trawl, longline and pot fisheries, and GOA groundfish trawl, longline, and pot fisheries. The Bering Sea/Aleutian Islands groundfish trawl fisheries caused one mortality of a minke whale in 2000. The total estimated mortality and serious injury incurred by this stock as a result of interactions with U.S. commercial fisheries is 0.32 minke whales annually.

3.8.4.8 Pacific White-sided Dolphin

Stock

North Pacific

Regulatory Status

Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The North Pacific stock is not classified as strategic.

Habitat Preferences

Pacific white-sided dolphins occur in temperate North Pacific waters over the outer continental shelf and slope, and in the open ocean. In the eastern north Pacific, the species occurs from the southern Gulf of California, north to the GOA, west to Amchitka in the Aleutian Islands, and is rarely encountered in the southern Bering Sea. The species is commonly found on both the high seas and along the continental margins, and animals are known to enter the inshore passes of Alaska, British Columbia, and Washington. (Angliss and Allen 2008, DoN 2006)

Population Size and Trends

The minimum population estimate for the North Pacific stock is 26,880 (CV=0.90) individuals (Angliss and Allen 2008). For purposes of acoustic impact modeling, a density of $0.0208/km^2$ was derived for Pacific white-sided dolphins in the TMAA as described in detail in Appendix E.

Distribution

Pacific white-sided dolphins occur across the central North Pacific waters to latitudes as low as (or lower than) 38°N and northward to the Bering Sea and coastal areas of southern Alaska. Surveys suggest a seasonal north-south movement of Pacific white-sided dolphins in the eastern north Pacific, with animals found primarily off California during the colder water months and highest densities shifting northward into Oregon and Washington State as water temperatures increase during late spring and summer. (Angliss and Allen 2008; DoN 2006)

Pacific white-sided dolphins occur regularly year-round throughout the GOA. They are widely distributed along the shelf break, continental slope, and in offshore waters. Inshore movements of Pacific white-sided dolphins are not common, but instances have been documented in Washington State, British Columbia, and southeast Alaska. In Alaska, peak abundance is between July and August, when Pacific white-sided dolphins tend to congregate near the Fairweather Grounds in the southeastern GOA and Portlock Bank in the northeast part of the TMAA. (Angliss and Allen 2008; DoN 2006)

Previous survey data did not indicate the potential for a large number of Pacific white-sided dolphins in the vicinity of the TMAA (DoN 2006). Waite (2003), however, reported sighting two large groups (an average group size 56) just off Kenai Peninsula. This was previously characterized as an area of rare occurrence (relatively shallow waters) (DoN 2006). As a result of this new information, for purposes of acoustic impact modeling Pacific white-sided dolphins are analyzed as having the second highest density for cetaceans in the TMAA. The GOALS survey encountered Pacific white-sided dolphins only once (a group of 60 individuals) although this was outside the TMAA inside the shelfbreak to the southeast of Kodiak Island (Rone et al. 2009).

Life History

The diet in the eastern North Pacific includes cephalopods and fish (Schwartz et al. 1992, Black 1994, Heise 1997, Brownell et al. 1999, Morton 2000), and includes salmonids off Washington (Stroud et al. 1981). In this gregarious species, group sizes range from tens to thousands of dolphins (Leatherwood et al. 1984). They frequently aggregate with Risso's and northern right whale dolphins (Brownell et al. 1999).

Reproduction/Breeding

Calving occurs from June through August (Heise 1997). There are no known areas used by pacific white-sided dolphins for reproduction or calving in the TMAA.

Diving Behavior

Details regarding the characterization of diving behavior for input into acoustic impact modeling for Pacific white-sided dolphins are provided in Appendix D. Pacific white-sided dolphins in the eastern north Pacific feed primarily on epipelagic fishes and cephalopods. This does not appear to be a deep-diving species. Based on feeding habits, it has been inferred that Pacific white-sided dolphins dive to at least 120 m. The majority of foraging dives last less than 15 to 25 sec. (DoN 2006)

Acoustics

Vocalizations produced by Pacific white-sided dolphins include whistles and echolocation clicks. Whistles are in the frequency range of 2 to 20 Hz. Echolocation clicks range in frequency from 50 to 80 kHz (see Table 3.8-3); the peak amplitude is 170 dB re 1 µPa @ 1 m. (DoN 2006)

Tremel et al. (1998) measured the underwater hearing sensitivity of Pacific white-sided dolphins from 0.075 kHz through 150 kHz. The greatest sensitivities were from 2 to 128 kHz, while the lowest measurable sensitivities were 145 dB at 100 Hz and 131 dB at 140 kHz. Below 8 Hz and above 100 kHz, this dolphin's hearing was similar to that of other toothed whales. (DoN 2006)

Impacts of Human Activity

Fisheries Interactions

As a result in changes in fishery practices, there were no serious injuries or mortalities incidental to observed commercial fisheries between 2000 and 2004 for this species. (Angliss and Allen 2008)

3.8.4.9 Stejneger's Beaked Whale

Stock

Alaska

Regulatory Status

Stejneger's beaked whales (*Mesoplodon stejnegeri*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The Alaska stock is not classified as strategic.

Habitat Preferences

Stejneger's beaked whales (also called Bering Sea beaked whales) appear to prefer cold-temperate and subpolar waters, although strandings have been reported as far south as Monterey, California (Reeves et al. 2002). World-wide, beaked whales normally inhabit continental slope and deep oceanic waters (>656 ft [200 m]). In many locales, occurrence patterns have been linked to physical features, in particular, the continental slope, canyons, and escarpments, and oceanic islands. Off Alaska, this species has been observed in waters ranging in bottom depth from 2,395 to 5,118 ft (730 to 1,560 m) on the steep slope of the continental shelf as it drops off into the Aleutian Basin which exceeds 11,483 ft (3,500 m) in bottom depth. (DoN 2006)

Population Size and Trends

No current estimates of abundance are available for Stejneger's beaked whales in Alaskan waters (Angliss and Allen 2008). Groups of 3 to 15 Stejneger's beaked whales were sighted on a number of occasions in the 1980s near the central Aleutian Islands (Rice 1986). There were no beaked whales detected acoustically or visually (although two groups of unidentified small whale were sighted) during the April 2009 survey of the TMAA (Rone et al. 2009). It has been suggested, however, that Stejneger's beaked whales are probably the most common beaked whales in these Alaskan waters (DoN 2006). For that reason, analysis of impacts for Stejneger's beaked whales will be considered using the results of acoustic impact modeling from Cuvier's beaked whales as a surrogate, given that sufficient information exists for Cuvier's beaked whales, they are in the same taxonomic family, and the predicted density of Cuvier's beaked whale in GOA is higher than that of Baird's beaked whales and therefore presumably errs on the side of overestimation.

Distribution

Stejneger's beaked whales (also called Bering Sea beaked whales) appear to prefer cold-temperate and subpolar waters and are found only in the North Pacific. The Alaska stock is recognized as separate from the species off California (Angliss and Outlaw 2007). Off Alaska, this species has been observed in waters ranging in bottom depth from 730 to 1,560 m (2,395 to 5,118 ft) on the steep slope of the continental shelf as it drops off into the Aleutian Basin (which exceeds 3,500 m [11,482 ft] in bottom depth) (DoN, 2006). Stejneger's beaked whales are found only in the North Pacific. The species range from the waters off southern California, north to the Bering Sea, and south to the Sea of Japan (Reeves et al. 2003).

Life History

Observed group sizes for beaked whales are typically small. Stejneger's beaked whales have been observed in groups of 5 to 15 individuals, often containing individuals of mixed sizes (Jefferson et al. 1993). Most sightings of beaked whales are brief since these whales are often difficult to approach and they actively avoid aircraft and vessels (e.g., Würsig et al. 1998).

Reproduction/Breeding

There is no available information on the reproduction or breeding of this species. There are no known areas used by Stejneger's beaked whales for reproduction or calving in the TMAA.

Diving Behavior

Most sightings of beaked whales are brief since these whales are often difficult to approach, and they actively avoid aircraft and vessels. Stejneger's beaked whale stomach contents include squids and pelagic fish. Until recently, it was thought that all beaked whales probably feed at or close to the bottom in deep oceanic waters, taking whatever suitable prey was encountered or was locally abundant, by suction-feeding. However, based on recent tagging data from Cuvier's and Blainville's beaked whales, it is suggested that feeding might actually occur at midwater rather than only at or near the bottom. Durations of long dives for *Mesoplodon* species are over 20 min. (DoN 2006)

Acoustics

There is no information available for Stejneger's beaked whale vocalizations. Sounds recorded from beaked whales are, in general, divided into two categories: whistles and pulsed sounds (clicks), with whistles likely serving a communicative function, and pulsed sounds being important in foraging and/or navigation. Whistle frequencies are about 2 to 12 kHz, while pulsed sounds range in frequency from 300 Hz to 135 kHz, however, higher frequencies may not be recorded due to equipment limitations. (DoN 2006)

There is no empirical information available on the hearing abilities of Stejneger's beaked whales. (DoN 2006)

Impacts of Human Activity

Fisheries Interactions

From 1990 to 2002, six different commercial fisheries operating within the range of the Alaska stock of Stejneger's beaked whale were monitored for incidental take. These fisheries included Bering Sea (and Aleutian Islands) ground fish trawl, longline, and pot fisheries and GOA groundfish trawl, longline, and pot fisheries. No Stejneger's beaked whale mortalities were observed. (Angliss and Outlaw 2007)

3.8.5 Non-ESA Pinniped Species

3.8.5.1 California Sea Lion

Stock

United States

Regulatory Status

California sea lions (*Zalophus californianus*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The U.S. stock is not classified as strategic.

Habitat Preferences

Alaska waters are north of the main breeding and feeding range located in California. California sea lions congregate near rookery islands in California waters and typically feed over the continental shelf staying within approximately 27 nm (50 km) of rookery islands although are occasionally sighted up to several hundred kilometers offshore (DoN 2006). California sea lions recorded in Alaska usually are observed at Steller sea lion rookeries and haulout sites and are present throughout the year (DoN 2006).

Population Size and Trends

The U.S. stock of California sea lions can be found in the GOA. The estimated stock is 238,000 individuals (Carretta et al. 2007b). This number is from counts during the 2001 breeding season of animals that were ashore at the four major rookeries in Southern California and at haulout sites north to the Oregon/California border. Sea lions that were at sea or were hauled out at other locations were not counted (Carretta et al. 2007b). The general trend for this stock is that the population is growing (NMFS 2007). There are not sufficient numbers of individuals of this species present in the TMAA to allow for acoustic impact modeling given they are rare.

Distribution

The primary rookeries for California sea lions are located on the California Channel Islands. California sea lions appear to be extending their feeding range farther north and increasing numbers of sightings are recorded in Alaskan waters (Maniscalco et al. 2004). The first recorded account of a California sea lion in Alaska was in 1973 at Point Elrington in the northern GOA (Maniscalco et al. 2004). Since then, California sea lions have been sighted throughout Alaska from Forrester Island in southeast Alaska to St. Matthews Bay, Prince William Sound, and St. Paul Island in the Bering Sea. Both male and female California sea lions have been observed as far north as the Pribilof Islands in the Bering Sea in recent years (Maniscalco 2002, DoN 2006). The few California sea lions recorded in Alaska usually are observed at Steller sea lion rookeries and haulout sites with most sightings recorded between March and May although they may be found in the GOA throughout the year. (Maniscalco et al. 2004, DoN 2006).

Life History

Survey data from 1975 to 1978 were analyzed to describe the seasonal shifts in the offshore distribution of California sea lions (Bonnell and Ford 1987). During summer, the highest densities were found immediately west of San Miguel Island. During autumn, peak densities of sea lions were centered on Santa Cruz Island. During winter and spring, peak densities occurred just north of San Clemente Island. The seasonal changes in the center of distribution were attributed to changes in the distribution of the prey species. If California sea lion distribution is determined primarily by prey abundance, these same areas might not be the center of sea lion distribution every year.

The distribution and habitat use of California sea lions vary with the sex of the animals and their reproductive phase. Adult males haul out on land to defend territories and breed from mid-to-late May until late July. Individual males remain on territories for 27–45 days without going to sea to feed. During August and September, after the mating season, the adult males migrate northward to feeding areas as far away as the GOA (Lowry et al. 1991). They remain there until spring (March–May), when they migrate back to the breeding colonies. Distribution of immature California sea lions is less well known, but some make northward migrations that are shorter in length than the migrations of adult males (Huber 1991). However, most immature seals are presumed to remain near the rookeries (Lowry et al. 1991). Adult females remain near the rookeries throughout the year.

Reproduction/Breeding

Most sea lion births occur from mid-June to mid-July (peak in late June) on the island rookeries in California and Mexico. GOA is outside the known breeding range for California sea lion. There are no known areas used by California sea lions for reproduction or calving in the TMAA.

Diving Behavior

California sea lions usually do not need to dive very deeply, since most of their food is found in shallow waters, about 85 to 243 ft (26 to 74 m) deep. They can, however, dive to depths of about 900 ft (274 m). California sea lions typically stay submerged 3 min or less; however, they can remain submerged for as long as 10 min. (Carretta et al. 2007b)

Acoustics

In air, California sea lions make incessant, raucous barking sounds; these have most of their energy at less than 2 kHz. The male barks have most of their energy at less than 1 kHz. Males vary both the number and rhythm of their barks depending on the social context; the barks appear to control the movements and other behavior patterns of nearby conspecifics. Females produce barks, squeals, belches, and growls in the frequency range of 0.25 to 5 kHz, while pups make bleating sounds at 0.25 to 6 kHz (see Table 3.8-3). California sea lions produce two types of underwater sounds: clicks (or short-duration sound pulses) and barks. All underwater sounds have most of their energy below 4 kHz. (DoN 2006)

The range of maximal sensitivity underwater is between 1 and 28 kHz. Functional underwater high frequency hearing limits are between 35 and 40 kHz, with peak sensitivities from 15 to 30 kHz. California sea lions show relatively poor hearing at frequencies below 1,000 Hz. Peak sensitivities in air are shifted to lower frequencies; the effective upper hearing limit is approximately 36 kHz. The best range of sound detection is from 2 to 16 kHz. Older sea lions (22 to 25 years of age) show in-air and underwater hearing losses that range from 10 dB at lower frequencies to 50 dB near the upper frequency limit. It has been determined that hearing sensitivity generally worsens with depth—hearing thresholds were lower in shallow water, except at the highest frequency tested (35 kHz), where this trend was reversed. (DoN 2006)

Impacts of Human Activity

Fisheries Interactions

Between 2000 and 2004, the mean annual serious injury and mortality to California sea lions from fisheries in California was 159 individuals. Other mortalities (boat collisions, power plant intake entrapment, shootings, marine debris, and unknown) added an additional 74 sea lions annually (NMFS 2007).

3.8.5.2 Harbor Seal

Stock

Three separate stocks of harbor seals are currently recognized in Alaska waters although there is substantial evidence that the population is more finely divided and may consist of a minimum of 12 stocks (DoN 2006, Angliss and Allen 2008). The three currently recognized stocks under MMPA are: Southeast Alaska stock (the Alaska/British Columbia border to Cape Suckling, Alaska), the Bering Sea stock (including all waters north of Unimak Pass), and the Gulf of Alaska stock (Cape Suckling, Alaska to Unimak Pass and throughout the Aleutian Islands). Animals from the Gulf of Alaska stock may be found in the TMAA.

Regulatory Status

Harbor Seal (*Phoca vitulina richardsi*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The U.S. stock is not classified as strategic.

Habitat Preferences

Harbor seals are coastal animals that primarily occur within 11 nm (20 km) from shore (Baird 2001, Lowery et al. 2001, Small et al. 2005). Harbor seals are considered abundant throughout most of their range which extends from Baja California to the eastern Aleutian Islands. In Alaska, they range from the Dixon Entrance to Kuskokwim Bay, are widely distributed along the coastal GOA (Angliss and Outlaw 2007), and are also found on offshore islands (Hoover 1988). There are over 300 coastal haulout sites for harbor seals in the GOA (Boveng et al. 2003). Harbor seals are abundant in fjords with tidewater glaciers, Prince William Sound, in several areas in the Kodiak Archipelago, and in major estuaries, particularly along the north side of the Alaska Peninsula (Hoover 1988, Lowrey et al. 2001, Boveng et al. 2003). There are haul outs along the shoreline of southeast Alaska, the south side of the Alaska Peninsula, the Aleutian Islands, and Middleton and Montague Islands (Hoover 1988, Lowrey et al. 2001). There is none of the harbor seal’s preferred coastal habitat within the waters of the TMAA.

Population Size and Trends

Minimum population estimates for the Gulf of Alaska stock is 45,975 (CV=0.04) (Angliss and Allen 2008).

Distribution

The harbor seal is one of the most widespread of the pinniped species distributed from the eastern Baltic Sea, west across the Atlantic and Pacific Oceans to southern Japan, along the coast and offshore islands of Gulf of Alaska (DoN 2006). The harbor seal’s preferred coastal habitat does not extend into the waters of the TMAA. Studies using satellite tags have documented the movements and home range of harbor seals in the vicinity of the TMAA (Lowry et al. 2001, Small et al. 2005). Although these tagging studies have documented harbor seal movement into deep water (beyond the shelf break) in the GOA, these movements are the exception. With few exceptions, harbor seals will be located in shallow nearshore areas and not at sea in the TMAA. Harbor seals, therefore, should be very rare in the small section of the

TMAA nearest Kenai Peninsula, Montague Island, and Middleton Island. No harbor seals were encountered within the TMAA during the April 2009 GOALS survey (Rone et al. 2009).

Life History

On land, harbor seals tend to congregate in small groups of about 30 to 80 individuals, although larger groups are found in areas where food is plentiful. In Alaska, group size at haulouts ranges from 25 animals to more than 1,000 in some areas. (DoN 2006)

Information from tagged seals has indicated movement from haulouts to sea was age dependent with 3-5 nm (5-10 km) for adults and 5-14 nm (10-25 km) for juveniles (Lowry et al. 2001). Although some harbor seal pups made extensive movements, approximately 97% of pups were located less than 25 km from their haulouts (Small et al. 2005).

Reproduction/Breeding

In the Gulf of Alaska, male harbor seals attain sexual maturity around 5 to 6 years of age, while females are usually sexually mature at 5 years. Pups are typically born from late May through June. In general, the pupping season lasts up to 10 weeks with a two-week peak. Suckling harbor seal pups spend as much as 40% of their time in the water. The nursing period is approximately four to six weeks and after the pups are weaned, mating, which takes place in the water, may take place shortly thereafter. In the Gulf of Alaska, mating takes place from late June through July. Delayed implantation occurs for about 11 weeks after mating. (Don 2006)

Diving Behavior

Harbor seals are generally shallow divers. About 50% of their diving is shallower than 40 m, and 95% is shallower than 250 m. Dive durations are typically shorter than 10 min, with about 90% lasting less than 7 min. A tagged harbor seal in Monterey Bay dove as deep as 481 m. Harbor seal pups swim and dive with their mothers, although they dive for short periods compared with their mothers. Recorded dive durations for older individuals may be as long as 32 min. (DoN 2006)

Acoustics

Harbor seal males produce a variety of low-frequency (<4 kHz) in-air vocalizations including snorts, grunts, and growls, while pups make individually unique calls for mother recognition (contain multiple harmonics with main energy below 0.35 kHz). Adult males also produce several underwater sounds during the breeding season that typically range from 0.025 to 4 kHz (duration range: 0.1 s to multiple seconds) with individual variation in the dominant frequency range of sounds between different males. (DoN 2006)

Harbor seals hear nearly as well in air as underwater (Kastak and Schusterman 1998). Harbor seals hear frequencies from 1 to 180 kHz (most sensitive at frequencies below 50 kHz; above 60 kHz sensitivity rapidly decreases) in water and from 0.25 kHz to 30 kHz in air (most sensitive from 6 to 16 kHz using behavior and auditory brainstem response testing). (DoN 2006)

Impacts of Human Activity

Fisheries Interactions

Harbor seals often become caught in from gillnets when attempting to salmon that have been caught. For the Gulf of Alaska stock, the estimated minimum annual mortality rate incidental to commercial fisheries is 24 animals (Angliss and Allen 2008).

Subsistence Interactions

The MMPA restricts the hunting of harbor seals to Alaska Natives. In some areas, harbor seals are an important part of the subsistence economy. Angliss and Allen (2008) report that based on data from Alaska Department of Fish and Game for the years 2000 to 2004, the annual number of harbor seal taken from the Gulf of Alaska stock is 795 animals.

3.8.5.3 Northern Elephant Seal

Stock

California Breeding

Regulatory Status

Northern elephant seals (*Mirounga angustirostris*) are not listed as threatened or endangered under the ESA or depleted under the MMPA. The California Breeding stock is not classified as strategic.

Habitat Preferences

Breeding and molting habitats for northern elephant seals are characterized by sandy beaches, mostly on offshore islands, but also in some mainland locations, along the coast. When on shore, seals will also use small coves and sand dunes behind and adjacent to breeding beaches. They rarely enter the water during the breeding season, but some seals will spend short periods in tide pools and alongshore; these are most commonly weaned pups that are learning to swim. Feeding habitat is mostly in deep, offshore waters of warm temperate to subpolar zones. Some seals will move into subtropical or tropical waters while foraging. (DoN 2006)

Population Size and Trends

The California Breeding stock of the northern elephant seal has recovered from near extinction in the early 1900s to an estimated 124,000 (Carretta et al., 2007b). Current census data suggest an increasing population trend. Although movement and genetic exchange continue between rookeries, most elephant seals return to their natal rookeries to breed. The California and Mexican Breeding groups may be demographically isolated and are currently considered two separate stocks. Individuals from the California Breeding stock do occur in the GOA, typically only sub-adult and adult male elephant seals forage in the GOA (Le Boeuf et al. 2000). The population size has to be estimated since all age classes are not ashore at any one time of the year. There are now at least 101,000 elephant seals in the California Breeding stock (Carretta et al. 2007), Numbers in this stock are increasing by around 6 percent annually (Stewart et al. 1994, Carretta et al. 2007). For purposes of acoustic impact modeling, a density of $0.0022/km^2$ was derived for elephant seals in the TMAA as described in detail in Appendix E.

Distribution

Northern elephant seals are endemic to the North Pacific Ocean, occurring almost exclusively in the eastern and central North Pacific. Adult males range further north into the GOA and along the Aleutian Islands. Vagrant individuals do sometimes range to the western North Pacific. The most far-ranging known individual appeared on Nijima Island, off the Pacific coast of Japan in 1989 demonstrating the great distances these animals are capable of covering. (DoN 2006)

Adult males and females segregate while foraging and migrating (Stewart and DeLong 1995, Stewart 1997). Adult females mostly range east to about 173°W, between the latitudes of 40°N and 45°N remaining far to the west of the TMAA. In contrast, adult males range further north and east into the GOA and along the Aleutian Islands to between 47°N and 58°N (Stewart and Huber 1993, Stewart and DeLong 1995, Le Boeuf et. al. 2000). Northern elephant seal males regularly occur in the GOA year-round (Calkins 1986). Adults stay offshore during migration, while juveniles and subadults are often seen along the coasts of Oregon, Washington State, and British Columbia (Condit and Le Boeuf 1984, Stewart and Huber 1993). Females may cover over 18,000 km (11,185 mi) and males over 21,000 km (13049 mi) during these postbreeding migrations (Stewart and DeLong 1995). There are few records of northern elephant seals being present in southeast Alaska. (DoN 2006)

Life History

Northern elephant seals haul out on land to give birth and breed from December through March, and pups remain hauled out through April. After spending time at sea to feed (post-breeding migration), they generally return to the same areas to molt (Odell 1974, Stewart and Yochem 1984, Stewart and DeLong 1995). However, they do not necessarily return to the same beach. Adult males tend to haul out to molt between June and August (peaking in July), whereas females and juveniles haul out to most between March and May (peaking in April). Sub-adult and adult male northern elephant seals are found in the MAA predominately in the spring and fall (Le Boeuf et al. 2000). For much of the year, northern elephant seals feed mostly in deep, offshore waters, and their foraging range extends thousands of kilometers offshore from the breeding range into the eastern and central North Pacific (Stewart and DeLong 1995, Stewart 1997, Le Boeuf et al. 2000). Adult males and females segregate while foraging and migrating; females mostly range west to about 173°W, between the latitudes of 40°N and 45°N, whereas males range further north into the GOA and along the Aleutian Islands, to between 47°N and 58°N (Stewart and Huber 1993, Stewart and DeLong 1995, Le Boeuf et al. 2000).

Reproduction/Breeding

The elephant seal pupping/breeding season occurs from December through March on the rookeries in California and Mexico. There are no known areas used by elephant seals for reproduction or calving in the TMAA.

Diving Behavior

Details regarding the characterization of diving behavior for input into acoustic impact modeling for elephant seals are provided in Appendix D. Elephant seals are probably the deepest and longest diving pinnipeds; few other mammals can match their abilities. Adults dive continuously, day and night, during their feeding migrations. Elephant seals may spend as much as 90 percent of their time submerged; this year-round pattern of continuous, long, deep dives explains why northern elephant seals are rarely seen at sea and why their oceanic whereabouts and migrations have long been unknown. The average diving cycle consists of a 23-min dive, followed by a 2- to 4-min surface interval. The longest known dive is 106 min. Dives average between 1,148 and 1,805 ft (350 and 550 m) in depth and can reach as deep as 5,121 ft (1,561 m; females) and 5,200 ft (1,585 m; males). (DoN 2006)

Acoustics

Northern elephant seals produce loud, low-frequency in-air vocalizations. The mean fundamental frequencies are in the range of 147 to 334 Hz for adult males. The mean source level of the male produced vocalizations during the breeding season is 110 dB re 20 ìPa. In-air calls made by aggressive males include (1) snoring, which is a low-intensity threat; (2) a snort (0.2 to 0.6 kHz) made by a dominant male when approached by a subdominant male; and (3) a clap threat (<2.5 kHz) which may contain signature information at the individual level. Seismic (low frequency) vibrations accompany these in-air vocalizations; they are produced as males move about and vocalize on sand beaches. These sounds appear to be important social cues. The mean fundamental frequency of airborne calls for adult females is 500 to 1,000 Hz. In-air sounds produced by females include a <0.7 kHz belch roar used in aggressive situations and a 0.5 to 1 kHz bark used to attract the pup. Pups use a <1.4 kHz call to maintain contact with the mother. Evidence for underwater sound production by this species is scant. Except for one unsubstantiated report, none have been definitively identified. (DoN 2006)

The audiogram of northern elephant seals indicates that this species is well-adapted for underwater hearing; sensitivity is best between 3.2 and 45 kHz (see Table 3.8-3), with greatest sensitivity at 6.4 kHz and an upper frequency cutoff of approximately 55 kHz. Elephant seals exhibit the greatest sensitivity to low frequency (<1 kHz) sound among seals in which hearing has been tested. In-air hearing is generally poor, but is best for frequencies between 3.2 and 15 kHz, with greatest sensitivity at 6.3 kHz. The upper frequency limit in air is approximately 20 kHz. Elephant seals are relatively good at detecting tonal signals over masking noise. (DoN 2006)

Impacts of Human Activity

Fisheries Interactions

Stranding data reported to the California, Oregon, and Washington Marine Mammal stranding Networks in 2000-2004 include elephant seal injuries caused by hook-and-line fisheries (two injuries) and gillnet fisheries (one injury). The estimated mortality and serious injury of northern elephant seals (California Breeding stock) in commercial fisheries that might take this species is less than 8.8 animals per year. (Carretta et al. 2007b)

Other Interactions

Stranding databases for California, Oregon, and Washington states that are maintained by NMFS contain the following records of human-related elephant seal mortalities and injuries in 2000-2004: (1) boat collisions (3 mortalities), (2) power plant entrainment (1 mortality), (3) shootings (4 mortalities), and (4) entanglement in marine debris (10 mortalities). This results in a minimum annual average of 1.6 nonfishery related mortalities for 2000-2004. (Carretta et al. 2007b)

3.8.5.4 Northern Fur Seal

Stock

Eastern Pacific

Regulatory Status

The northern fur seal is not listed as threatened or endangered under the ESA. The Eastern Pacific stock of northern fur seal is classified as a strategic stock because it is designated as depleted under the MMPA.

Habitat Preferences

Northern fur seals are a highly oceanic species spending all but 35 to 45 days per year at sea. They are usually sighted 38 to 70 nm (70 to 130 km) from land along the continental shelf and slope, seamounts, submarine canyons, and sea valleys, where there are upwellings of nutrient-rich water. The Pribilof Islands in the Bering Sea are the rookery location for most of the worldwide population during the summer breeding season (Angliss and Allen 2008). Following the breeding season, most females and juveniles migrate south to waters off British Columbia, Washington, Oregon, and California, and most adult males remain in the GOA (DoN 2006).

Population Size and Trends

Two stocks of northern fur seals are recognized in U.S. waters: an Eastern Pacific stock and a San Miguel Island stock. The Eastern Pacific stock includes the Pribilof Island breeding group in the Bering Sea. The most recent population estimate for the Eastern Pacific stock is 665,550 (Angliss and Allen, 2008). In 1999, the population began to recover, and by 2002 the total pup count was 1,946 (Carretta et al., 2007b). It is a “strategic” stock because it is considered “depleted” under the MMPA because the population has declined from the 1.8 million animals estimated in the 1950s (Angliss and Outlaw 2006). For purposes of acoustic impact modeling, a density of $0.1180/km^2$ was derived for northern fur seals in the TMAA as described in detail in Appendix E.

Distribution

Northern fur seals occur from Southern California north to the Bering Sea and west to the Okhotsk Sea and Honshu Island, Japan (Carretta et al., 2006). They are a coldwater species and when at sea they are usually sighted in forage areas along the continental shelf and slope 38 to 70 nm (70 to 130 km) from land and along the continental shelf and slope where they typically forage (Kajimura 1984). The Eastern Pacific stock spends May–November in northern waters and at northern breeding colonies (north of the GOA). In late November, females and young begin to arrive in offshore waters of California, with some animals moving south into continental shelf and slope waters. Adult males from the Eastern Pacific stock generally migrate only as far south as the GOA (Kajimura 1984). Maximum numbers are found in the southern extent of their range in waters from 42ºN to 34ºN during February–April. By early June, most seals of the Eastern Pacific stock have migrated back to northern waters (Antonelis and Fiscus 1980).

Peak abundance in the TMAA should occur between March and June during the annual migration north to the Pribilof Islands breeding grounds (Fiscus et al. 1976, Consiglieri et al. 1982). Tagging data presented by Ream et al. (2005) indicate the main foraging areas and the main migration route through the GOA are located far to the west of the TMAA. There are no rookeries or haulout sites in the vicinity of the TMAA. Some northern fur seals, particularly juvenile males and nonpregnant females, remain in the GOA throughout the summer and have been documented in the nearshore waters of Southeastern Alaska, Prince William Sound, Portlock Bank, and the middle of the GOA (Calkins 1986, Fiscus et al. 1976). (DoN 2006) The 2009 GOALS survey (Rone et al. 2009) did not encounter any northern fur seals in the TMAA although the acoustic analysis assumes they are the second-most abundant marine mammal in the area. It is likely, therefore, that effects from Navy activities on this species in this analysis are an overestimate.

Life History

Northern fur seals are solitary at sea but tend to congregate in food-rich areas where as many as 100 individuals have been sighted (Antonelis and Fiscus 1980, Kajimura 1984). Northern fur seals feed opportunistically on a variety of fish and squids species throughout their range (Kajimura, 1984). Northern fur seals are gregarious during the breeding season and maintain a complex social structure on the rookeries. The largest rookery is on St. Paul and St. George Islands in the Pribilof Islands Archipelago in Alaska. Smaller breeding colonies are located on the Kuril Islands, Robben Island, and the Commander Islands in Russia; Bogoslof Island in the southeastern Bering Sea; and San Miguel and the Farallon Islands in California (Pyle et al. 2001, Robson 2002).

Reproduction/Breeding

Pupping and breeding occur between June and August on the Pribilof Islands (York, 1987). Pups are weaned at around 4 months (Gentry, 1998). There are no known areas used by Northern fur seals for reproduction or calving in the TMAA.

Diving Behavior

Details regarding the characterization of diving behavior for input into acoustic impact modeling for northern fur seals are provided in Appendix D. Northern fur seals are solitary at sea but tend to congregate in food-rich areas where as many as 100 individuals have been sighted. The average dive time for northern fur seals is 2.6 min, with a maximum between 5 and 7 min. The deepest recorded dive is 679 ft (207 m), but most are between 66 and 459 ft (20 and 140 m) and are probably associated with feeding. (DoN 2006)

Acoustics

Northern fur seals produce underwater clicks, and in-air bleating, barking, coughing, and roaring sounds. Males vocalize (roar) almost continuously at rookeries. Females and pups produce airborne sounds (bawls) to reunite after separation. The hearing ability of this species has been measured in air and underwater by behavioral methods. (DoN 2006)

Of all the pinniped species for which hearing information is available, northern fur seals are the most sensitive to airborne sound. In air, this species can hear sounds ranging from 0.1 to 36 kHz, with best sensitivity from 2 to 16 kHz. There is an anomalous in-air hearing loss at around 4 or 5 kHz, which is attributed to a middle specialization. The underwater hearing range of northern fur seals ranges from 0.5 Hz to 40 kHz (most sensitive from 2 to 32 kHz). The underwater hearing sensitivity of this species is 15 to 20 dB better than in the air. (DoN 2006)

Impacts of Human Activity

Fisheries Interactions

The estimated mortality and serious injury of northern fur seals in commercial fisheries that might take this species is approximately 1.9 animals per year. (Angliss and Allen 2008)

Subsistence Interactions

Alaska Natives residing on the Pribilof Islands are allowed an annual subsistence harvest of northern fur seals, with a take range determined from annual household surveys. Between 2001 and 2006, there was an annual average of 667 seals harvested per year. (Angliss and Allen 2008)

Other Interactions

Mortality resulting from entanglement in marine debris has been implicated as a contributing factor in the previous decline of Eastern Pacific stock of northern fur seal. The average entanglement rate for adult males from 1998 to 2002 was 0.27 percent (Angliss and Allen 2008), and if that rate was sustained, the result would be approximately 1,900 mortalities to male fur seals based on the current minimum population estimate.

3.8.6 Current Requirements and Practices

As presented in Section 5.1.7, a comprehensive suite of protective measures and standard operating procedures (SOPs) is implemented by the Navy to avoid and reduce impacts to marine mammals. In particular, the following categories of measures all serve to reduce or eliminate potential impacts of Navy activities on marine mammals that may be present in the vicinity of training activities:

- Training personnel and watchstander to identify and locate nearby marine mammals;
- Maintaining minimum buffer zones for surface vessel approach to marine mammals;
- Maintaining minimum aircraft overflight buffer zones of critical habitat and pinniped rookeries and haulout sites;
- Maneuvering to avoid interactions and collisions with marine species;
- Reducing mid-frequency active sonar emissions when marine mammals are in the proximity of training activities; and
- Establishing marine mammal-free exclusion zones for activities involving at-sea explosions.

3.8.7 Environmental Consequences

As described previously in Section 3.8.1, the ROI for marine mammals is the TMAA, which is more than 12 nm (22 km) from the closest point of land. As such, this section distinguishes between U. S. territorial seas (shoreline to 12 nm [22 km]) and nonterritorial seas, (seaward of 12 nm [22 km]) for the purposes of applying the appropriate regulations (National Environmental Policy Act [NEPA] or Executive Order [EO] 12114) to analyze potential environmental effects. There are no activities in the Proposed Action taking place in U.S. territorial seas.

3.8.7.1 Approach to Analysis

This section describes potential environmental effects associated with conducting naval training activities for three proposed alternatives in the TMAA. These activities are configured in various combinations to define specific warfare areas. The activities under Alternatives 1 and 2 include use of active sonar; surface vessel, submarine, and aircraft warfare training activities; weapons firing and non-explosives ordnance use; electronic combat; and discharges of expendable materials.

This section distinguishes between U.S. territorial seas (shoreline to 12 nm [22 km]) and nonterritorial seas, (seaward of 12 nm [22 km]) for the purposes of applying the appropriate regulation (EO 12114) to analyze potential environmental effects.

Executive Order 12114

EO 12114 directs federal agencies to provide for informed decision making for major federal actions outside the United States, including the global commons, the environment of a nonparticipating foreign nation, or impacts on protected global resources. An OEIS is required when an action has the potential to significantly harm the environment of the global commons. “Global commons” are defined as “geographical areas that are outside of the jurisdiction of any nation, and include the oceans outside territorial limits (outside 12 nm [22 km] from the coast) and Antarctica. Global commons do not include contiguous zones and fisheries zones of foreign nations” (32 C.F.R. 187.3). The Navy has published procedures for implementing EO 12114 in 32 C.F.R. 187, Environmental Effects Abroad of Major Department of Defense Actions, as well as the October 2007 Office of the Chief of Naval Operations Instruction (OPNAVINST) 5090.1C.

Unlike NEPA, EO 12114 does not require a scoping process. However, the EIS and OEIS have been combined into one document, as permitted under NEPA and EO 12114, in order to reduce duplication. Therefore, the scoping requirements found in NEPA were implemented with respect to actions occurring seaward of U.S. territorial seas (outside 12 nm [22 km]), and discussions regarding scoping requirements will reference the combined GOA Draft EIS/OEIS.

Regulatory Framework

The MMPA and ESA prohibit the unauthorized harassment of marine mammals and endangered species, and provide the regulatory processes for authorizing any such harassment that might occur incidental to an otherwise lawful activity. These two acts also establish the context for determining potentially adverse impacts to marine mammals from military activities.

Marine Mammal Protection Act

The MMPA of 1972 established, with limited exceptions, a moratorium on the “taking” of marine mammals in waters or on lands under U.S. jurisdiction. The act further regulates “takes” of marine mammals in the global commons (that is, the high seas) by vessels or persons under U.S. jurisdiction. The term “take,” as defined in Section 3 (16 U.S.C. 1362) of the MMPA, means “to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.” “Harassment” was further defined in the 1994 amendments to the MMPA, which provided two levels of harassment, Level A (potential injury) and Level B (potential behavioral disturbance).

The National Defense Authorization Act of Fiscal Year 2004 (Public Law 108-136) amended the definition of harassment as applied to military readiness activities or scientific research activities conducted by or on behalf of the federal government, consistent with Section 104(c)(3) [16 U.S.C. 1374 (c)(3)]. The Fiscal Year 2004 National Defense Authorization Act adopted the definition of "military readiness activity" as set forth in the Fiscal Year 2003 National Defense Authorization Act (Public Law 107-314). Military training activities within the TMAA constitute military readiness activities as that term is defined in Public Law 107-314 because training activities constitute "training and operations of the Armed Forces that relate to combat" and constitute "adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat use."

For military readiness activities, the relevant definition of harassment is any act that:

- Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment").
- Disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered ("Level B harassment") [16 U.S.C. 1362 (18)(B)(i)(ii)].

Section 101(a)(5) of the MMPA directs the Secretary of the Department of Commerce to allow, upon request, the incidental (but not intentional) taking of marine mammals by U.S. citizens who engage in a specified activity (exclusive of commercial fishing), if certain findings are made and regulations are issued. Permission will be granted by the Secretary for the incidental take of marine mammals if the taking will have a negligible impact on the species or stock and will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses.

In support of the Proposed Action for the Preferred Alternative, the Navy is requesting a Letter of Authorization (LOA) pursuant to Section 101(a)(5)(A) of the MMPA. After the application is reviewed by NMFS, a Notice of Receipt of Application will be published in the Federal Register. Publication of the Notice of Receipt of Application will initiate the 30-day public comment period, during which time anyone can obtain a copy of the application by contacting NMFS. In addition, the MMPA requires NMFS to develop regulations governing the issuance of an LOA and to publish these regulations in the Federal Register. Specifically, the regulations for each allowed activity establish (1) permissible methods of taking, and other means of affecting the least practicable adverse impact on such species or stock and its habitat, and on the availability of such species or stock for subsistence, and (2) requirements for monitoring and reporting of such taking. For military readiness activities (as described in the National Defense Authorization Act), a determination of "least practicable adverse impacts" on a species or stock that includes consideration, in consultation with the Department of Defense (DoD), of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

Several species of marine mammals occur in the TMAA. Accordingly, the Navy has initiated the MMPA compliance process with NMFS, by submission of a request for a LOA.

Endangered Species Act

The ESA of 1973 established protection over and conservation of threatened and endangered species and the ecosystems upon which they depend. An "endangered" species is a species that is in danger of extinction throughout all or a significant portion of its range, while a "threatened" species is one that is likely to become endangered within the foreseeable future throughout all or in a significant portion of its range. The USFWS and NMFS jointly administer the ESA and are also responsible for the listing of species (designating a species as either threatened or endangered). The USFWS has primary management responsibility for management of terrestrial and freshwater species, while NMFS has primary responsibility for marine species and anadromous fish species (species that migrate from saltwater to freshwater to spawn). The ESA allows the designation of geographic areas as critical habitat for threatened or endangered species.

The ESA requires federal agencies to conserve listed species and consult with the USFWS and/or NMFS to ensure that proposed actions that may affect listed species or critical habitat are consistent with the requirements of the ESA. The ESA specifically requires agencies not to "take" or "jeopardize" the continued existence of any endangered or threatened species, or to destroy or adversely modify habitat critical to any endangered or threatened species. Under Section 9 of the ESA, "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect. Under Section 7 of the ESA, "jeopardize" means to engage in any action that would be expected to reduce appreciably the likelihood of the survival and recovery of a listed species by reducing its reproduction, numbers, or distribution.

Regulations implementing the ESA expand the consultation requirement to include those actions that "may affect" a listed species or adversely modify critical habitat. If an agency's proposed action would take a listed species, the agency must obtain an incidental take statement from the responsible wildlife agency. Consultation is complete once NMFS prepares a final Biological Opinion and issues an incidental take statement.

Seven marine mammal species that are listed as endangered under the ESA could potentially occur in the TMAA. Critical habitat for Northern Pacific right whales and Steller sea lions has been designated under the ESA, however, these areas are outside the action area of the TMAA. Accordingly, the Navy has initiated the ESA Section 7 consultation process with NMFS.

Data Sources

A comprehensive and systematic review of relevant literature and data was conducted to complete this analysis. Of the available scientific and technical literature (both published and unpublished), the following types of documents were utilized: journals, books, periodicals, bulletins, DoD operations reports, theses, dissertations, endangered species recovery plans, species management plans, stock assessment reports, environmental impact statements, range complex management plans, and other technical reports published by government agencies, private businesses, or consulting firms. Scientific and technical literature was also consulted during the search for geographic location data (geographic coordinates) on the occurrence of marine resources within the GOA.

Information was collected from the following sources to summarize the occurrence of and to evaluate the impacts to marine mammal species in the Study Area:

- Marine Resource Assessment (MRA) for the TMAA and marine mammal density estimates for the GOA;
- On-line databases: Ingenta, Web of Science; Aquatic Sciences and Fisheries Abstracts, Science Direct, Synergy, BIOSIS previews;
- The Internet, including various databases and related websites: National Oceanic and Atmospheric Administration (NOAA)-Coastal Services Center, NMFS, Ocean Biogeographic Information System, U.S. Geological Survey, WhaleNet, Blackwell-Science, FishBase, Food and Agriculture Organization, Federal Register, Pacific and North Pacific Fishery Management Councils;

- Federal and state agencies: the DoN, Pacific Fishery Management Council, NMFS Highly Migratory Species Division, NMFS Northwest Fisheries Science Center, NMFS Southwest Fisheries Science Center, NMFS Alaska Fisheries Science Center, NMFS Northwest Regional Office, NMFS Office of Habitat Protection, NMFS Office of Protected Resources, NOAA: Marine Managed Areas Inventory, USFWS Ecological Services Field Offices, U.S. Environmental Protection Agency, U.S. Geological Survey: Sirenia Project, Bureau of Land Management, Minerals Management Service, California Department of Fish and Game, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife; and
- Marine resource experts and specialists.

General Approach to Analysis

Each alternative analyzed in this Draft EIS/OEIS includes several warfare areas (for example, Anti-Surface Warfare [ASUW] and Anti-Submarine Warfare [ASW]). Most warfare areas include multiple types of training activities (for example, ASW Tracking Exercise [TRACKEX]). Likewise, many activities (for example, vessel movements, aircraft overflights, and weapons firing) are common to many training scenarios. Accordingly, the analysis of the consequences to marine mammals is organized by specific activity and/or stressors associated with that activity, rather than warfare area.

The following general steps were used to analyze the potential environmental consequences of the alternatives to marine mammals:

- Identify those aspects of the Proposed Action that are likely to act as stressors to marine mammals by having a direct or indirect effect on the physical, chemical, and biotic environment. As part of this step, the spatial extent of these stressors, including changes in that spatial extent over time, were identified. The results of this step identified those aspects of the Proposed Action that required detailed analysis in this Draft EIS/OEIS.
- Identify marine mammal resources that may occur in the action area.
- Identify the marine mammal resources that are likely to co-occur with the stressors in space and time, and the nature of that co-occurrence (exposure analysis).
- Determine whether and how marine mammals are likely to respond given their exposure to the proposed activities based on available scientific knowledge of their probable responses.
- Estimate the effectiveness of proposed mitigation measures in avoiding, offsetting, and reducing the intensity of any potential adverse impacts to marine mammals.
- Determine implications of the estimated risks under the ESA and MMPA.

Warfare Areas and Associated Environmental Stressors

Navy subject matter experts, in consultation with NMFS, identified the warfare areas and activities included in the Proposed Action to identify specific activities that could act as stressors to marine mammals. Public and agency scoping comments, previous environmental analyses, previous agency consultations, laws, regulations, executive orders, and resource-specific information were also evaluated. This process was used to organize the information presented and analyzed in the affected environment and environmental consequences sections of this Draft EIS/OEIS. Potential stressors and the type of effect to marine mammals include:

- Vessel movements;
- Aircraft overflights;
- Non-explosive practice ordnance;

- High explosive ordnance (at-sea explosions);
- Active sonar; and
- Expended materials (ordnance related materials, targets, flares, chaff, sonobuoys, and marine dye markers).

As discussed in Section 3.2 (Expended Materials) and Section 3.4 (Acoustic Environment) of this Draft EIS/OEIS, some water and air pollutants would be released into the environment as a result of the proposed action. Those sections indicated that any increases in water or air pollutant concentrations resulting from Navy training would be negligible and localized. Impacts to water and air quality would be less than significant. Thus, water and air quality changes would have no effect on marine mammals. Accordingly, the effects of water and air quality changes on marine mammals are not addressed further in this Draft EIS/OEIS.

3.8.7.2 Acoustic Effects

Assessing Marine Mammal Responses to Sound

As summarized by the National Academies of Science (NAS), the possibility that human-generated sound could harm marine mammals or significantly interfere with their “normal” activities has been an issue of concern (National Research Council [NRC] 2005). This section evaluates the potential quantification for specific Navy acoustic sources proposed for use in the TMAA to result in harassment of or injury to marine mammals.

Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic sources, the marine mammals that may be present in the vicinity of the sound, and the effects that sound may have on the physiology and behavior of those marine mammals. Although it is known that sound is important for marine mammal communication, navigation and foraging (NRC 2003, NRC 2005), there are many unknowns in assessing the effects and significance of marine mammals responses to sound exposures related to the context for the exposure and the disposition of the marine mammal (Southall et al. 2007). For this reason, the Navy enlisted the expertise of NMFS as a cooperating agency. Their input assisted the Navy in developing a conceptual analytical framework for evaluating what sound levels marine mammals might receive as a result of Navy training actions, whether marine mammals might respond to these exposures, and whether that response might have a mode of action on the biology or ecology of marine mammals such that the response should be considered a potential harassment. From this framework of evaluating the potential for harassment incidents to occur, an assessment of whether acoustic sources might impact populations, stocks or species of marine mammals can be conducted.

The flow chart in Figure 3.8-3 is a representation of the general analytical framework utilized in applying the specific thresholds discussed in this section. The framework presented in the flow chart is organized from left to right and is compartmentalized according to the phenomena that occur within each. These include the physics of sound propagation (Physics), the potential physiological processes associated with sound exposure (Physiology), the potential behavioral processes that might be affected as a function of sound exposure (Behavior), and the immediate effects these changes may have on functions the animal is engaged in at the time of exposure (Life Function – Proximate). These compartmentalized effects are extended to longer term life functions (Life Function – Ultimate) and into population and species effects (“life functions” are the basic processes organisms undergo to survive and reproduce such as feeding and breeding).

Throughout the flow chart, dotted and solid lines are used to connect related events. Solid lines designate those effects that “will” happen; dotted lines designate those that “might” happen but must be considered (including those hypothesized to occur but for which there is no direct evidence).

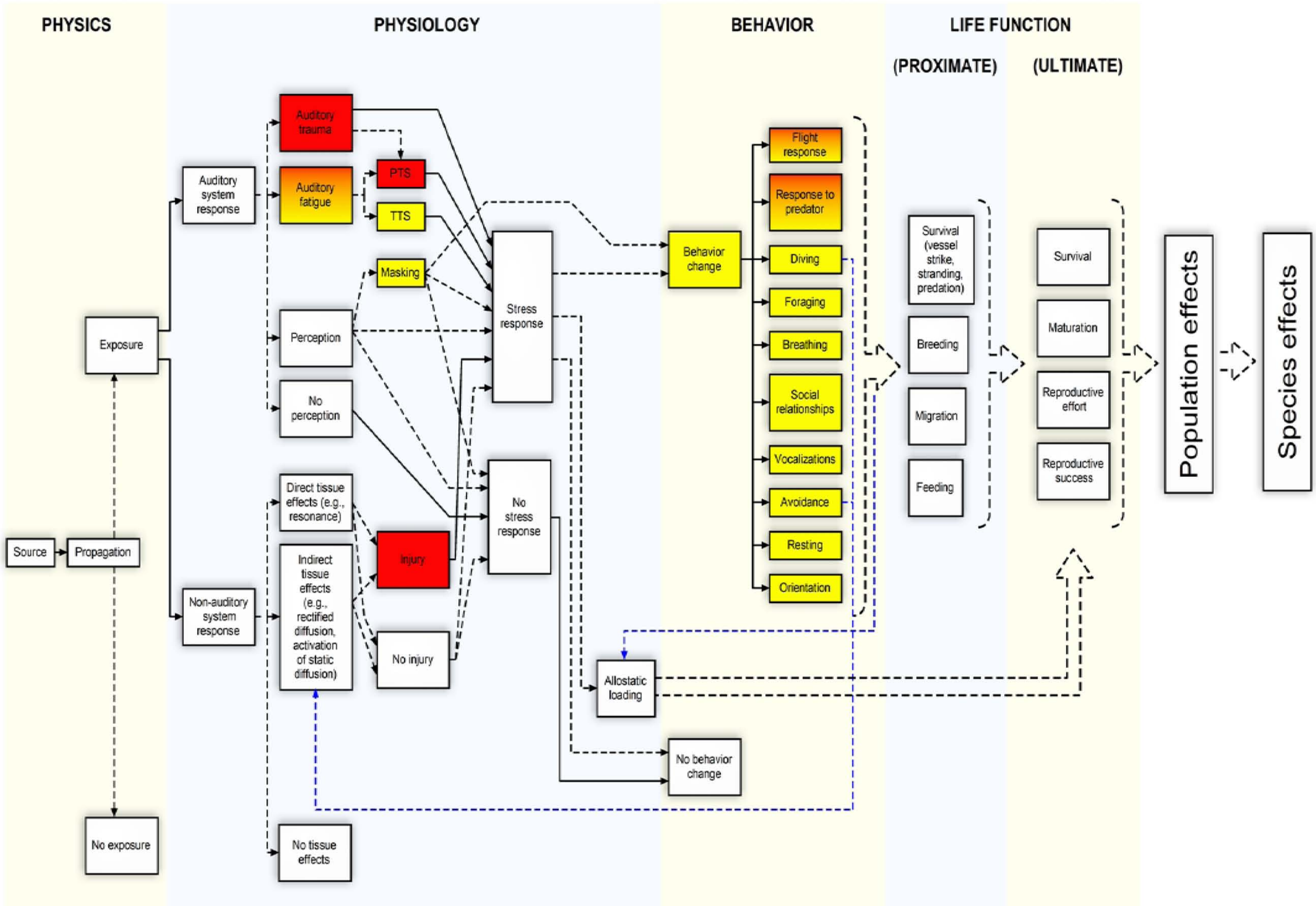


Figure 3.8-3: Analytical Framework for Evaluating Sonar Effects to Marine Mammals

Some boxes contained within the flow chart are colored according to how they relate to the definitions of harassment in the MMPA. Red boxes correspond to events that are injurious. By prior ruling and usage, these events would be considered as Level A harassment under the MMPA. Yellow boxes correspond to events that have the potential to qualify as Level B harassment under the MMPA. Based on prior ruling, the specific instance of Temporary Threshold Shift (TTS) is considered as part of Level B harassment (Level B harassment includes TTS, non-TTS, and sub-TTS). Boxes that are shaded from red to yellow have the potential for injury (Level A harassment) and behavioral disturbance (Level B harassment).

The analytical framework outlined within the flow chart acknowledges that physiological responses must always precede behavioral responses (i.e., there can be no behavioral response without first some physiological effect of the sound) and an organization where each functional block only occurs once and all relevant inputs/outputs flow to/from a single instance.

Physics

Starting with a sound source, the attenuation of an emitted sound due to propagation loss is determined. Uniform animal distribution is overlaid onto the calculated sound fields to assess if animals are physically present at sufficient received sound levels to be considered "exposed" to the sound. If the animal is determined to be exposed, two possible scenarios must be considered with respect to the animal's physiology – effects on the auditory system and effects on nonauditory system tissues. These are not independent pathways and both must be considered since the same sound could affect both auditory and nonauditory tissues. Note that the model does not account for any animal response; rather the animals are considered stationary, accumulating energy until the threshold is tripped.

Physiology

Potential impacts to the auditory system are assessed by considering the characteristics of the received sound (e.g., amplitude, frequency, duration) and the sensitivity of the exposed animals. Some of these assessments can be numerically based (e.g., TTS, Permanent Threshold Shift [PTS], perception). Others will be necessarily qualitative, due to lack of information, or will need to be extrapolated from other species for which information exists. Potential physiological responses to the sound exposure are ranked in descending order, with the most severe impact (auditory trauma) occurring at the top and the least severe impact occurring at the bottom (the sound is not perceived).

1. Auditory trauma represents direct mechanical injury to hearing related structures, including tympanic membrane rupture, disarticulation of the middle ear ossicles, and trauma to the inner ear structures such as the organ of Corti and the associated hair cells. Auditory trauma is always injurious but could be temporary and not result in PTS. Auditory trauma is always assumed to result in a stress response.

2. Auditory fatigue refers to a loss of hearing sensitivity after sound stimulation. The loss of sensitivity persists after, sometimes long after, the cessation of the sound. The mechanisms responsible for auditory fatigue differ from auditory trauma and would primarily consist of metabolic exhaustion of the hair cells and cochlear tissues. The features of the exposure (e.g., amplitude, frequency, duration, temporal pattern) and the individual animal's susceptibility would determine the severity of fatigue and whether the effects were temporary (TTS) or permanent (PTS). Auditory fatigue (PTS or TTS) is always assumed to result in a stress response.

3. Sounds with sufficient amplitude and duration to be detected among the background ambient noise are considered to be perceived. This category includes sounds from the threshold of audibility through the normal dynamic range of hearing (i.e., not capable of producing fatigue). To determine whether an animal perceives the sound, the received level, frequency, and duration of the sound are compared to what is known of the species' hearing sensitivity.

Since audible sounds may interfere with an animal's ability to detect other sounds at the same time, perceived sounds have the potential to result in auditory masking. Unlike auditory fatigue, which always results in a stress response because the sensory tissues are being stimulated beyond their normal physiological range, masking may or may not result in a stress response, depending on the degree and duration of the masking effect. Masking may also result in a unique circumstance where an animal's ability to detect other sounds is compromised without the animal's knowledge. This could conceivably result in sensory impairment and subsequent behavior change; in this case, the change in behavior is the *lack of a response* that would normally be made if sensory impairment did not occur. For this reason, masking also may lead directly to behavior change without first causing a stress response.

The features of perceived sound (e.g., amplitude, duration, temporal pattern) are also used to judge whether the sound exposure is capable of producing a stress response. Factors to consider in this decision include the probability of the animal being naïve or experienced with the sound (i.e., what are the known/unknown consequences of the exposure).

The received level is not of sufficient amplitude, frequency, and duration to be perceptible by the animal. By extension, this does not result in a stress response (not perceived).

Potential impacts to tissues other than those related to the auditory system are assessed by considering the characteristics of the sound (e.g., amplitude, frequency, duration) and the known or estimated response characteristics of nonauditory tissues. Some of these assessments can be numerically based (e.g., exposure required for rectified diffusion). Others will be necessarily qualitative, due to lack of information. Each of the potential responses may or may not result in a stress response.

1. Direct tissue effects – Direct tissue responses to sound stimulation may range from tissue shearing (injury) to mechanical vibration with no resulting injury. Any tissue injury would produce a stress response, whereas noninjurious stimulation may or may not.

2. Indirect tissue effects – Based on the amplitude, frequency, and duration of the sound, it must be assessed whether exposure is sufficient to indirectly affect tissues. For example, the hypothesis that rectified diffusion occurs is based on the idea that bubbles that naturally exist in biological tissues can be stimulated to grow by an acoustic field. Under this hypothesis, one of three things could happen: (1) bubbles grow to the extent that tissue hemorrhage occurs (injury); (2) bubbles develop to the extent that a complement immune response is triggered or nervous tissue is subjected to enough localized pressure that pain or dysfunction occurs (a stress response without injury); or (3) the bubbles are cleared by the lung without negative consequence to the animal. The probability of rectified diffusion, or any other indirect tissue effect, will necessarily be based on what is known about the specific process involved.

3. No tissue effects – The received sound is insufficient to cause either direct mechanical) or indirect effects to tissues. No stress response occurs.

The Stress Response

The acoustic source is considered a potential stressor if, by its action on the animal, via auditory or nonauditory means, it may produce a stress response in the animal. The term "stress" has taken on an ambiguous meaning in the scientific literature, but with respect to the discussions of allostasis and allostatic loading, the stress response will refer to an increase in energetic expenditure that results from exposure to the stressor and which is predominantly characterized by either the stimulation of the sympathetic nervous system (SNS) or the hypothalamic-pituitary-adrenal (HPA) axis (Reeder and Kramer 2005).

The presence and magnitude of a stress response in an animal depends on a number of factors. These include the animal's life history stage (e.g., neonate, juvenile, adult), the environmental conditions, reproductive or developmental state, and experience with the stressor.

Not only will these factors be subject to individual variation, but they will also vary within an individual over time. Prior experience with a stressor may be of particular importance as repeated experience with a stressor may dull the stress response via acclimation (St. Aubin and Dierauf 2001). In considering potential stress responses of marine mammals to acoustic stressors, each of these should be considered. For example, is the acoustic stressor in an area where animals engage in breeding activity? Are animals in the region resident and likely to have experience with the stressor (i.e., repeated exposures)? Is the region a foraging ground or are the animals passing through as transients? What is the ratio of young (naïve) to old (experienced) animals in the population? It is unlikely that all such questions can be answered from empirical data; however, they should be addressed in any qualitative assessment of a potential stress response as based on the available literature.

Marine mammals naturally experience stressors within their environment and as part of their life histories. Changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with conspecifics, and interactions with predators all contribute to the stress a marine mammal experiences. In some cases, naturally occurring stressors can have profound impacts on marine mammals; for example, chronic stress, as observed in stranded animals with long-term debilitating conditions (e.g., disease), has been demonstrated to result in an increased size of the adrenal glands and an increase in the number of epinephrine-producing cells (Clark et al. 2006). Anthropogenic activities have the potential to provide additional stressors above and beyond those that occur naturally. Potential stressors resulting from anthropogenic activities must be considered not only as to their direct impact on the animal but also as to their cumulative impact with environmental stressors already experienced by the animal.

Studies on the stress response of odontocete cetaceans to acute acoustic stimuli were previously discussed Thomas et al. 1990, Miksis et al. 2001, Romano et al. 2004). Other types of stressors include the presence of vessels, fishery interactions, acts of pursuit and capture, the act of stranding, and pollution. In contrast to the limited amount of work performed on stress responses resulting from sound exposure, a considerably larger body of work exists on stress responses associated with pursuit, capture, handling and stranding. Pursuit, capture and short-term holding of belugas has been observed to result in a decrease in thyroid hormones (St. Aubin and Geraci 1988) and increases in epinephrine (St. Aubin and Dierauf 2001). In dolphins, the trend is more complicated with the duration of the handling time potentially contributing to the magnitude of the stress response (St. Aubin et al. 1996, Ortiz and Worthy 2000, St. Aubin 2002). Elephant seals demonstrate an acute cortisol response to handling, but do not demonstrate a chronic response; on the contrary, adult females demonstrate a reduction in the adrenocortical response following repetitive chemical immobilization (Engelhard et al. 2002). With respect to anthropogenic sound as a stressor, the current limited body of knowledge will require extrapolation from species for which information exists to those for which no information exists.

The stress response may or may not result in a behavioral change, depending on the characteristics of the exposed animal. However, provided a stress response occurs, we assume that some contribution is made to the animal's allostatic load. Allostasis is the ability of an animal to maintain stability through change by adjusting its physiology in response to both predictable and unpredictable events (McEwen and Wingfield 2003). The same hormones associated with the stress response vary naturally throughout an animal's life, providing support for particular life history events (e.g., pregnancy) and predictable environmental conditions (e.g., seasonal changes). The allostatic load is the cumulative cost of allostasis incurred by an animal and is generally characterized with respect to an animal's energetic expenditure. Perturbations to an animal that may occur with the presence of a stressor, either biological (e.g., predator) or anthropogenic (e.g., construction), can contribute to the allostatic load (McEwen and Wingfield 2003). Additional costs are cumulative and additions to the allostatic load over time may contribute to reductions in the probability of achieving ultimate life history functions (e.g., survival, maturation, reproductive effort and success) by producing pathophysiological states. The contribution to the allostatic load from a stressor requires estimating the magnitude and duration of the stress response, as well as any secondary contributions that might result from a change in behavior.

If the acoustic source does not produce tissue effects, is not perceived by the animal, or does not produce a stress response by any other means, Figure 3.8-3 assumes that the exposure does not contribute to the allostatic load. Additionally, without a stress response or auditory masking, it is assumed that there can be no behavioral change. Conversely, any immediate effect of exposure that produces an injury (i.e., red boxes on the flow chart in Figure 3.8-3) is assumed to also produce a stress response and contribute to the allostatic load.

Behavior

Acute stress responses may or may not cause a behavioral reaction. However, all changes in behavior are expected to result from an acute stress response. This expectation is based on the idea that some sort of physiological trigger must exist to change any behavior that is already being performed. The exception to this rule is the case of masking. The presence of a masking sound may not produce a stress response, but may interfere with the animal's ability to detect and discriminate biologically relevant signals. The inability to detect and discriminate biologically relevant signals hinders the potential for normal behavioral responses to auditory cues and is thus considered a behavioral change.

Numerous behavioral changes can occur as a result of stress response, and Figure 3.8-3 lists only those that might be considered the most common types of response for a marine animal. For each potential behavioral change, the magnitude in the change and the severity of the response needs to be estimated. Certain conditions, such as stampeding (i.e., flight response) or a response to a predator, might have a probability of resulting in injury. For example, a flight response, if significant enough, could produce a stranding event. Under the MMPA, such an event would be considered a MMPA Level A harassment. Each altered behavior may also have the potential to disrupt biologically significant events (e.g., breeding or nursing) and may need to be qualified as MMPA Level B harassment. Exposures to sonar resulting in non-TTS behavioral disturbance and exposure to at-sea explosions resulting in sub-TTS behavioral disturbance are quantified as MMPA Level B harassment. All behavioral disruptions have the potential to contribute to the allostatic load. This secondary potential is signified by the feedback from the collective behaviors to allostatic loading (physiology block).

The response of a marine mammal to an anthropogenic sound source will depend on the frequency content, duration, temporal pattern and amplitude of the sound as well as the animal's prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). The direction of the responses can vary, with some changes resulting in either increases or decreases from baseline (e.g., decreased dive times and increased respiration rate). Responses can also overlap; for example, an increased respiration rate is likely to be coupled to a flight response. Differential responses between and within species are expected since hearing ranges vary across species and the behavioral ecology of individual species is unlikely to completely overlap.

A review of marine mammal responses to anthropogenic sound was first conducted by Richardson and others in 1995. A more recent review (Nowacek et al. 2007) addresses studies conducted since 1995 and focuses on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated. The following sections provide a very brief overview of the state of knowledge of behavioral responses. The overviews focus on studies conducted since 2000 but are not meant to be comprehensive; rather, they provide an idea of the variability in behavioral responses that would be expected given the differential sensitivities of marine mammal species to sound and the wide range of potential acoustic sources to which a marine mammal may be exposed. Estimates of the types of behavioral responses that could occur for a given sound exposure should be determined from the literature that is available for each species, or extrapolated from closely related species when no information exists.

Flight Response

A flight response is a dramatic change in normal movement to a directed and rapid movement away from the perceived location of a sound source. Relatively little information on flight responses of marine mammals to anthropogenic signals exists, although observations of flight responses to the presence of predators have occurred (Connor and Heithaus 1996). Flight responses have been speculated as being a component of marine mammal strandings associated with sonar activities (Evans and England 2001).

Response to Predators

Evidence suggests that at least some marine mammals have the ability to acoustically identify potential predators. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by certain groups of killer whales, but not others. The seals discriminate between the calls of threatening and non-threatening killer whales (Deecke et al. 2002), a capability that should increase survivorship while reducing the energy required for attending to and responding to all killer whale calls. The occurrence of masking or hearing impairment provides a means by which marine mammals may be prevented from responding to the acoustic cues produced by their predators. Whether or not this is a possibility depends on the duration of the masking/hearing impairment and the likelihood of encountering a predator during the time that predator cues are impeded.

Diving

Changes in dive behavior can vary widely. They may consist of increased or decreased dive times and surface intervals as well as changes in the rates of ascent and descent during a dive. Variations in dive behavior may reflect interruptions in biologically significant activities (e.g., foraging) or they may be of little biological significance. Variations in dive behavior may also expose an animal to potentially harmful conditions (e.g., increasing the chance of ship-strike) or may serve as an avoidance response that enhances survivorship. The impact of a variation in diving resulting from an acoustic exposure depends on what the animal is doing at the time of the exposure and the type and magnitude of the response.

Nowacek et al. (2004) reported disruptions of dive behaviors in foraging North Atlantic right whales when exposed to an alerting stimulus, an action, they noted, that could lead to an increased likelihood of ship strike. However, the whales did not respond to playbacks of either right whale social sounds or vessel noise, highlighting the importance of the sound characteristics in producing a behavioral reaction. Conversely, Indo-Pacific humpback dolphins have been observed to dive for longer periods of time in areas where vessels were present and/or approaching (Ng and Leung 2003). In both of these studies, the influence of the sound exposure cannot be decoupled from the physical presence of a surface vessel, thus complicating interpretations of the relative contribution of each stimulus to the response. Indeed, the presence of surface vessels, their approach and speed of approach, seemed to be significant factors in the response of the Indo-Pacific humpback dolphins (Ng and Leung 2003). Low frequency signals of the Acoustic Thermometry of Ocean Climate (ATOC) sound source were not found to affect dive times of humpback whales in Hawaiian waters (Frankel and Clark 2000) or to overtly affect elephant seal dives (Costa et al. 2003). They did, however, produce subtle effects that varied in direction and degree among the individual seals, illustrating the equivocal nature of behavioral effects and consequent difficulty in defining and predicting them.

Due to past incidents of beaked whale strandings associated with sonar operations, feedback paths are provided between avoidance and diving and indirect tissue effects. This feedback accounts for the hypothesis that variations in diving behavior and/or avoidance responses can possibly result in nitrogen tissue supersaturation and nitrogen off-gassing, possibly to the point of deleterious vascular bubble formation (Jepson et al. 2003). Although hypothetical, the potential process is being debated within the scientific community.

Foraging

Disruption of feeding behavior can be difficult to correlate with anthropogenic sound exposure, so it is usually inferred by observed displacement from known foraging areas, the appearance of secondary indicators (e.g., bubble nets or sediment plumes), or changes in dive behavior. Noise from seismic surveys was not found to impact the feeding behavior in western gray whales off the coast of Russia (Yazvenko et al. 2007) and sperm whales engaged in foraging dives did not abandon dives when exposed to distant signatures of seismic airguns (Madsen et al. 2006). Balaenopterid whales exposed to moderate low-frequency signals similar to the ATOC sound source demonstrated no variation in foraging activity (Croll et al. 2001), whereas five out of six North Atlantic right whales exposed to an acoustic alarm interrupted their foraging dives (Nowacek et al. 2004). Although the received sound pressure level at the animals was similar in the latter two studies, the frequency, duration, and temporal pattern of signal presentation were different. These factors, as well as differences in species sensitivity, are likely contributing factors to the differential response. A determination of whether foraging disruptions incur fitness consequences will require information on or estimates of the energetic requirements of the individuals and the relationship between prey availability, foraging effort and success, and the life history stage of the animal.

Breathing

Variations in respiration naturally vary with different behaviors and variations in respiration rate as a function of acoustic exposure can be expected to co-occur with other behavioral reactions, such as a flight response or an alteration in diving. However, respiration rates in and of themselves may be representative of annoyance or an acute stress response. Mean exhalation rates of gray whales at rest and while diving were found to be unaffected by seismic surveys conducted adjacent to the whale feeding grounds (Gailey et al. 2007). Studies with captive harbor porpoises showed increased respiration rates upon introduction of acoustic alarms (Kastelein et al. 2000, Kastelein et al. 2006a) and emissions for underwater data transmission (Kastelein et al. 2005). However, exposure of the same acoustic alarm to a striped dolphin under the same conditions did not elicit a response (Kastelein et al. 2006a), again highlighting the importance in understanding species differences in the tolerance of underwater noise when determining the potential for impacts resulting from anthropogenic sound exposure.

Social relationships

Social interactions between mammals can be affected by noise via the disruption of communication signals or by the displacement of individuals. Disruption of social relationships therefore depends on the disruption of other behaviors (e.g., caused avoidance, masking, etc.) and no specific overview is provided here. However, social disruptions must be considered in context of the relationships that are affected. Long-term disruptions of mother/calf pairs or mating displays have the potential to affect the growth and survival or reproductive effort/success of individuals, respectively.

Vocalizations

Vocal changes in response to anthropogenic noise can occur across the repertoire of sound production modes used by marine mammals, such as whistling, echolocation click production, calling, and singing. Changes may result in response to a need to compete with an increase in background noise or may reflect an increased vigilance or startle response. For example, in the presence of low-frequency active sonar, humpback whales have been observed to increase the length of their ”songs” (Miller et al. 2000, Fristrup et al. 2003), possibly due to the overlap in frequencies between the whale song and the low-frequency active sonar. A similar compensatory effect for the presence of low frequency vessel noise has been suggested for right whales; right whales have been observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks et al. 2007). Killer whales off the northwestern coast of the United States have been observed to increase the duration of primary calls once a threshold in observing vessel density (e.g., whale watching) was reached, which has been suggested as a response to increased masking noise produced by the vessels (Foote et al. 2004). In contrast, both sperm and pilot whales potentially ceased sound production during the Heard Island feasibility test (Bowles et al. 1994), although it cannot be absolutely determined whether the inability to acoustically detect the animals was due to the cessation of sound production or the displacement of animals from the area.

Avoidance

Avoidance is the displacement of an individual from an area as a result of the presence of a sound. It is qualitatively different from the flight response in its magnitude (i.e., directed movement, rate of travel, etc.). Oftentimes avoidance is temporary, and animals return to the area once the noise has ceased. Longer term displacement is possible, however, which can lead to changes in abundance or distribution patterns of the species in the affected region if they do not become acclimated to the presence of the sound (Blackwell et al. 2004, Bejder et al. 2006, Teilmann et al. 2006). Acute avoidance responses have been observed in captive porpoises and pinnipeds exposed to a number of different sound sources (Kastelein et al. 2000, Finneran et al. 2003, Kastelein et al. 2006a, Kastelein et al. 2006b). Short term avoidance of seismic surveys, low frequency emissions, and acoustic deterrents has also been noted in wild populations of odontocetes (Bowles et al. 1994; Goold 1996, 1998; Stone et al. 2000; Morton and Symonds 2002) and to some extent in mysticetes (Gailey et al. 2007), while longer term or repetitive/chronic displacement for some dolphin groups and for manatees has been suggested to be due to the presence of chronic vessel noise (Haviland-Howell et al. 2007, Miksis-Olds et al. 2007).

Orientation

A shift in an animal's resting state or an attentional change via an orienting response represent behaviors that would be considered mild disruptions if occurring alone, and thus are placed at the bottom of the framework behavior list. As previously mentioned, the responses may co-occur with other behaviors; for instance, an animal may initially orient toward a sound source, and then move away from it. Thus, any orienting response should be considered in context of other reactions that may occur.

Life Functions

Proximate Life Functions

Proximate life history functions are the functions that the animal is engaged in at the time of acoustic exposure. The disruption of these functions, and the magnitude of the disruption, is something that must be considered in determining how the ultimate life history functions are affected. Consideration of the magnitude of the effect to each of the proximate life history functions is dependent upon the life stage of the animal. For example, an animal on a breeding ground which is sexually immature will suffer relatively little consequence to disruption of breeding behavior when compared to an actively displaying adult of prime reproductive age.

Ultimate Life Functions

The ultimate life functions are those that enable an animal to contribute to the population (or stock, or species, etc.). The impact to ultimate life functions will depend on the nature and magnitude of the perturbation to proximate life history functions. Depending on the severity of the response to the stressor, acute perturbations may have nominal to profound impacts on ultimate life functions. For example, unit-level use of sonar by a vessel transiting through an area that is utilized for foraging, but not for breeding, may disrupt feeding by exposed animals for a brief period of time. Because of the brevity of the perturbation, the impact to ultimate life functions may be negligible. By contrast, weekly training over a period of years may have a more substantial impact because the stressor is chronic. Assessment of the magnitude of the stress response from the chronic perturbation would require an understanding of how and whether animals acclimate to a specific, repeated stressor and whether chronic elevations in the stress response (e.g., cortisol levels) produce fitness deficits.

The proximate life functions are loosely ordered in decreasing severity of impact. Mortality (survival) has an immediate effect, in that no future reproductive success is feasible and there is no further addition to the population resulting from reproduction. Severe injuries may also lead to reduced survivorship (longevity) and prolonged alterations in behavior. The latter may further affect an animal's overall reproductive success and reproductive effort. Disruptions of breeding have an immediate impact on reproductive effort and may impact reproductive success. The magnitude of the effect will depend on the duration of the disruption and the type of behavior change that was provoked. Disruptions to feeding and migration can affect all of the ultimate life functions; however, the impacts to reproductive effort and success are not likely to be as severe or immediate as those incurred by mortality and breeding disruptions. Taking into account these considerations, it was determined if there were population and species effects.

Regulatory Framework

The MMPA prohibits the unauthorized harassment of marine mammals and provides the regulatory processes for authorization for any such incidental harassment that might occur during an otherwise lawful activity.

The model for estimating potential acoustic effects from ASW training activities on cetacean species makes use of the methodology that was developed in cooperation with the NOAA for the Navy's Draft EIS/OEIS (DoN 2005). Via response comment letter to Undersea Warfare Training Range (USWTR) received from NMFS dated January 30, 2006, NMFS concurred with the use of Energy Flux Density Level (EL) for the determination of physiological effects to marine mammals. Therefore, this methodology is used to estimate the annual exposure of marine mammals that may be considered MMPA Level A harassment or MMPA Level B harassment as a result of temporary, recoverable physiological effects.

In addition, the approach for estimating potential effects from training activities on marine mammal makes use of the comments received and documents associated with previous Navy NEPA documents analyzing Navy training activities (DoN 2008). As a result of these analyses and in consultation with NMFS, this analysis uses a risk function approach to evaluate the potential for non-TTS MMPA Level B harassment from behavioral effects. The risk function is further explained in Section 3.8.6.3.

A number of Navy actions and NOAA rulings have helped to qualify possible events deemed as "harassment" under the MMPA (e.g. DoN 2008). As stated previously, "harassment" under the MMPA includes both potential injury (Level A), and disruptions of natural behavioral patterns to a point where they are abandoned or significantly altered (Level B). NMFS also includes mortality as a possible outcome to consider in addition to MMPA Level A and MMPA Level B harassment. The acoustic effects analysis and exposure calculations are based on the following premises:

Harassment that may result from Navy training activities described in this Draft EIS/OEIS is unintentional and incidental to those activities.

The acoustic effects analysis is based on primary exposures only. Secondary, or indirect, effects, such as susceptibility to predation following injury and injury resulting from disrupted behavior, while possible, can only be reliably predicted in circumstances where the responses have been well documented. Consideration of secondary effects would result in much MMPA Level A harassment being considered MMPA Level B harassment, and vice versa, since much injury (Level A harassment) has the potential to disrupt behavior (Level B harassment), and much temporary physiological or behavioral disruption (Level B) could be conjectured to have the potential for injury (Level A). Consideration of secondary effects would lead to circular definitions of harassment. However, consistent with prior ruling (NOAA 2001, 2006b), this analysis assumes that MMPA Level A and MMPA Level B do not overlap so as to preclude circular definitions of harassment.

An individual animal predicted to experience simultaneous multiple injuries, multiple disruptions, or both, is counted as a single take (NOAA 2001, 2006b, 2009). NMFS has defined a 24-hour "refresh rate," or amount of time in which an individual can be harassed no more than once. Behavioral harassment, under the risk function presented in this request, uses received SPL over a 24-hour period as the metric for determining the probability of harassment. The Navy has determined that all proposed sonar activities would be shorter than a 24-hour period. Additional model assumptions account for ship movement, make adjustments for multiple ships and make adjustments for the presence of land shadows.

Integration of Regulatory and Biological Frameworks

This section presents a biological framework within which potential effects can be categorized and then related to the existing regulatory framework of injury (MMPA Level A harassment) and behavioral disruption (MMPA Level B harassment). The information presented in this section was used to develop specific numerical exposure thresholds and risk function exposure estimations. Exposure thresholds are combined with sound propagation models and species distribution data to estimate the potential exposures.

Physiological and Behavioral Effects

Sound exposure may affect multiple biological traits of a marine animal; however, the MMPA as amended directs which traits should be used when determining effects. Effects that address injury are considered Level A harassment under MMPA. Effects that address behavioral disruption are considered Level B harassment under MMPA.

The biological framework proposed here is structured according to potential physiological and behavioral effects resulting from sound exposure. The range of effects may then be assessed to determine which qualify as injury or behavioral disturbance under MMPA regulations Physiology and behavior are chosen over other biological traits because:

- They are consistent with regulatory statements defining harassment by injury and harassment by disturbance.
- They are components of other biological traits that may be relevant.
- They are a more sensitive and immediate indicator of effect.

For example, ecology is not used as the basis of the framework because the ecology of an animal is dependent on the interaction of an animal with the environment. The animal's interaction with the environment is driven both by its physiological function and its behavior, and an ecological impact may not be observable over short periods of observation. Ecological information is considered in the analysis of the effects of individual species.

A "physiological effect" is defined here as one in which the "normal" physiological function of the animal is altered in response to sound exposure. Physiological function is any of a collection of processes ranging from biochemical reactions to mechanical interaction and operation of organs and tissues within an animal. A physiological effect may range from the most significant of impacts (i.e., mortality and serious injury) to lesser effects that would define the lower end of the physiological impact range, such as the noninjurious distortion of auditory tissues. This latter physiological effect is important to the integration of the biological and regulatory frameworks and will receive additional attention in later sections.

A "behavioral effect" is one in which the "normal" behavior or patterns of behavior of an animal are overtly disrupted in response to an acoustic exposure. Examples of behaviors of concern can be derived from the harassment definitions in the MMPA.

In this Draft EIS/OEIS the term "normal" is used to qualify distinctions between physiological and behavioral effects. Its use follows the convention of normal daily variation in physiological and behavioral function without the influence of anthropogenic acoustic sources. As a result, this Draft EIS/OEIS uses the following definitions:

- A **physiological effect** is a variation in an animal's respiratory, endocrine, hormonal, circulatory, neurological, or reproductive activity and processes, beyond the animal's normal range of variability, in response to human activity or to an exposure to a stimulus such as active sonar.
- A **behavioral effect** is a variation in the pattern of an animal's breathing, feeding, resting, migratory, intraspecific behavior (such as reproduction, mating, territorial, rearing, and agonistic behavior), and interspecific beyond the animal's normal pattern of variability in response to human activity or to an exposure to a stimulus such as active sonar.

The definitions of physiological effect and behavioral effect used within this document should not be confused with more global definitions applied to the field of biology or to existing federal law. It is reasonable to expect some physiological effects to result in subsequent behavioral effects. For example, a marine mammal that suffers a severe injury may be expected to alter diving or foraging to the degree that its variation in these behaviors is outside that which is considered normal for the species. If a physiological effect is accompanied by a behavioral effect, the overall effect is characterized as a physiological effect; physiological effects take precedence over behavioral effects with regard to their ordering. This approach provides the most conservative ordering of effects with respect to severity, provides a rational approach to dealing with the overlap of the definitions, and avoids circular arguments.

The severity of physiological effects generally decreases with decreasing sound exposure and/or increasing distance from the sound source. The same generalization does not consistently hold for behavioral effects because they do not depend solely on the received sound level. Behavioral responses also depend on an animal's learned responses, innate response tendencies, motivational state, the pattern of the sound exposure, and the context in which the sound is presented. However, to provide a tractable approach to predicting acoustic effects that is relevant to the terms of behavioral disruption described in the MMPA, it is assumed here that the severities of behavioral effects also decrease with decreasing sound exposure and/or increasing distance from the sound source. Figure 3.8-4 shows the relationship between severity of effects, source distance, and exposure level, as defined in this Draft EIS/OEIS.

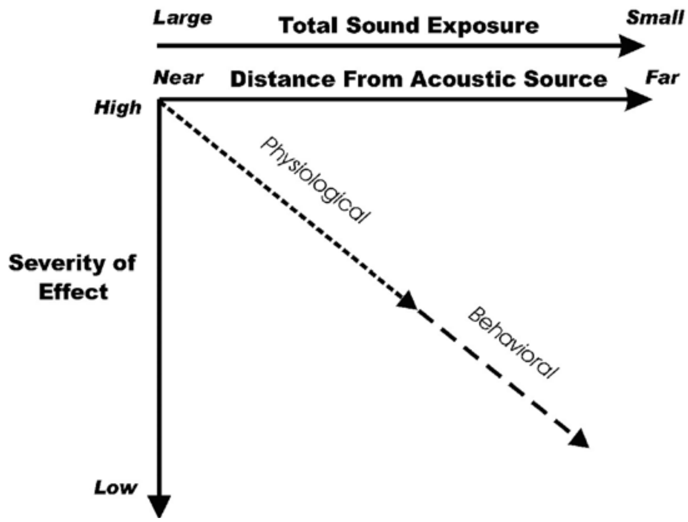


Figure 3.8-4: Relationship between Severity of Effects, Source Distance, and Exposure Level

MMPA Level A Harassment and MMPA Level B Harassment

Categorizing potential effects as either physiological or behavioral effects allows them to be related to the harassment definitions. For military readiness activities, MMPA Level A harassment includes any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild. Injury, as defined in this Draft EIS/OEIS and previous rulings (NOAA 2001, 2002a, 2008b, 2008c), is the destruction or loss of biological tissue from a species. The destruction or loss of biological tissue will result in an alteration of physiological function that exceeds the normal daily physiological variation of the intact tissue. For example, increased localized histamine production, edema, production of scar tissue, activation of clotting factors, white blood cell response, etc., may be expected following injury. Therefore, this Draft EIS/OEIS assumes that all injury is qualified as a physiological effect and, to be consistent with prior actions and rulings (NOAA 2001, 2008b, 2008c), all injuries (slight to severe) are considered MMPA Level A harassment.

Public Law 108-136 (2004) amended the MMPA definitions of Level B harassment for military readiness activities, which applies to this action. For military readiness activities, MMPA Level B harassment is defined as “any act that disturbs or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behaviors are abandoned or significantly altered.” Unlike MMPA Level A harassment, which is solely associated with physiological effects, both physiological and behavioral effects may cause MMPA Level B harassment.

For example, some physiological effects (such as TTS) can occur that are non-injurious but that can potentially disrupt the behavior of a marine mammal. These include temporary distortions in sensory tissue that alter physiological function, but that are fully recoverable without the requirement for tissue replacement or regeneration. For example, an animal that experiences a temporary reduction in hearing sensitivity suffers no injury to its auditory system, but may not perceive some sounds due to the reduction in sensitivity. As a result, the animal may not respond to sounds that would normally produce a behavioral reaction. This lack of response qualifies as a temporary disruption of normal behavioral patterns – the animal is impeded from responding in a normal manner to an acoustic stimulus.

The harassment status of slight behavior disruption has been addressed in workshops, previous actions, and rulings (NOAA 2001, 2008b, 2008c; DoN 2001a). The conclusion is that a momentary behavioral reaction of an animal to a brief, time-isolated acoustic event does not qualify as MMPA Level B harassment. A more general conclusion, that MMPA Level B harassment occurs only when there is "a potential for a significant behavioral change or response in a biologically important behavior or activity," is found in recent rulings (NOAA 2002a, 2008b, 2008c). Public Law 108-136 (2004) amended the definition of MMPA Level B harassment for military readiness activities, which applies to this action. For military readiness activities, MMPA Level B harassment is defined as "any act that disturbs or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns…to a point where such behaviors are abandoned or significantly altered."

Although the temporary lack of response discussed above may not result in abandonment or significant alteration of natural behavioral patterns, the acoustic effect inputs used in the acoustic model assume that temporary hearing impairment (slight to severe) is considered MMPA Level B harassment. Although modes of action are appropriately considered, as outlined in Figure 3.8-5, the conservative assumption used here is to consider all hearing impairment as harassment from TTS. As a result, the actual incidental harassment of marine mammals associated with this action may be less than predicted via the analytical framework.

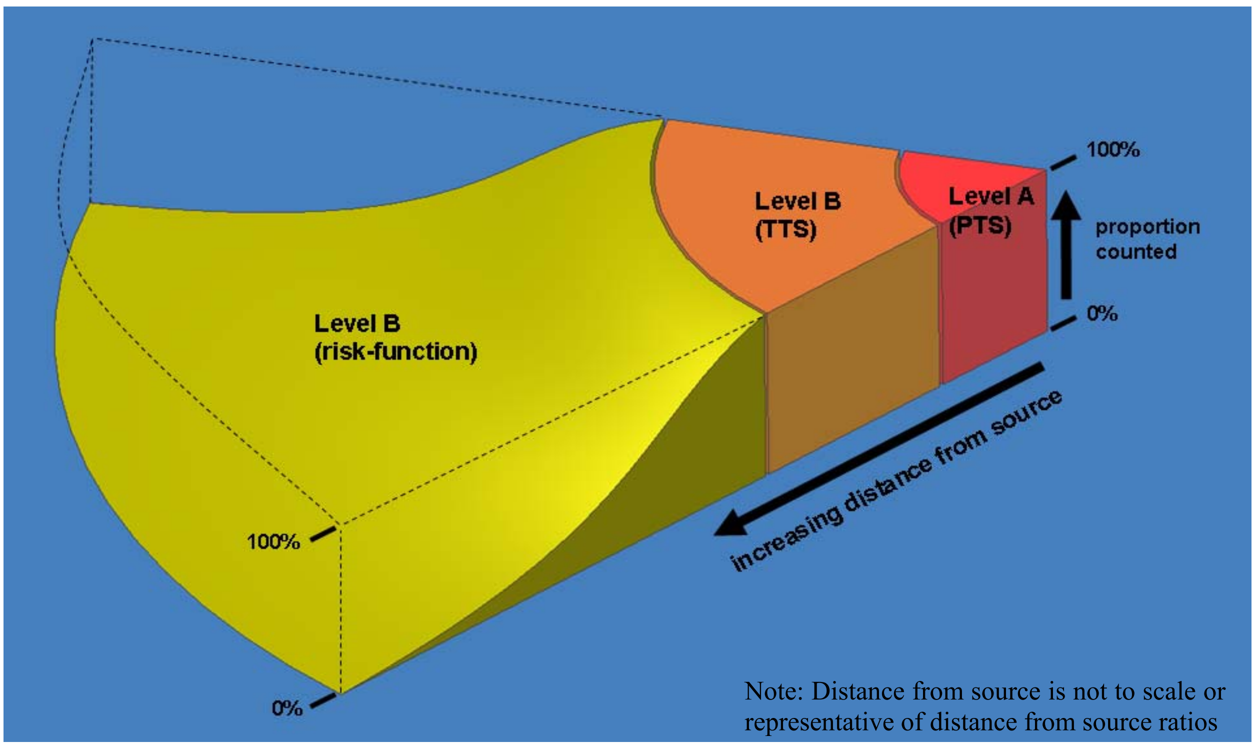


Figure 3.8-5: Exposure Zones Extending from a Hypothetical, Directional Sound Source

MMPA Exposure Zones

Two acoustic modeling approaches are used to account for both physiological and behavioral effects to marine mammals. When using a threshold of accumulated energy (EL) the volumes of ocean in which MMPA Level A and MMPA Level B harassment from a Threshold Shift (TS) are predicted to occur are described as exposure zones. As a conservative estimate, all marine mammals predicted to be in a zone are considered exposed to accumulated sound levels that may result in harassment within the applicable MMPA Level A (PTS) or MMPA Level B (TTS) harassment categories. MMPA non-TTS Level B (risk-function) is not derived from EL, but is an estimate of the probability of non-TTS behavioral responses that NMFS would classify as harassment. See Section 3.8.6.3 for a thorough description of the risk function methodology. Figure 3.8-5 illustrates harassment zones extending from a hypothetical, directional sound source and is for illustrative purposes only and does not represent the sizes or shapes of the actual exposure zones.

As depicted in Figure 3.8-5, the red MMPA Level A (PTS) exposure zone extends from the source out to the distance and exposure at which the slightest amount of injury is predicted to occur (a distance of approximately 33 ft [10 m] from a SQS-53 sonar in the TMAA). The acoustic exposure that produces the slightest degree of injury is therefore the threshold value defining the outermost limit of the MMPA Level A exposure zone. Use of the threshold associated with the onset of slight injury as the most distant point and least injurious exposure takes account of all more serious injuries by inclusion within the MMPA Level A harassment zone.

The orange MMPA Level B (TTS) exposure zone begins just beyond the point of slightest injury (33 ft [10 m]) and extends outward from that point to include all animals that may possibly experience MMPA Level B harassment from TTS (a distance of approximately 584 ft [178 m] from an SQS sonar in the TMAA). Physiological effects extend beyond the range of slightest injury to a point where slight temporary distortion of the most sensitive tissue occurs, but without destruction or loss of that tissue (such as occurs with inner ear hair cells subjected to TTS). The animals predicted to be in this zone are assumed to experience MMPA Level B harassment from TTS by virtue of temporary impairment of sensory function (altered physiological function) that can disrupt behavior. The criterion and threshold used to define the outer limit of the MMPA Level B exposure zone for the on-set of certain physiological effects are given in Figure 3.8-5.

On Figure 3.8-5 in the yellow non-TTS MMPA Level B harassment exposure zone, varying percentages of exposed animals would be included under MMPA Level B harassment from behavioral reactions (to a distance of approximately 105 km [57 nm] from a SQS-53 in the TMAA).

Auditory Tissues as Indicators of Physiological Effects

Exposure to continuous-type sound may cause a variety of physiological effects in mammals. For example, exposure to very high sound levels may affect the function of the visual system, vestibular system, and internal organs (Ward, 1997). Exposure to high-intensity, continuous type sounds of sufficient duration may cause injury to the lungs and intestines (e.g., Dalecki et al. 2002). Sudden, intense sounds may elicit a “startle” response and may be followed by an orienting reflex (Ward 1997, Jansen 1998). The primary physiological effects of sound, however, are on the auditory system (Ward 1997).

The mammalian auditory system consists of the outer ear, middle ear, inner ear, and central nervous system. Sound waves are transmitted through the middle ears to fluids within the inner ear except cetaceans. The inner ear contains delicate electromechanical hair cells that convert the fluid motions into neural impulses that are sent to the brain. The hair cells within the inner ear are the most vulnerable to over-stimulation by sound exposure (Yost 1994).

Very high sound levels may rupture the eardrum or damage the small bones in the middle ear (Yost 1994). Lower level exposures of sufficient duration may cause permanent or temporary hearing loss; such an effect is called a noise-induced threshold shift, or simply a TS (Miller 1974). A TS may be either permanent, in which case it is called a PTS, or temporary, in which case it is called a TTS. Still lower levels of sound may result in auditory masking (described in Section 3.8.6.2), which may interfere with an animal’s ability to hear other concurrent sounds.

Because the tissues of the ear appear to be the most susceptible to the physiological effects of sound and TSs tend to occur at lower exposures than other more serious auditory effects, PTS and TTS are used here as the biological indicators of physiological effects. TTS is the first indication of physiological noninjurious change and is not physical injury. The remainder of this section is, therefore, focused on TSs, including PTSs and TTSs. Since masking (without a resulting TS) is not associated with abnormal physiological function, it is not considered a physiological effect in this Draft EIS/OEIS, but rather a potential behavioral effect. Descriptions of other potential physiological effects, including acoustically mediated bubble growth and air cavity resonance, are described in the Appendix F.

Noise-Induced Threshold Shifts

The amount of TS depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward 1997). For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur between exposures) (Kryter et al. 1966, Ward 1997).

The magnitude of a TS normally decreases with the amount of time post-exposure (Miller, 1974). The amount of TS just after exposure is called the initial TS. If the TS eventually returns to zero (the threshold returns to the pre-exposure value), the TS is a TTS. Since the amount of TTS depends on the time post-exposure, it is common to use a subscript to indicate the time in min after exposure (Quaranta et al. 1998). For example, TTS_2 means a TTS measured 2 min after exposure. If the TS does not return to zero but leaves some finite amount of TS, then that remaining TS is a PTS. The distinction between PTS and TTS is based on whether there is a complete recovery of a TS following a sound exposure. Figure 3.8-6 shows two hypothetical TSs: one that completely recovers, a TTS, and one that does not completely recover, leaving some PTS.

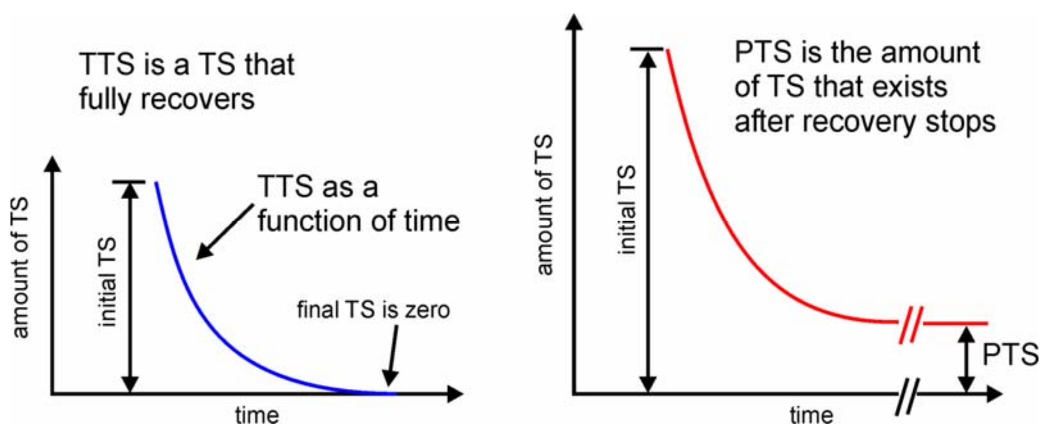


Figure 3.8-6: Hypothetical Temporary and Permanent Threshold Shifts

PTS, TTS, and Exposure Zones

PTS is non-recoverable and, by definition, must result from the destruction of tissues within the auditory system. PTS therefore qualifies as an injury and is classified as Level A harassment under the wording of the MMPA. In the TMAA, the smallest amount of PTS (onset- PTS) is taken to be the indicator for the smallest degree of injury that can be measured. The acoustic exposure associated with onset-PTS is used to define the outer limit of the MMPA Level A exposure zone.

TTS is recoverable and, as in recent rulings (NOAA 2001, 2002a, 2009), is considered to result from the temporary, non-injurious distortion of hearing-related tissues. In the TMAA, the smallest measurable amount of TTS (onset-TTS) is taken as the best indicator for slight temporary sensory impairment.

Because it is considered non-injurious, the acoustic exposure associated with onset-TTS is used to define the outer limit of the portion of the MMPA Level B exposure zone attributable to physiological effects. This follows from the concept that hearing loss potentially affects an animal's ability to react normally to the sounds around it. Therefore, in the TMAA, the potential for TTS is considered as a MMPA Level B harassment that is mediated by physiological effects on the auditory system.

Criteria and Thresholds for Physiological Effects (Sensory Impairment)

This section presents the effect criteria and thresholds for physiological effects of sound leading to injury and behavioral disturbance as a result of sensory impairment. Tissues of the ear are the most susceptible to physiological effects of underwater sound. PTS and TTS were determined to be the most appropriate biological indicators of physiological effects that equate to the onset of injury (Level A harassment) and behavioral disturbance (Level B harassment from TTS), respectively. This section is, therefore, focused on criteria and thresholds to predict PTS and TTS in marine mammals.

Marine mammal ears are functionally and structurally similar to terrestrial mammal ears; however, there are important differences (Ketten 1998). The most appropriate information from which to develop PTS/TTS criteria for marine mammals would be experimental measurements of PTS and TTS from marine mammal species of interest. TTS data exist for several marine mammal species and may be used to develop meaningful TTS criteria and thresholds. Because of the ethical issues presented, PTS data do not exist for marine mammals and are unlikely to be obtained. Therefore, PTS criteria must be extrapolated using TTS criteria and estimates of the relationship between TTS and PTS.

This section begins with a review of the existing marine mammal TTS data. The review is followed by a discussion of the relationship between TTS and PTS. The specific criteria and thresholds for TTS and PTS used in this Draft EIS/OEIS are then presented. This is followed by discussions of sound energy flux density level (EL), the relationship between EL and SPL, and the use of SPL and EL in previous environmental compliance documents.

EL and SPL

EL is measure of the sound energy flow per unit area expressed in dB. EL is stated in dB re 1 μPa^2-s for underwater sound and dB re $(20\ \mu Pa)^2$-s for airborne sound.

SPL is a measure of the root-mean square (rms), or "effective," sound pressure in decibels. SPL is expressed in dB re 1 µPa for underwater sound and dB re 20 µPa for airborne sound.

TTS in Marine Mammals

A number of investigators have measured TTS in marine mammals. These studies measured hearing thresholds in trained marine mammals before and after exposure to intense sounds. Some of the more important data obtained from these studies are onset-TTS levels – exposure levels sufficient to cause a just-measurable amount of TTS, often defined as 6 dB of TTS (for example, Schlundt et al. 2000). The existing cetacean and pinniped underwater TTS data are summarized in the following bullets.

- Schlundt et al. (2000) reported the results of TTS experiments conducted with bottlenose dolphins and white whales exposed to 1-second tones. This paper also includes a reanalysis of preliminary TTS data released in a technical report by Ridgway et al. (1997). At frequencies of 3, 10, and 20 kHz, SPLs necessary to induce measurable amounts (6 dB or more) of TTS were between 192 and 201 dB re 1 µPa (EL = 192 to 201 dB re 1 μPa^2-s). The mean exposure SPL and EL for onset-TTS were 195 dB re 1 µPa and 195 dB re 1 μPa^2-s, respectively. The sound exposure stimuli (tones) and relatively large number of test subjects (five dolphins and two white whales) make the

Schlundt et al. (2000) data the most directly relevant TTS information for the scenarios described in this Draft EIS/OEIS.

- Finneran et al. (2001, 2003, 2005) described TTS experiments conducted with bottlenose dolphins exposed to 3-kHz tones with durations of 1, 2, 4, and 8 seconds. Small amounts of TTS (3 to 6 dB) were observed in one dolphin after exposure to ELs between 190 and 204 dB re 1 μPa^2-s. These results were consistent with the data of Schlundt et al. (2000) and showed that the Schlundt et al. (2000) data were not significantly affected by the masking sound used. These results also confirmed that, for tones with different durations, the amount of TTS is best correlated with the exposure EL rather than the exposure SPL.

- Finneran et al. (2007) conducted TTS experiments with bottlenose dolphins exposed to intense 20 kHz fatiquing tone. Behavioral and auditory evoked potentials (using sinusoidal amplitude modulated tones creating auditory steady state response [AASR]) were used to measure TTS. The fatiguing tone was either 16 (mean = 193 re 1µPa, SD = 0.8) or 64 seconds (185-186 re 1µPa) in duration. TTS ranged from 19-33db from behavioral measurements and 40-45dB from ASSR measurements.

- Nachtigall et al. (2003) measured TTS in a bottlenose dolphin exposed to octave-band sound centered at 7.5 kHz. Nachtigall et al. (2003a) reported TTSs of about 11 dB measured 10 to 15 min after exposure to 30 to 50 min of sound with SPL 179 dB re 1 µPa (EL about 213 dB re μPa^2-s). No TTS was observed after exposure to the same sound at 165 and 171 dB re 1 µPa. Nachtigall et al. (2003b) reported TTSs of around 4 to 8 dB 5 min after exposure to 30 to 50 min of sound with SPL 160 dB re 1 µPa (EL about 193 to 195 dB re 1 μPa^2-s). The difference in results was attributed to faster post-exposure threshold measurement—TTS may have recovered before being detected by Nachtigall et al. (2003a). These studies showed that, for long-duration exposures, lower sound pressures are required to induce TTS than are required for short-duration tones. These data also confirmed that, for the cetaceans studied, EL is the most appropriate predictor for onset-TTS.

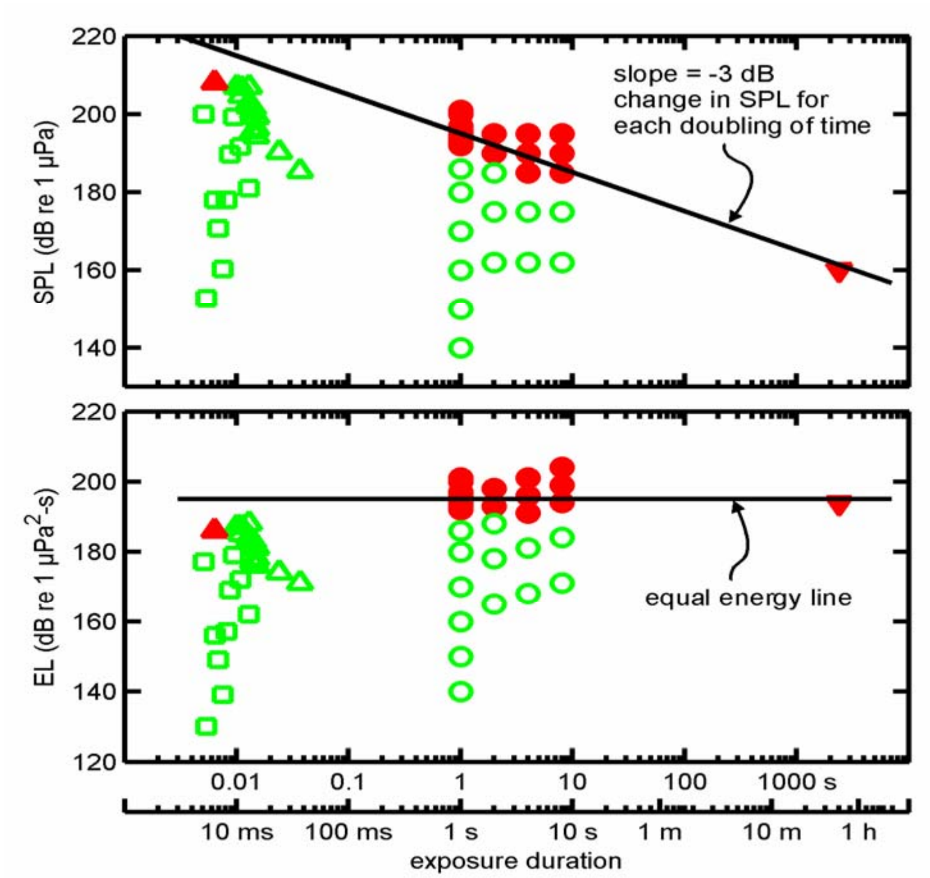
- Finneran et al. (2000, 2002) conducted TTS experiments with dolphins and white whales exposed to impulsive sounds similar to those produced by distant at-sea explosions and seismic water guns. These studies showed that, for very short-duration impulsive sounds, higher sound pressures were required to induce TTS than for longer-duration tones.

- Kastak et al. (1999, 2005) conducted TTS experiments with three species of pinnipeds, California sea lion, northern elephant seal and a Pacific harbor seal, exposed to continuous underwater sounds at levels of 80 and 95 dB Sensation Level (referenced to the animal's absolute auditory threshold at the center frequency) at 2.5 and 3.5 kHz for up to 50 min. Mean TTS shifts of up to 12.2 dB occurred with the harbor seals showing the largest shift of 28.1 dB. Increasing the sound duration had a greater effect on TTS than increasing the sound level from 80 to 95 dB.

Figure 3.8-7 shows the existing TTS data for cetaceans (dolphins and white whales). Individual exposures are shown in terms of SPL versus exposure duration (upper panel) and EL versus exposure duration (lower panel). Exposures that produced TTS are shown as filled symbols. Exposures that did not produce TTS are represented by open symbols. The squares and triangles represent impulsive test results from Finneran et al. 2000 and 2002, respectively. The circles show the 3-, 10-, and 20-kHz data from Schlundt et al. (2000) and the results of Finneran et al. (2003). The inverted triangle represents data from Nachtigall et al. (2003b).

Figure 3.8-7 illustrates that the effects of the different sound exposures depend on the SPL and duration. As the duration decreases, higher SPLs are required to cause TTS. In contrast, the ELs required for TTS do not show the same type of variation with exposure duration. At this time the raw data for pinnipeds is not available to construct a similar graph of TTS in pinnipeds as there is for cetaceans in Figure 3.8-7.

The solid line in the upper panel of Figure 3.8-7 has a slope of -3 dB per doubling of time. This line passes through the point where the SPL is 195 dB re 1 µPa and the exposure duration is 1 second. Since EL = SPL + 10log10 (duration), doubling the duration increases the EL by 3 dB. Subtracting 3 dB from the SPL decreases the EL by 3 dB. The line with a slope of -3 dB per doubling of time, therefore, represents an equal energy line – all points on the line have the same EL, which is, in this case, 195 dB re 1 µPa^2-s. This line appears in the lower panel as a horizontal line at 195 dB re 1 µPa^2-s. The equal energy line at 195 dB re 1 µPa^2-s fits the tonal and sound data (the nonimpulsive data) very well, despite differences in exposure duration, SPL, experimental methods, and subjects.



Legend: Filled symbol: Exposure that produced TTS, Open symbol: Exposure that did not produce TTS Squares: Impulsive test results from Finneran et al. 2000, Triangles: Impulsive test results from Finneran et al. 2002, Circles: 3, 10, and 20-kHz data from Schlundt et al. (2000) and results of Finneran et al. (2003), and Inverted triangle: Data from Nachtigall et al. 2004.

Figure 3.8-7: Existing TTS Data for Cetaceans

In summary, the existing cetacean TTS data show that, for the species studied and sounds (nonimpulsive) of interest, the following is true:

- The growth and recovery of TTS are analogous to those in land mammals. This means that, as in land mammals, cetacean TSs depend on the amplitude, duration, frequency content, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward 1997). For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur between exposures) (Kryter et al. 1966, Ward 1997).

- SPL by itself is not a good predictor of onset-TTS, since the amount of TTS depends on both SPL and duration.
- Exposure EL is correlated with the amount of TTS and is a good predictor for onset-TTS for single, continuous exposures with different durations. This agrees with human TTS data presented by Ward et al. (1958, 1959).
- An energy flux density level of 195 dB re 1 μPa^2-s is the most appropriate predictor for onset-TTS from a single, continuous exposure.
- For the purposes of this Draft EIS/OEIS a measurable amount of 6 dB is considered the onset of TTS.

Relationship between TTS and PTS

Since marine mammal PTS data do not exist, onset-PTS levels for these animals must be estimated using TTS data and relationships between TTS and PTS. Much of the early human TTS work was directed towards relating TTS_2 after 8 hours of sound exposure to the amount of PTS that would exist after years of similar daily exposures (e.g., Kryter et al. 1966). Although it is now acknowledged that susceptibility to PTS cannot be reliably predicted from TTS measurements, TTS data do provide insight into the amount of TS that may be induced without a PTS. Experimental studies of the growth of TTS may also be used to relate changes in exposure level to changes in the amount of TTS induced. Onset-PTS exposure levels may therefore be predicted by:

- Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.
- Estimating the additional exposure, above the onset-TTS exposure, necessary to reach the maximum allowable amount of TTS that, again, may be induced without PTS. This is equivalent to estimating the growth rate of TTS – how much additional TTS is produced by an increase in exposure level.

Experimentally induced TTSs, from short duration sounds 1-8 seconds in the range of 3.5-20 kHz, in marine mammals have generally been limited to around 2 to 10 dB, well below TSs that result in some PTS. Experiments with terrestrial mammals have used much larger TSs and provide more guidance on how high a TS may rise before some PTS results. Early human TTS studies reported complete recovery of TTSs as high as 50 dB after exposure to broadband sound (Ward 1960; Ward et al. 1958, 1959). Ward et al. (1959) also reported slower recovery times when TTS_2 approached and exceeded 50 dB, suggesting that 50 dB of TTS_2 may represent a “critical” TTS. Miller et al. (1963) found PTS in cats after exposures that were only slightly longer in duration than those causing 40 dB of TTS. Kryter et al. (1966) stated: “A TTS_2 that approaches or exceeds 40 dB can be taken as a signal that danger to hearing is imminent.” These data indicate that TSs up to 40 to 50 dB may be induced without PTS, and that 40 dB is a reasonable upper limit for TS to prevent PTS.

The small amounts of TTS produced in marine mammal studies also limit the applicability of these data to estimates of the growth rate of TTS. Fortunately, data do exist for the growth of TTS in terrestrial mammals. For moderate exposure durations (a few min to hours), TTS_2 varies with the logarithm of exposure time (Ward et al. 1958, 1959; Quaranta et al. 1998). For shorter exposure durations the growth of TTS with exposure time appears to be less rapid (Miller 1974, Keeler 1976). For very long-duration exposures, increasing the exposure time may fail to produce any additional TTS, a condition known as asymptotic threshold shift (Saunders et al. 1977, Mills et al. 1979).

Ward et al. (1958, 1959) provided detailed information on the growth of TTS in humans. Ward et al. (1958, 1959) presented the amount of TTS measured after exposure to specific SPLs and durations of broadband sound. Since the relationship between EL, SPL, and duration is known, these same data could be presented in terms of the amount of TTS produced by exposures with different ELs.

Figure 3.8-8 shows results from Ward et al. (1958, 1959) plotted as the amount of TTS_2 versus the exposure EL. The data in Figure 3.8-8 (a) are from broadband (75 Hz to 10 kHz) sound exposures with durations of 12 to 102 min (Ward et al. 1958). The symbols represent mean TTS_2 for 13 individuals exposed to continuous sound. The solid line is a linear regression fit to all but the two data points at the lowest exposure EL. The experimental data are fit well by the regression line (R2 = 0.95). These data are important for two reasons: (1) they confirm that the amount of TTS is correlated with the exposure EL; and (2) the slope of the line allows one to estimate the in additional amount of TTS produced by an increase in exposure. For example, the slope of the line in Figure 3.8-8 (a) is approximately 1.5 dB TTS_2 per dB of EL. This means that each additional dB of EL produces 1.5 dB of additional TTS_2.

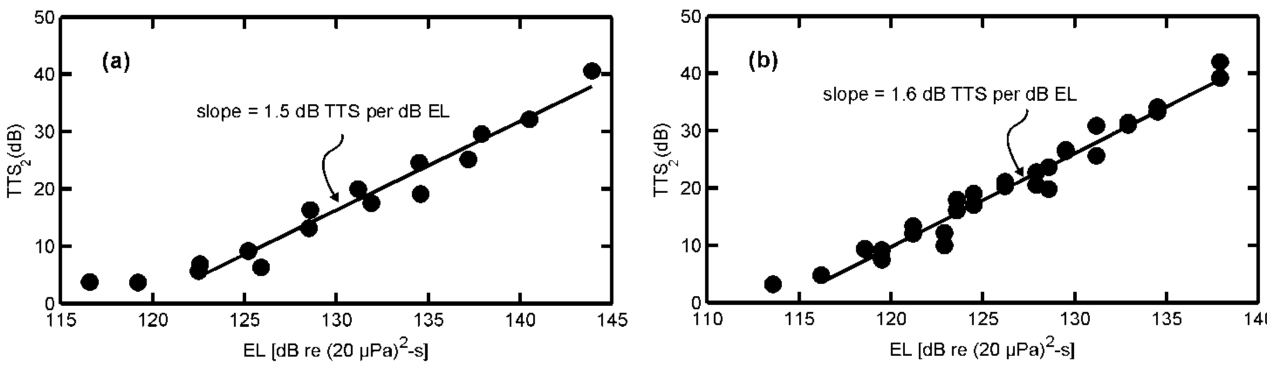


Figure 3.8-8: Growth of TTS versus the Exposure EL (from Ward et al. [1958, 1959])

The data in Figure 3.8-8 (b) are from octave-band sound exposures (2.4 to 4.8 kHz) with durations of 12 to 102 min (Ward et al. 1959). The symbols represent mean TTS for 13 individuals exposed to continuous sound. The linear regression was fit to all but the two data points at the lowest exposure EL. The slope of the regression line fit to the mean TTS data was 1.6 dB TTS_2/dB EL. A similar procedure was carried out for the remaining data from Ward et al. (1959), with comparable results. Regression lines fit to the TTS versus EL data had slopes ranging from 0.76 to 1.6 dB TTS_2/dB EL, depending on the frequencies of the sound exposure and hearing test.

An estimate of 1.6 dB TTS2 per dB increase in exposure EL is the upper range of values from Ward et al. (1958, 1959) and gives the most conservative estimate – it predicts a larger amount of TTS from the same exposure compared to the lines with smaller slopes. The difference between onset-TTS (6 dB) and the upper limit of TTS before PTS (40 dB) is 34 dB. To move from onset-TTS to onset-PTS, therefore, requires an increase in EL of 34 dB divided by 1.6 dB/dB, or approximately 21 dB. An estimate of 20 dB between exposures sufficient to cause onset-TTS and those capable of causing onset-PTS is a reasonable approximation.

To summarize:

In the absence of marine mammal PTS data, onset-PTS exposure levels may be estimated from marine mammal TTS data and PTS/TTS relationships observed in terrestrial mammals. This involves:

- Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.
- Estimating the growth rate of TTS – how much additional TTS is produced by an increase in exposure level.
- A variety of terrestrial mammal data sources point toward 40 dB as a reasonable estimate of the largest amount of TS that may be induced without PTS. A conservative is that continuous-type exposures producing TSs of 40 dB or more always result in some amount of PTS.
- Data from Ward et al. (1958, 1959) reveal a linear relationship between TTS_2 and exposure EL. A value of 1.6 dB TTS_2 per dB increase in EL is a conservative estimate of how much additional TTS is produced by an increase in exposure level for continuous- type sounds.
- There is a 34 dB TS difference between onset-TTS (6 dB) and onset-PTS (40 dB). The additional exposure above onset-TTS that is required to reach PTS is therefore 34 dB divided by 1.6 dB/dB, or approximately 21 dB.
- Exposures with ELs 20 dB above those producing TTS may be assumed to produce a PTS. This number is used as a conservative simplification of the 21 dB number derived above.

Threshold Levels for Harassment from Physiological Effects

For this specified action, sound exposure thresholds for modeling TTS and PTS exposures are as presented in Table 3.8-4.

Table 3.8-4: Summary of the Physiological Effects Thresholds for TTS and PTS for Cetaceans and Pinnipeds in the TMAA

Species	Criteria	Threshold (dB re 1μPa^2-s)	MMPA Harassment
Cetaceans All species	TTS PTS	195 215	Level B Level A
Pinniped			
California Sea Lion	TTS PTS	206 226	Level B Level A
Northern Elephant Seal	TTS PTS	204 224	Level B Level A
Northern Fur Seal	TTS PTS	206 226	Level B Level A
Steller Sea Lion	TTS PTS	206 226	Level B Level A

Notes: dB re 1μPa^2-s = decibels referenced to 1 micropascal squared per second, MMPA = Marine Mammal Protection Act, PTS = Permanent Threshold Shift, TTS = Temporary Threshold Shift

Cetaceans predicted to receive a sound exposure with EL of 215 dB re 1 μPa^2-s or greater are assumed to experience PTS and are counted as MMPA Level A harassment. Cetaceans predicted to receive a sound exposure with EL greater than or equal to 195 dB re 1 μPa^2-s but less than 215 dB re 1 μPa^2-s are assumed to experience TTS and are counted as MMPA Level B harassment from TTS.

The TTS and PTS thresholds for pinnipeds vary with species. A threshold of 206 dB re 1 μPa^2-s for TTS and 226 dB re 1 μPa^2-s for PTS is used for otariids (California sea lion, Steller sea lion, and Northern fur seal). Although this criteria is based on data from studies on California sea lions (Kastak et al. 1999, 2005), all three species are morphologically related (e.g., similar body structure and anatomy), and have similar breeding and foraging behaviors. Northern elephant seals are similar to otariids and use thresholds of TTS = 204 dB re 1 μPa^2-s, PTS = 224 dB re 1 μPa^2-s. A lower threshold is used for harbor seals (TTS = 183 dB re 1 μPa^2-s, PTS = 203 dB re 1 μPa^2-s).

Derivation of Effect Threshold

Cetacean Threshold

The TTS threshold is primarily based on the cetacean TTS data from Schlundt et al. (2000). Since these tests used short-duration tones similar to sonar pings, they are the most directly relevant data. The mean exposure EL required to produce onset-TTS in these tests was 195 dB re 1 μPa^2-s. This result is corroborated by the short-duration tone data of Finneran et al. (2001, 2003, 2005) and the long-duration sound data from Nachtigall et al. (2003a, b). Together, these data demonstrate that TTS in cetaceans is correlated with the received EL and that onset-TTS exposures are fit well by an equal-energy line passing through 195 dB re 1 μPa^2-s.

The PTS threshold is based on a 20-dB increase in exposure EL over that required for onset-TTS. The 20-dB value is based on estimates from terrestrial mammal data of PTS occurring at 40 dB or more of TS, and on TS growth occurring at a rate of 1.6 dB/dB increase in exposure EL. This is conservative because: (1) 40 dB of TS is actually an upper limit for TTS used to approximate onset-PTS, and (2) the 1.6 dB/dB growth rate is the highest observed in the data from Ward et al. (1958, 1959).

Pinniped Threshold

The TTS threshold for pinnipeds is based on TTS data from Kastak et al. (1999, 2005). Although their data is from continuous noise rather than short duration tones, pinniped TTS can be extrapolated using equal energy curves. Continuous sound at a lower intensity level can produce TTS similar to short duration but higher intensity sounds such as sonar pings.

Use of EL for Physiological Effect Thresholds

Effect thresholds are expressed in terms of total received EL. Energy flux density is a measure of the flow of sound energy through an area. Marine and terrestrial mammal data show that, for continuous-type sounds of interest, TTS and PTS are more closely related to the energy in the sound exposure than to the exposure SPL.

The EL for each individual ping is calculated from the following equation:

$$EL = SPL + 10\log_{10}(\text{duration})$$

The EL includes both the ping SPL and duration. Longer-duration pings and/or higher-SPL pings will have a higher EL.

If an animal is exposed to multiple pings, the energy flux density in each individual ping is summed to calculate the total EL. Since mammalian TS data show less effect from intermittent exposures compared to continuous exposures with the same energy (Ward 1997), basing the effect thresholds on the total received EL is a conservative approach for treating multiple pings; in reality, some recovery will occur between pings and lessen the effect of a particular exposure.

Therefore, estimates are conservative because recovery is not taken into account – intermittent exposures are considered comparable to continuous exposures.

The total EL depends on the SPL, duration, and number of pings received. The TTS and PTS thresholds do not imply any specific SPL, duration, or number of pings. The SPL and duration of each received ping are used to calculate the total EL and determine whether the received EL meets or exceeds the effect thresholds. For example, the TTS threshold would be reached through any of the following exposures:

- A single ping with SPL = 195 dB re 1 μPa and duration = 1 second.
- A single ping with SPL = 192 dB re 1 μPa and duration = 2 seconds.
- Two pings with SPL = 192 dB re 1 μPa and duration = 1 second.
- Two pings with SPL = 189 dB re 1 μPa and duration = 2 seconds.

Previous Use of EL for Physiological Effects

Originally for effects criteria from at-sea (underwater) explosions, energy measures were part of dual criteria for cetacean auditory effects in ship shock trials, which only involve impulsive-type sounds (DoN 1997, 2001a). These previous actions used 192 dB re 1 μPa^2-s as a reference point to derive a TTS threshold in terms of EL. A second TTS threshold, based on peak pressure, was also used. If either threshold was exceeded, effect was assumed.

The 192 dB re 1 μPa^2-s reference point differs from the threshold of 195 dB re 1 μPa^2-s used in this Draft EIS/OEIS. The 192 dB re 1 μPa^2-s value was based on the minimum observed by Ridgway et al. (1997) and Schlundt et al. (2000) during TTS measurements with bottlenose dolphins exposed to 1-second tones. At the time, no impulsive test data for marine mammals were available and the 1-second tonal data were considered to be the best available. The minimum value of the observed range of 192 to 201 dB re 1 μPa^2-s was used to protect against misinterpretation of the sparse data set available. The 192 dB re 1 μPa^2-s value was reduced to 182 dB re 1 μPa^2-s to accommodate the potential effects of pressure peaks in impulsive waveforms.

The additional data now available for onset-TTS in small cetaceans confirm the original range of values and increase confidence in it (Finneran et al. 2001, 2003; Nachtigall et al. 2003a, 2003b). This Draft EIS/OEIS therefore, uses the more complete data available and the mean value of the entire Schlundt et al. (2000) data set (195 dB re 1 μPa^2-s), instead of the minimum of 192 dB re 1 μPa^2-s. Use of the data in this manner has been established as standard by NMFS for these types of actions in other Navy training locations in the Pacific (NOAA 2009). From the standpoint of statistical sampling and prediction theory, the mean is the most appropriate predictor—the "best unbiased estimator"—of the EL at which onset-TTS should occur; predicting the number of exposures in future actions relies (in part) on using the EL at which onset-TTS will most likely occur. When that EL is applied over many pings in each of many sonar exercises, that value will provide the most accurate prediction of the actual number of exposures by onset-TTS over all of those exercises. Use of the minimum value would overestimate the number of exposures because many animals counted would not have experienced onset-TTS. Further, there is no logical limiting minimum value of the distribution that would be obtained from continued successive testing. Continued testing and use of the minimum would produce more and more erroneous estimates.

Criteria and Thresholds for Level B Harassment from Non-TTS

This Section presents the effect criterion and threshold for non-TTS behavioral effects of sound leading to behavioral disturbance without accompanying physiological effects as has been established by NMFS (NOAA 2009). Since TTS is used as the biological indicator for a physiological effect leading to behavioral disturbance, the non-TTS behavioral effects discussed in this section may be thought of as behavioral disturbance occurring at exposure levels below those causing TTS.

A large body of research on terrestrial animal and human response to airborne sound exists, but results from those studies are not readily extendible to the development of effect criteria and thresholds for marine mammals. For example, "annoyance" is one of several criteria used to define impact to humans from exposure to industrial sound sources. Comparable criteria cannot be developed for marine mammals because there is no acceptable method for determining whether a nonverbal animal is annoyed. Further, differences in hearing thresholds, dynamic range of the ear, and the typical exposure patterns of interest (e.g., human data tend to focus on 8-hour-long exposures) make extrapolation of human sound exposure standards inappropriate.

Behavioral observations of marine mammals exposed to anthropogenic sound sources exist; however, there are few observations and no controlled measurements of behavioral disruption of cetaceans caused by sound sources with frequencies, waveforms, durations, and repetition rates comparable to those employed by the tactical sonars to be used in the TMAA. At the present time there is no consensus on how to account for behavioral effects on marine mammals exposed to continuous-type sounds (NRC, 2003).

3.8.7.3 Assessing MMPA Level B Non-TTS Behavioral Harassment Using Risk Function

Background

Based on available evidence, marine animals are likely to exhibit any of a suite of potential behavioral responses or combinations of behavioral responses upon exposure to sonar transmissions. Potential behavioral responses include, but are not limited to: avoiding exposure or continued exposure; behavioral disturbance (including distress or disruption of social or foraging activity); habituation to the sound; becoming sensitized to the sound; or not responding to the sound.

Existing studies of behavioral effects of human-made sounds in marine environments remain inconclusive, partly because many of those studies have lacked adequate controls, applied only to certain kinds of exposures (which are often different from the exposures being analyzed in the study), and had limited ability to detect behavioral changes that may be significant to the biology of the animals that were being observed. These studies are further complicated by the wide variety of behavioral responses marine mammals exhibit and the fact that those responses can vary significantly by species, individual, and the context of an exposure. In some circumstances, some individuals will continue normal behavioral activities in the presence of high levels of human-made noise. In other circumstances, the same individual or other individuals may avoid an acoustic source at much lower received levels (Richardson et al. 1995, Wartzok et al. 2003). These differences within and between individuals appear to result from a complex interaction of experience, motivation, and learning that are difficult to quantify and predict.

It is possible that some marine mammal behavioral reactions to anthropogenic sound may result in strandings. As detailed in Appendix F, several "mass stranding" events—strandings that involve two or more individuals of the same species (excluding a single cow–calf pair)—that have occurred over the past two decades have been associated with naval training activities, seismic surveys, and other anthropogenic activities that introduced sound into the marine environment. Based on the results of recent experiments with tagged beaked whales, it has been suggested that that beaked whales may be "particularly sensitive to anthropogenic sounds, but there is no evidence that they have a special sensitivity to sonar compared with other signals" (Tyack 2009). Sonar exposure has, however, been identified as a contributing cause or factor in five specific mass stranding events: Greece in 1996; the Bahamas in March 2000; Madeira, Portugal in 2000; the Canary Islands in 2002, and Spain in 2006 (Advisory Committee on Acoustic Impacts on Marine Mammals 2006).

In these five events, exposure to acoustic energy has been considered a potential indirect cause of the death of marine mammals (Cox et al. 2006). A popular hypothesis regarding a potential cause of the strandings is that tissue damage results from a "gas and fat embolic syndrome" (Fernandez et al. 2005; Jepson et al. 2003, 2005). Models of nitrogen saturation in diving marine mammals have been used to suggest that altered dive behavior might result in the accumulation of nitrogen gas such that the potential for nitrogen bubble formation is increased (Houser et al. 2001, Zimmer and Tyack 2007). If so, this mechanism might explain the findings of gas and bubble emboli in stranded beaked whales. It is also possible that stranding is a behavioral response to a sound under certain contextual conditions and that the subsequently observed physiological effects of the strandings (e.g., overheating, decomposition, or internal hemorrhaging from being on shore) were the result of the stranding and not the direct result of exposure to sonar (Cox et al. 2006).

Non-TTS Risk Function Adapted from Feller (1968)

To assess the potential effects on marine mammals associated with active sonar used during training activity, the Navy and NMFS as cooperating agencies in previous analysis (NOAA 2008b, 2008c) applied a risk function that estimates the probability of behavioral responses that NMFS would classify as harassment for the purposes of the MMPA given exposure to specific received levels of MFA sonar. The mathematical function is derived from a solution in Feller (1968) as defined in the SURTASS LFA Sonar Final OEIS/EIS (DoN 2001), and relied on in the Supplemental SURTASS LFA Sonar EIS (DoN 2007a) for the probability of MFA sonar risk for MMPA Level B non-TTS behavioral harassment with input parameters modified by NMFS for MFA sonar for mysticetes, odontocetes (except harbor porpoises), and pinnipeds (NMFS 2008, NOAA 2009). The same risk function and input parameters will be applied to high frequency active (HFA) (>10 kHz) sources until applicable data becomes available for high frequency sources.

In order to represent a probability of risk, the function should have a value near zero at very low exposures, and a value near one for very high exposures. One class of functions that satisfies this criterion is cumulative probability distributions, a type of cumulative distribution function. In selecting a particular functional expression for risk, several criteria were identified:

- The function must use parameters to focus discussion on areas of uncertainty;
- The function should contain a limited number of parameters;
- The function should be capable of accurately fitting experimental data; and
- The function should be reasonably convenient for algebraic manipulations.

As described in DoN (2001), the mathematical function below is adapted from a solution in Feller (1968).

$$R = \frac{1 - \left(\frac{L - B}{K}\right)^{-A}}{1 - \left(\frac{L - B}{K}\right)^{-2A}}$$

Where: R = risk (0 – 1.0);

L = Received Level (RL) in dB;

B = basement RL in dB; (120 dB);

K = the RL increment above basement in dB at which there is 50 percent risk;

A = risk transition sharpness parameter (10 for odontocetes, 8 for mysticetes).

In order to use this function, the values of the three parameters (B, K, and A) need to be established. The values used in this Draft EIS/OEIS analysis are based on three sources of data: TTS experiments conducted at SSC and documented in Finneran, et al. (2001, 2003, and 2005; Finneran and Schlundt 2004); reconstruction of sound fields produced by the USS SHOUP associated with the behavioral responses of killer whales observed in Haro Strait and documented in Department of Commerce, NMFS (2005), DoN (2004), and Fromm (2004a, 2004b); and observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components documented in Nowacek et al. (2004). The input parameters, as defined by NMFS, are based on very limited data that represent the best available science at this time.

Data Sources Used For Risk Function

There is widespread consensus that cetacean response to MFA sound signals needs to be better defined using controlled experiments. Navy is contributing to an ongoing behavioral response study in the Bahamas that has provided some initial information on beaked whales, the species identified as potentially the most sensitive to MFA sonar. NMFS is leading this international effort with scientists from various academic institutions and research organizations to conduct studies on how marine mammals respond to underwater sound exposures. Field experiments in 2007 and 2008 with tagged beaked whales found reactions to all introduced sound stimulus consisted of the animals stopping their clicking, producing fewer foraging buzzes than normal, and ending their dive in a long and an unusually slow ascent moving away from the sound source (Tyack 2009). This suggested that beaked whales may be "particularly sensitive to anthropogenic sounds, but there is no evidence that they have a special sensitivity to sonar compared with other signals" (Tyack 2009). These initial findings are not in conflict with the current risk function. Until additional data beyond the three recently completed experimental exposures are available, NMFS and the Navy will continue use of the risk function established for recent Final Rules under MMPA for Navy training activities (e.g., NOAA 2009). NMFS and the Navy have determined that the following three data sets remain the most applicable for the direct use in developing risk function parameters for MFA/HFA sonar. These data sets represent the only known data that specifically relate altered behavioral responses to exposure to MFA sound sources.

Data from SSC's Controlled Experiments

Most of the observations of the behavioral responses of toothed whales resulted from a series of controlled experiments on bottlenose dolphins and beluga whales conducted by researchers at SSC's facility in San Diego, California (Finneran et al. 2001, 2003, 2005; Finneran and Schlundt 2004; Schlundt et al. 2000). In experimental trials with marine mammals trained to perform tasks when prompted, scientists evaluated whether the marine mammals performed these tasks when exposed to mid-frequency tones. Altered behavior during experimental trials usually involved refusal of animals to return to the site of the sound stimulus. This refusal included what appeared to be deliberate attempts to avoid a sound exposure or to avoid the location of the exposure site during subsequent tests. (Schlundt et al. 2000, Finneran et al. 2002) Bottlenose dolphins exposed to 1-sec intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 micropascal (ìPa) root mean square (rms), and beluga whales did so at received levels of 180 to 196 dB and above. Test animals sometimes vocalized after an exposure to impulsive sound from a seismic watergun (Finneran et al. 2002). In some instances, animals exhibited aggressive behavior toward the test apparatus (Ridgway et al. 1997, Schlundt et al. 2000).

Finneran and Schlundt (2004) examined behavioral observations recorded by the trainers or test coordinators during the Schlundt et al. (2000) and Finneran et al. (2001, 2003, 2005) experiments featuring 1-second (sec) tones. These included observations from 193 exposure sessions (fatiguing stimulus level > 141 dB re 1µPa) conducted by Schlundt et al. (2000) and 21 exposure sessions conducted by Finneran et al. (2001, 2003, 2005). The observations were made during exposures to sound sources at 0.4 kHz, 3 kHz, 10 kHz, 20 kHz, and 75 kHz. The TTS experiments that supported Finneran and Schlundt (2004) are further explained below:

Schlundt et al. (2000) provided a detailed summary of the behavioral responses of trained marine mammals during TTS tests conducted at SSC San Diego with 1-sec tones. Schlundt et al. (2000) reported eight individual TTS experiments. Fatiguing stimuli durations were 1-sec; exposure frequencies were 0.4 kHz, 3 kHz, 10 kHz, 20 kHz and 75 kHz. The experiments were conducted in San Diego Bay. Because of the variable ambient noise in the bay, low-level broadband masking noise was used to keep hearing thresholds consistent despite fluctuations in the ambient noise. Schlundt et al. (2000) reported that "behavioral alterations," or deviations from the behaviors the animals being tested had been trained to exhibit, occurred as the animals were exposed to increasing fatiguing stimulus levels.

Finneran et al. (2001, 2003, 2005) conducted TTS experiments using tones at 3 kHz. The test method was similar to that of Schlundt et al. (2000) except the tests were conducted in a pool with very low ambient noise level (below 50 dB re 1 µPa/Hz), and no masking noise was used. Two separate experiments were conducted using 1-sec tones. In the first, fatiguing sound levels were increased from 160 to 201 dB SPL. In the second experiment, fatiguing sound levels between 180 and 200 dB re 1 µPa were randomly presented.

Data from Studies of Baleen (Mysticetes) Whale Responses

The only mysticete data available resulted from a field experiments in which baleen whales (mysticetes) were exposed to a range frequency sound sources from 120 Hz to 4500 Hz (Nowacek et al. 2004). An alert stimulus, with a mid-frequency component, was the only portion of the study used to support the risk function input parameters.

Nowacek et al. (2004) documented observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components. To assess risk factors involved in ship strikes, a multi-sensor acoustic tag was used to measure the responses of whales to passing ships and experimentally tested their responses to controlled sound exposures, which included recordings of ship noise, the social sounds of conspecifics and a signal designed to alert the whales. The alert signal was 18-min of exposure consisting of three 2-minute signals played sequentially three times over. The three signals had a 60 percent duty cycle and consisted of: (1) alternating 1-sec pure tones at 500 Hz and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 Hz to 500 Hz; and (3) a pair of low (1,500 Hz)-high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1-sec long. The purposes of the alert signal were (a) to provoke an action from the whales via the auditory system with disharmonic signals that cover the whales estimated hearing range; (b) to maximize the signal to noise ratio (obtain the largest difference between background noise) and c) to provide localization cues for the whale. Five out of six whales reacted to the signal designed to elicit such behavior. Maximum received levels ranged from 133 to 148 dB re 1µPa.

Observations of Killer Whales in Haro Strait in the Wild

In May 2003, killer whales (*Orcinus orca*) were observed exhibiting behavioral responses while the USS SHOUP was engaged in MFA sonar activities in the Haro Strait in the vicinity of Puget Sound, Washington. Although these observations were made in an uncontrolled environment, the sound field that may have been associated with the sonar activities had to be estimated, and the behavioral observations were reported for groups of whales, not individual whales, the observations associated with the USS SHOUP provide the only data set available of the behavioral responses of wild, noncaptive animal upon exposure to the SQS-53 MFA sonar. U.S. Department of Commerce (NMFS 2005), DoN (2004), Fromm (2004a, 2004b) documented reconstruction of sound fields produced by the USS SHOUP associated with the behavioral response of killer whales observed in Haro Strait. Observations from this reconstruction included an approximate closest approach time which was correlated to a reconstructed estimate of received level at an approximate whale location (which ranged from 150 to 180 dB), with a mean value of 169.3 dB.

Limitations of the Risk Function Data Sources

There are significant limitations and challenges to any risk function derived to estimate the probability of marine mammal behavioral responses; these are largely attributable to sparse data. Ultimately there should be multiple functions for different marine mammal taxonomic groups, but the current data are insufficient to support them. The goal is unquestionably that risk functions be based on empirical measurement.

The risk function presented here is based on three data sets that NMFS and Navy have determined are the best available science at this time. The Navy and NMFS acknowledge each of these data sets has limitations. However, this risk function, if informed by the limited available data relevant to the MFA sonar application, has the advantages of simplicity and the fact that there is precedent for its application and foundation in marine mammal research.

While NMFS considers all data sets as being weighted equally in the development of the risk function, the Navy believes the SSC San Diego data is the most rigorous and applicable for the following reasons:

- The data represents the only source of information where the researchers had complete control over and ability to quantify the noise exposure conditions.
- The altered behaviors were identifiable due to long term observations of the animals.
- The fatiguing noise consisted of tonal exposures with limited frequencies contained in the MFA sonar bandwidth.

However, the Navy and NMFS do agree that the following are limitations associated with the three data sets used as the basis of the risk function:

- The three data sets represent the responses of only four species: trained bottlenose dolphins and beluga whales, North Atlantic right whales in the wild and killer whales in the wild.
- None of the three data sets represent experiments designed for behavioral observations of animals exposed to MFA sonar.
- The behavioral responses of marine mammals that were observed in the wild (observations of killer whales in Haro Strait) are based on an estimated received level of sound exposure; they do not take into consideration (due to minimal or no supporting data):
    - Potential relationships between acoustic exposures and specific behavioral activities (e.g., feeding, reproduction, changes in diving behavior, etc.), variables such as bathymetry, or acoustic waveguides; or
    - Differences in individuals, populations, or species, or the prior experiences, reproductive state, hearing sensitivity, or age of the marine mammal.

SSC San Diego Trained Bottlenose Dolphins and Beluga Data Set:

- The animals were trained animals in captivity; therefore, they may be more or less sensitive than cetaceans found in the wild (Domjan 1998).
- The tests were designed to measure TTS, not behavior.
- Because the tests were designed to measure TTS, the animals were exposed to much higher levels of sound than the baseline risk function (only two of the total 193 observations were at levels below 160 dB re 1 μPa^2-s).
- The animals were not exposed in the open ocean but in a shallow bay or pool.

North Atlantic Right Whales in the Wild Data Set

- The observations of behavioral response were from exposure to alert stimuli that contained mid-frequency components but was not similar to a MFA sonar ping. The alert signal was 18 min of exposure consisting of three 2-min signals played sequentially three times over. The three signals had a 60 percent duty cycle and consisted of (1) alternating 1-sec pure tones at 500 Hz and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 Hz to 500 Hz; and (3) a pair of low (1,500 Hz)- high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1-sec long. This 18-min alert stimuli is in contrast to the average 1-sec ping every 30 sec in a comparatively very narrow frequency band used by military sonar.
- The purpose of the alert signal was, in part, to provoke an action from the whales through an auditory stimulus.

Killer Whales in the Wild Data Set

- The observations of behavioral harassment were complicated by the fact that there were other sources of harassment in the vicinity (other vessels and their interaction with the animals during the observation).
- The observations were anecdotal and inconsistent. There were no controls during the observation period, with no way to assess the relative magnitude of the any observed response as opposed to baseline conditions.

Input Parameters Risk Function

The values of B, K, and A need to be specified in order to utilize the risk function defined in Section 3.8.6.3. The risk continuum function approximates the dose-response function in a manner analogous to pharmacological risk assessment. In this case, the risk function is combined with the distribution of sound exposure levels to estimate aggregate impact on an exposed population.

Basement Value for Risk – The B Parameter

The B parameter defines the basement value for risk, below which the risk is so low that calculations are impractical. This 120 dB level is taken as the estimate received level (RL) below which the risk of significant change in a biologically important behavior approaches zero for the MFA/HFA sonar risk assessment. This level is based on a broad overview of the levels at which multiple species have been reported responding to a variety of sound sources, both mid-frequency and other, was recommended by the NMFS, and has been used in other publications (DoN 2008, NOAA 2009). The Navy recognizes that for actual risk of changes in behavior to be zero, the signal-to-noise ratio of the animal must also be zero. However, the present convention of ending the risk calculation at 120 dB for MFA/HFA sonar has a negligible impact on the subsequent calculations, because the risk function does not attain appreciable values at received levels that low.

The K Parameter

NMFS and the Navy used the mean of the following values to define the midpoint of the function: (1) the mean of the lowest received levels (185.3 dB) at which individuals responded with altered behavior to 3 kHz tones in the SSC data set; (2) the estimated mean received level value of 169.3 dB produced by the reconstruction of the USS SHOUP incident in which killer whales exposed to MFA sonar (range modeled possible received levels: 150 to 180 dB); and (3) the mean of the five maximum received levels at which Nowacek et al. (2004) observed significantly altered responses of right whales to the alert stimuli than to the control (no input signal) is 139.2 dB SPL. The arithmetic mean of these three mean values is 165 dB SPL. The value of K is the difference between the value of B (120 dB SPL) and the 50 percent value of 165 dB SPL; therefore, K=45.

Risk Transition – The A Parameter

The A parameter controls how rapidly risk transitions from low to high values with increasing receive level. As A increases, the slope of the risk function increases. For very large values of A, the risk function can approximate a threshold response or step function. In consultation for the Hawaii Range Complex (HRC) EIS/OEIS, NMFS recommended that the Navy use A=10 as the value for odontocetes (except harbor porpoises), and pinnipeds, and A=8 for mysticetes (Figures 3.8-9 and 3.8-10) (NMFS 2008, NOAA 2009)

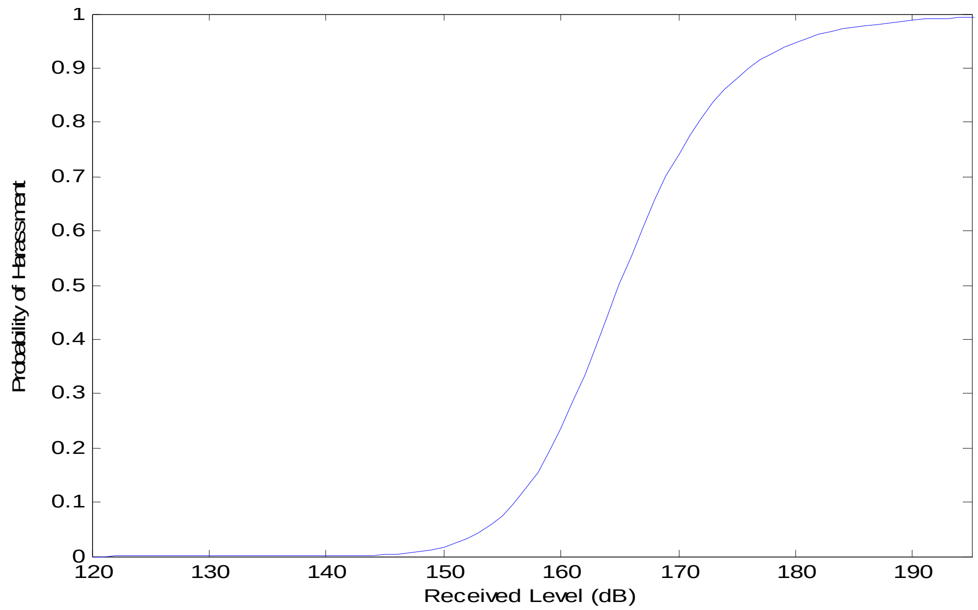


Figure 3.8-9: Risk Function Curve for Odontocetes (toothed whales) and Pinnipeds

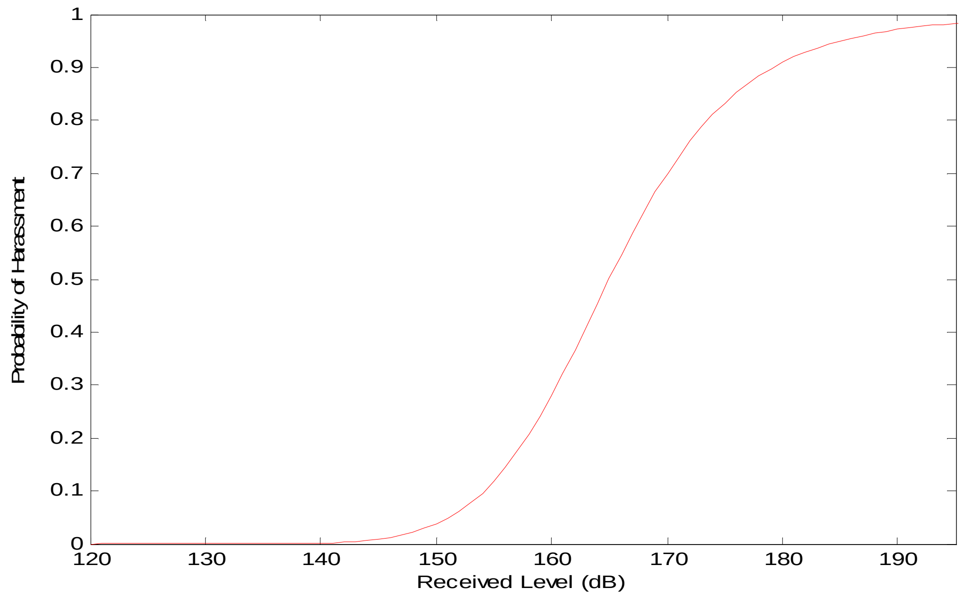


Figure 3.8-10: Risk Function Curve for Mysticetes (baleen whales)

Justification for the Steepness Parameter of A=10 for the Odontocete Curve

The NMFS independent review process described in Section 4.1.2.4.9 of DoN (2008) provided the impetus for the selection of the parameters for the risk function curves. One scientist recommended staying close to the risk continuum concept as used in the SURTASS LFA sonar EIS. This scientist opined that both the basement and slope values; B=120 dB and A=10 respectively, from the SURTASS LFA sonar risk continuum concept are logical solutions in the absence of compelling data to select alternate values supporting the Feller-adapted risk function for MFA sonar. Another scientist indicated a steepness parameter needed to be selected, but did not recommend a value. Four scientists did not specifically address selection of a slope value. After reviewing the six scientists' recommendations, the two NMFS scientists recommended selection of A=10. Direction was provided by NMFS to use the A=10 curve for odontocetes based on the scientific review of potential risk functions developed for the HRC EIS/OEIS (Section 4.1.2.4.9.2 of DoN 2008; NOAA 2009).

As background, a sensitivity analysis of the A=10 parameter was undertaken and presented in Appendix D of the SURTASS/LFA FEIS (DoN 2001). The analysis was performed to support the A=10 parameter for mysticete whales responding to a low-frequency sound source, a frequency range to which the mysticete whales are believed to be most sensitive to. The sensitivity analysis results confirmed the increased risk estimate for animals exposed to sound levels below 165 dB. Results from the Low Frequency Sound Scientific Research Program (LFS SRP) phase II research showed that whales (specifically gray whales in their case) did scale their responses with received level as supported by the A=10 parameter (Buck and Tyack, 2000). In the second phase of the LFS SRP research, migrating gray whales showed responses similar to those observed in earlier research (Malme et al. 1983, 1984) when the low frequency source was moored in the migration corridor (1.1 nm [2 km] from shore). The study extended those results with confirmation that a louder SL elicited a larger scale avoidance response. However, when the source was placed offshore (2.2 nm [4 km] from shore) of the migration corridor, the avoidance response was not evident. This implies that the inshore avoidance model – in which 50 percent of the whales avoid exposure to levels of 141 + 3 dB – may not be valid for whales in proximity to an offshore source (DoN 2001). As concluded in the SURTASS LFA Sonar Final OEIS/EIS (DoN 2001), the value of A=10 produces a curve that has a more gradual transition than the curves developed by the analyses of migratory gray whale studies (Malme et al. 1984; Buck and Tyack 2000; and SURTASS LFA Sonar EIS, Subchapters 1.43, 4.2.4.3 and Appendix D; NMFS 2008; NOAA 2009).

Justification for the steepness parameter of A=8 for the Mysticete Curve

The Nowacek et al. (2004) study provides the only available data source for a mysticete species behaviorally responding to a sound source (i.e., alert stimuli) with frequencies in the range of tactical mid-frequency sonar (1-10 kHz), including empirical measurements of received levels (RLs). While there are fundamental differences in the stimulus used by Nowacek et al. (2004) and tactical mid-frequency sonar (e.g., source level, waveform, duration, directionality, likely range from source to receiver), they are generally similar in frequency band and the presence of modulation patterns. Thus, while they must be considered with caution in interpreting behavioral responses of mysticetes to mid-frequency sonar, they seemingly cannot be excluded from this consideration given the overwhelming lack of other information. The Nowacek et al. (2004) data indicate that five out the six North Atlantic right whales exposed to an alert stimuli "significantly altered their regular behavior and did so in identical fashion" (i.e., ceasing feeding and swimming to just under the surface). For these five whales, maximum RLs associated with this response ranged from root- mean-square sound (rms) pressure levels of 133-148 dB (re: 1 µPa).

When six scientists (one of them being Nowacek) were asked to independently evaluate available data for constructing a dose response curve based on a solution adapted from Feller (1968), the majority of them (4 out of 6; one being Nowacek) indicated that the Nowacek et al. (2004) data were not only appropriate but also necessary to consider in the analysis. While other parameters associated with the solution adapted from Feller (1968) were provided by many of the scientists (i.e., basement parameter [B], increment above basement where there is 50 percent risk [K]), only one scientist provided a suggestion for the risk transition parameter, A.

A single curve may provide the simplest quantitative solution to estimating behavioral harassment. However, the policy decision, by NMFS-OPR, to adjust the risk transition parameter from A=10 to A=8 for mysticetes and create a separate curve was based on the fact the use of this shallower slope better reflected the increased risk of behavioral response at relatively low RLs suggested by the Nowacek et al. (2004) data. In other words, by reducing the risk transition parameter from 10 to 8, the slope of the curve for mysticetes is reduced. This results in an increase the proportion of the population being classified as behaviorally harassed at lower RLs. It also slightly reduces the estimate of behavioral response probability at quite high RLs, though this is expected to have quite little practical result owing to the very limited probability of exposures well above the mid-point of the function. This adjustment allows for a slightly more conservative approach in estimating behavioral harassment at relatively low RLs for mysticetes compared to the odontocete curve and is supported by the only dataset currently available. It should be noted that the current approach (with A=8) still yields an extremely low probability for behavioral responses at RLs between 133-148 dB, where the Nowacek data indicated significant responses in a majority of whales studied. (Note: Creating an entire curve based strictly on the Nowacek et al. [2004] data alone for mysticetes was advocated by several of the reviewers and considered inappropriate, by NMFS-OPR, since the sound source used in this study was not identical to tactical mid-frequency sonar, and there were only five data points available). The policy adjustment made by NMFS-OPR was also intended to capture some of the additional recommendations and considerations provided by the scientific panel (i.e., the curve should be more data driven and that a greater probability of risk at lower RLs be associated with direct application of the Nowacek et al. 2004 data).

Harbor Porpoises

The information currently available regarding these inshore species that inhabit shallow and coastal waters suggests a very low threshold level of response for both captive and wild animals. Threshold levels at which both captive (e.g. Kastelein et al. 2000, 2005b, 2006) and wild harbor porpoises (e.g. Johnston,

2002) responded to sound (e.g. acoustic harassment devices (AHDs), acoustic deterrent devices (ADDs), or other nonpulsed sound sources) is very low (e.g. ~120 dB SPL), although the biological significance of the disturbance is uncertain. Therefore, Navy has not used the risk function curve but has applied a step function threshold of 120 dB SPL to estimate MMPA Level B non-TTS behavioral harassment exposure of harbor porpoises in the TMAA (i.e., assumes that all harbor porpoises exposed to 120 dB or higher MFAS will respond in a way NMFS considers behavioral harassment).

Application of the Risk Function and Current Regulatory Scheme

The risk function is used (in all cases other than the harbor porpoise) to estimate the percentage of an exposed population that is likely to exhibit behaviors that would qualify as MMPA Level B harassment (as that term is defined by the MMPA applicable to military readiness activities, such as the Navy's training and testing with mid- and high-frequency active sonar) at a given received level of sound (NOAA 2009). For example, at 165 dB SPL (dB re: 1μPa rms), the risk (or probability) of harassment is defined according to this function as 50 percent, and Navy/NMFS applies that by estimating that 50 percent of the individuals exposed at that received level are likely to respond by exhibiting behavior that NMFS would classify as behavioral harassment (NOAA 2009). The risk function is not applied to individual animals, only to exposed populations.

The data used to produce the risk function were compiled from four species that had been exposed to sound sources in a variety of different circumstances. As a result, the risk function represents a general relationship between acoustic exposures and behavioral responses that is then applied to specific circumstances. That is, the risk function represents a relationship that is deemed to be generally true, based on the limited, best-available science, but may not be true in specific circumstances. In particular, the risk function, as currently derived, treats the received level as the only variable that is relevant to a marine mammal's behavioral response. However, we know that many other variables—the marine mammal's gender, age, and prior experience; the activity it is engaged in during an exposure event, its distance from a sound source, the number of sound sources, and whether the sound sources are approaching or moving away from the animal—can be critically important in determining whether and how a marine mammal will respond to a sound source (Southall et al. 2007). The data that are currently available do not allow for incorporation of these other variables in the current risk functions; however, the risk function represents the best use of the data that are available (NOAA 2009).

As more specific and applicable data become available, NMFS can use these data to modify the outputs generated by the risk function to make them more realistic (and ultimately, data may exist to justify the use of additional, alternate, or multi-variate functions). As mentioned above, it is known that the distance from the sound source and whether it is perceived as approaching or moving away can affect the way an animal responds to a sound (Wartzok et al. 2003, Southall et al. 2007). In the TMAA, modeling indicates animals exposed to received levels between 120 and 130 dB may be 36 to 57 nm (76 to 105 km) from a sound source; those distances would influence whether those animals might perceive the sound source as a potential threat, and their behavioral responses to that threat (DoN 2008, NOAA 2009). Though there are data showing marine mammal responses to sound sources at that received level, NMFS does not currently have any data that describe the response of marine mammals to sounds at that distance (or to other contextual aspects of the exposure, such as the presence of higher frequency harmonics), much less data that compare responses to similar sound levels at varying distances (NOAA 2009). However, if data were to become available that suggested animals were less likely to respond (in a manner NMFS would classify as harassment) to certain levels beyond certain distances, or that they were more likely to respond at certain closer distances, Navy will re-evaluate the risk function to try to incorporate any additional variables into the "take" estimates. For distances to MMPA Level B harassments from non-TTS and the percent of MMPA Level B harassments for those distances in the TMAA for an SQS-53 sonar, see Table 3.8-5 and Figure 3.8-11.

Table 3.8-5: Non-TTS MMPA Level B Harassments at Each Received Level Band in the TMAA from SQS-53 Sonar

Received Level (dB SPL)	Distance at which Levels Occur in GOA	Percent of Behavioral Harassments Occurring at Given Levels
Below 138	42 km – 105 km	~ 0 %
138<Level<144	28 km – 42 km	< 1 %
144<Level<150	17 km – 28 km	~1 %
150<Level<156	9 km – 17 km	7 %
156<Level<162	5 km – 9 km	18 %
162<Level<168	2.5 km – 5 km	26 %
168<Level<174	1.2 km – 2.5 km	22 %
174<Level<180	0.5 km – 1.2 km	14 %
180<Level<186	335 m – 0.5 km	6 %
186<Level<TTS	178 m – 335 m	5 %

Notes: dB = decibel, GOA = Gulf of Alaska, km = kilometer, TMAA = Temporary Maritime Activities Area, MMPA = Marine Mammal Protection Act, nm = nautical mile, SPL = Sound Pressure Level

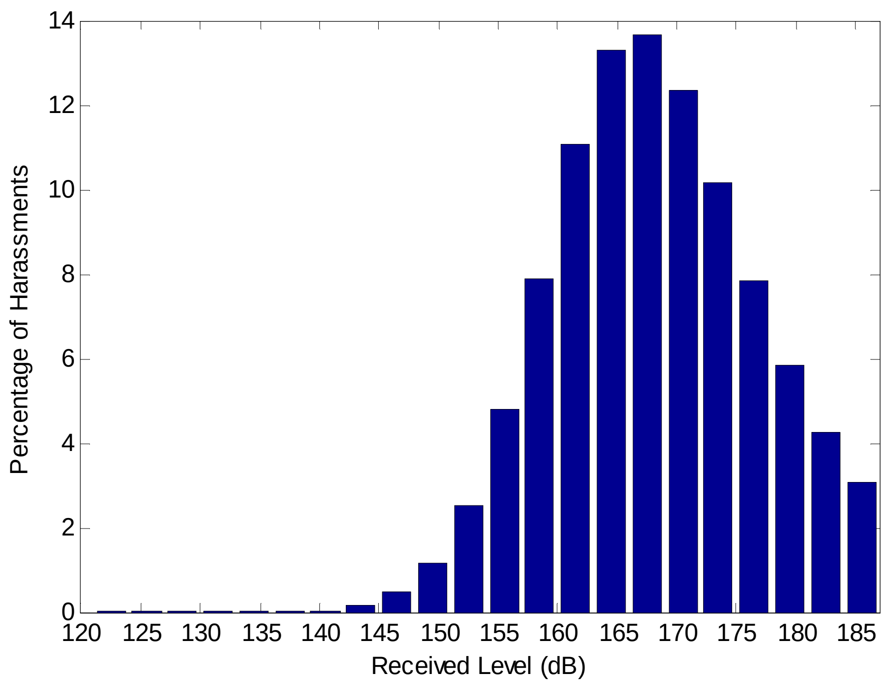


Figure 3.8-11: The Percentage of MMPA Level B Harassments from Non-TTS for Every 3 dB of Received Level in the TMAA

It is worth noting that Navy and NMFS would expect an animal exposed to the levels at the bottom of the risk function to exhibit non-TTS MMPA Level B harassment behavioral responses that are less likely to adversely affect the longevity, survival, or reproductive success of the animals that might be exposed, based on received level, and the fact that the exposures will occur in the absence of some of the other contextual variables that would likely be associated with increased severity of effects, such as the proximity of the sound source(s) or the proximity of other vessels, aircraft, submarines, etc. maneuvering in the vicinity of the exercise. NMFS will consider all available information (other variables, etc.), but all else being equal, takes that result from exposure to lower received levels and at greater distances from the exercises would be less likely to contribute to population level effects (NMFS 2008, NOAA 2009).

3.8.7.4 Navy Protocols for Acoustic Modeling Analysis of Marine Mammal Exposures

The quantification of the acoustic modeling results for sonar includes additional analysis to increase the accuracy of the number of marine mammals affected. Table 3.8-6 provides a summary of the modeling protocols used in the standard Navy analysis. Modeling for ASW and other sound generating activities in the TMAA differ from these protocols in that the annual required sonar hours data was derived from projected future needs based on input gathered during previous Northern Edge Exercise planning conferences and discussions with U.S. Navy Third Fleet training directorate. Post modeling analysis includes reducing acoustic footprints where they encounter land masses, accounting for acoustic footprints for sources that overlap to accurately sum the total area when multiple ships are operating together, and to better account for the maximum number of individuals of a species that could potentially be exposed to sound sources within the course of one day or a discreet continuous event.

Table 3.8-6: Navy Protocols Providing for Modeling Quantification of Marine Mammal Exposures to Sonar

Historical Data	Sonar Positional Reporting System (SPORTS)	Annual active sonar usage data is obtained from the SPORTS database to determine the number of active sonar hours and the geographic location of those hours for modeling purposes.
Acoustic Parameters	SQS-53 and SQS-56	The SQS-53 and the SQS-56 active sonar sources are modeled separately to account for the differences in source level, frequency, and exposure effects.
	Submarine Sonar	Submarine active sonar use during ASW or ASUW is included in effects analysis calculations using the SPORTS database.
Post Modeling Analysis	Land Shadow	For sound sources within the acoustic footprint of land, the land area is subtracted from the marine mammal exposure calculation.
	Multiple Ships	Correction factors are used to address the maximum potential of exposures to marine mammals resulting from multiple counting based on the acoustic footprint when there are occasions for more than one ship operating within approximately 76 nm (140 km) of one another.
	Multiple Exposures	Accurate accounting for TMAA training events within the course of one day or a discreet continuous sonar event:

Notes: ASW = Anti-submarine Warfare, ASUW = Anti-Surface Warfare, GOA = Gulf of Alaska, km = kilometer, TMAA = Temporary Maritime Activities Areas, nm = nautical mile

3.8.7.5 Analytical Framework for Assessing Marine Mammal Response to At-Sea Explosions

The effects of an at-sea explosion on a marine mammal depends on many factors, including the size, type, and depth of both the animal and the explosive charge; the depth of the water column; the standoff distance between the charge and the animal; and the sound propagation properties of the environment. Potential impacts can range from brief acoustic effects (such as behavioral disturbance), tactile perception, physical discomfort, slight injury of the internal organs and the auditory system, to death of the animal (Yelverton et al. 1973, O'Keeffe and Young 1984, DoN 2001). Non-lethal injury includes slight injury to internal organs and the auditory system; however, delayed lethality can be a result of individual or cumulative sublethal injuries (DoN 2001a). Short-term or immediate lethal injury would result from massive combined trauma to internal organs as a direct result of proximity to the point of detonation (DoN 2001a).

<u>**Criteria**</u>

The criterion for mortality for marine mammals is "onset of severe lung injury" as presented in the Final Rule for the Hawaii Range Complex MMPA Letter of Authorization (NOAA 2009). This is conservative in that it corresponds to a 1 percent chance of mortal injury, and yet any animal experiencing onset severe lung injury is counted as a lethal exposure.

- The threshold is stated in terms of the Goertner (1982) modified positive impulse with value "indexed to 31 psi-ms.'" Since the Goertner approach depends on propagation, source/animal depths, and animal mass in a complex way, the actual impulse value corresponding to the 31-psi-ms index is a complicated calculation. Again, to be conservative, CHURCHILL used the mass of a calf dolphin (at 26.4 pound [lb] [12.2 kilogram {kg}]), so that the threshold index is 30.5 pounds per square inch (psi)-ms (Table 3.8-7).
- Two criteria are used for injury: onset of slight lung hemorrhage and 50 percent eardrum rupture (tympanic membrane [TM] rupture). These criteria are considered indicative of the onset of injury (Table 3.8-7).
- The threshold for onset of slight lung injury is calculated for a small animal (a dolphin calf weighing 27 lb [12 kg]), and is given in terms of the "Goertner modified positive impulse," indexed to 13 psi-ms in the (DoN 2001a, 2008d). This threshold is conservative since the positive impulse needed to cause injury is proportional to animal mass, and therefore, larger animals require a higher impulse to cause the onset of injury.
- The threshold for TM rupture corresponds to a 50 percent rate of rupture (i.e., 50 percent of animals exposed to the level are expected to suffer TM rupture); this is stated in terms of an SEL value of 205 dB re 1 μPa^2-s. The criterion reflects the fact that TM rupture is not necessarily a serious or life-threatening injury, but is a useful index of possible injury that is well correlated with measures of permanent hearing impairment (e.g., Ketten 1998 indicates a 30 percent incidence of PTS at the same threshold).

Table 3.8-7: Effects Analysis Criteria for At-Sea Explosions

	Criterion	Metric	Threshold	Comments
Mortality	Mortality Onset of extensive lung hemorrhage	Shock Wave Goertner modified positive impulse	30.5 psi-msec*	All marine mammals (dolphin calf)
Level A Harassment	Slight Injury Onset of slight lung hemorrhage	Shock Wave Goertner modified positive impulse	13.0 psi-msec*	All marine mammals (dolphin calf)
	Slight Injury 50 percent Tympanic Membrane (TM) Rupture	Shock Wave Sound Exposure Level (SEL) for *any single exposure*	205 dB re:1µPa^2-sec	All marine mammals
Level B Harassment	TTS Temporary Auditory Effects	Noise Exposure greatest SEL in any 1/3-octave band *over all exposures*	182 dB re:1µPa^2-sec	For odontocetes greatest SEL for frequencies ≥100 Hz and for mysticetes ≥10 Hz
	TTS Temporary Auditory Effects	Noise Exposure Peak Pressure	23 psi	All marine mammals
	Sub-TTS Behavioral Disturbance (MSE only)	Noise Exposure greatest SEL in any 1/3-octave band *over all exposures*	177 dB re:1µPa^2-sec	For odontocetes greatest SEL for frequencies ≥100 Hz and for mysticetes ≥10 Hz

Notes: Goertner 1982. Prediction of at-sea explosion safe ranges for sea mammals. Naval Surface Weapons Center, White Oak Laboratory, Silver Spring, MD. NSWC/WOL TR-82-188. 25 pp.
Department of the Navy, 2001a. USS Churchill Shock Trail FEIS- February, 2001.
NMFS. Briefed to NMFS for VAST-IMPASS.
dB re 1µPa^2-s = decibels referenced to 1 micropascal squared per second, Hz = hertz
MSE = Multiple Successive Explosions, msec = millisecond
psi = pounds per square inch, SEL = Sound Exposure Level
TM = Tympanic membrane, TTS = Temporary Threshold Shift

The following criterion is considered for noninjurious harassment TTS, which is a temporary, recoverable, loss of hearing sensitivity (NMFS 2001, DoN 2001a, NOAA 2009).

- A threshold of 12 psi peak pressure was developed for 10,000-lb charges as part of the CHURCHILL Final EIS (DoN 2001a, [FR70/160, 19 Aug 05; FR 71/226, 24 Nov 06]). It was introduced to provide a more conservative safety zone for TTS when the explosive or the animal approaches the sea surface (for which case the explosive energy is reduced but the peak pressure is not). Navy policy with concurrence from NMFS is to use a 23 psi criterion for explosive charges less than 2,000 lb (907 kg) and the 12 psi criterion for explosive charges larger than 2,000 lb (907 kg). This is below the level of onset of TTS for an odontocete (Finneran et al. 2002). All explosives modeled for the TMAA are less than 1,500 lb (608 kg).
- A threshold of 182 dB re:1µPa^2-sec for any 1/3 octave band over all exposures

The approximate nominal radial distance from various at-sea explosives to these thresholds in the TMAA during the summer time-frame are presented In Table 3.8-7a.

Table 3.8-7a. Approximate Distance to Effects for At-Sea Explosives in the Temporary Maritime Activities Area

Explosive Source	MMPA Level B Harassment (behavioral disturbance)			MMPA Level A Harassment (slight injury)		Severe Injury or Mortality
	Sub-TTS, 177 dB re 1 μPa^2-s	TTS, 182 dB re 1 μPa2-s	TTS, 23 psi peak pressure	50 percent TM rupture, 205 dB re 1 μPa^2-s	Lung injury, 13 psi-ms	30.5 psi-ms impulse pressure
MK-82	2720	1584	809	302	263	153
MK-83	4056	2374	1102	468	330	195
MK-84	5196	3050	1327	611	378	226
76 mm	168	95	150	19	25	13
5 inch	413	227	269	43	44	23
SSQ-110A sonobuoy (EER/IEER)	NA	325	271	71	135	76

Notes: dB re 1 μPa^2-s = decibels referenced to 1 micropascal squared per second, EER = Extended Echo Ranging, IEER = Improved Extended Echo Ranging, mm = millimeters, MMPA = Marine Mammal Protection Act, psi = pounds per square inch, psi-ms= pounds per square inch per millisecond, TM = Tympanic Membrane, TTS = Temporary Threshold Shift

MMPA Level B Harassment from Sub-TTS for Multiple Successive Explosions (MSE)

There may be rare occasions when multiple successive explosions are part of a static location event such as during SINKEX, BOMBEX, or GUNEX (when using other than inert weapons). For MSEs, accumulated energy over the entire training time is the natural extension for energy thresholds since energy accumulates with each subsequent shot; this is consistent with the treatment of multiple arrivals as first presented in Churchill (DoN 2001). For positive impulse, NMFS has determined it is consistent with Churchill to use the maximum value over all impulses received (NOAA 2009).

For MSE, the acoustic criterion for sub-TTS MMPA Level B harassment is used to account for behavioral effects significant enough to be judged as harassment, but occurring at lower sound energy levels than those that may cause TTS. The threshold for MMPA Level B harassment from sub-TTS is derived following the approach NMFS has established for the energy-based TTS threshold (NOAA 2009).

The research on pure tone exposures reported in Schlundt et al. (2000) and Finneran and Schlundt (2004) provided the pure-tone threshold of 192 dB as the lowest TTS value. This value is modified for explosives by (a) interpreting it as an energy metric, (b) reducing it by 10 dB to account for the time constant of the mammal ear, and (c) measuring the energy in 1/3 octave bands, the natural filter band of the ear. The resulting TTS threshold for explosives is 182 dB re 1 mPa^2-s in any 1/3 octave band. As reported by Schlundt et al. (2000) and Finneran and Schlundt (2004), instances of altered behavior in the pure tone research generally began five dB lower than those causing TTS. The threshold is therefore derived by subtracting five dB from the 182 dB re 1 mPa^2-s in any 1/3 octave band threshold, resulting in a 177 dB re 1 μPa^2-s sub-TTS MMPA Level B harassment threshold for multiple successive explosives that may result in behavioral disturbance (NOAA 2009).

3.8.7.6 Environmental Consequences

This section discusses the potential environmental effects associated with the use of active sonar and other Navy training activities within the TMAA. In determining the potential environmental consequences, an approach was established to differentiate between significant and non-significant effects. This approach involved using either documented regulatory criteria or the best scientific information available at the time of analysis. Further, the extent of significance was evaluated using the context (e.g., short- versus long-term) of the Proposed Action and the intensity (severity) of the potential effect.

Acoustic Impact Model Process Applicable to All Alternative Discussions

The methodology for analyzing potential impacts from sonar and explosives is presented in Appendix D, which explains the modeling process in detail, describes how the impact threshold derived from Navy-NMFS consultations are derived, and discusses relative potential impact based on species biology.

The Navy acoustic exposure model process uses a number of inter-related software tools to assess potential exposure of marine mammals to Navy generated underwater sound including sonar and explosions. For sonar, these tools estimate potential impact volumes and areas over a range of thresholds for sonar specific operating modes. Results are based upon extensive pre-computations over the range of acoustic environments that might be encountered in the operating area (Appendix D).

The acoustic model includes four steps used to calculate potential exposures:

1. Identify unique acoustic environments that encompass the operating area. Parameters include depth and seafloor geography, bottom characteristics and sediment type, wind and surface roughness, sound velocity profile, surface duct, sound channel, and convergence zones.

2. Compute transmission loss (TL) data appropriate for each sensor type in each of these acoustic environments. Propagation can be complex depending on a number of environmental parameters listed in step one, as well as sonar operating parameters such as directivity, source level, ping rate, and ping length, and for explosives the amount of explosive material detonated. The standard Navy Comprehensive Acoustic Simulation System/Gaussian Ray Bundle (CASS-GRAB) acoustic propagation model is used to resolve complexities for underwater propagation prediction.

3. Use that TL to estimate the total sound energy received at each point in the acoustic environment.

4. Apply this energy to predicted animal density for that area to estimate potential acoustic exposure, with animals distributed in 3-D based on best available science on animal dive profiles.

Model Results Explanation

A large body of research on terrestrial animal and human response to airborne sound exists, but results from those studies are not readily applicable to the development of behavioral criteria and thresholds for marine mammals. Differences in hearing thresholds, dynamic range of the ear, and the typical exposure patterns of interest (e.g., human data tend to focus on 8-hour-long exposures), and the difference between acoustics in air and in water make extrapolation of human sound exposure standards inappropriate.

For purposes of predicting potential acoustic and explosive effects on marine mammals, the Navy uses an acoustic impact model process with numeric criteria agreed upon with the NMFS (NOAA 2009). While this process is described more completely in Appendix D, there are some caveats necessary to understand in order to put these exposures in context and used in recent Final Rules (NOAA 2008b, 2008c).

For instance, (1) significant scientific uncertainties are implied and carried forward in any analysis using marine mammal density data as a predictor for animal occurrence within a given geographic area; (2) there are limitations to the actual model process based on information available (animal densities, animal depth distributions, animal motion data, impact thresholds, and supporting statistical model); and (3) determination and understanding of what constitutes a significant behavioral effect is still unresolved.

The sources of marine mammal densities used in this analysis are derived from NMFS broad scale surveys. However, although survey design includes statistical placement of survey tracks, the survey itself can only cover so much ocean area and post-survey statistics are used to calculate animal abundances and densities (Barlow and Forney, 2007). There is often significant statistical variation inherit within the calculation of the final density values depending on how many sightings were available during a survey.

Occurrence of marine mammals within any geographic area, such as the TMAA, is highly variable and strongly correlated to parameters such as oceanographic conditions, prey availability, and ecosystem level patterns rather than broad changes in a stock's reproduction success and survival (Forney 2000, Ferguson and Barlow 2001, Benson et al. 2002, Moore et al. 2002, Tynan 2005, Redfern 2006). For some species, distribution may be even more highly influence by relative small scale features over both short and long-term time scales (Balance et al. 2006, Etnoyer et al. 2006, Ferguson et al. 2006, Skov et al. 2007). Unfortunately, the scientific level of understanding of some large scale and most small scale processes thought to influence marine mammal distribution is incomplete.

Given the uncertainties in marine mammal density estimation and localized distributions, the Navy's acoustic impact models can not currently be used to predict occurrence of marine mammals within specific regions of the GOA. To resolve this issue and allow modeling to proceed, animals are uniformly distributed within acoustic modeling provinces as described in Appendix D. This process does not account for animals that move into or out of the region based on foraging and migratory patterns, and adds a significant amount of variability to the model predictions. Parameters have, therefore, been chosen to err on the side of overestimation.

Results, therefore, from acoustic impact exposure models should be regarded as exceedingly conservative estimates strongly influenced by limited biological data. While numbers generated allow establishment of predicted marine mammal exposures for consultation with NMFS, the short duration and limited geographic extent of most sonar and at-sea explosive events does not necessarily mean that these exposures will in fact occur.

In addition to the predicted exposure numbers or expected values resulting from acoustic modeling, there remains the possibility, although rare, that a marine mammal may be present in the TMAA when Navy activities are occurring (rare in this context refers to a species that is few in number in the GOA).

For some species whose numbers are few but have a known abundance (e.g., sperm whale, gray whale, minke whale), acoustic modeling was completed but the results indicate no predicted exposures for at-sea explosions under any alternative. For other species (blue whale, California sea lion, harbor porpoise, harbor seal, North Pacific Right whale, and sei whale), there are no valid abundance or density estimates for the TMAA. However, even if an accurate abundance or density could be derived for these species, being so few in number in the TMAA, accepted modeling methodology will predict zero exposures (based on modeling results for species with higher abundance such as sperm and gray whale, but having no predicted exposures). To account for the possibility that harassment of rare marine mammals may occur, special consideration has been given these cases. Therefore, for each proposed 21-day exercise period, the number of behavioral harassments per rare species will be based on an assumption of having exposed the species average group size[1] to one instance of behavioral harassment to account for all at-sea explosions and one instance average group size behavioral harassment to account for all acoustic sources

[1] With regard to marine mammals, the "average group size" (sometimes also "mean group size") is a commonly reported estimate derived from data collected during a marine mammal survey. Average group size is typically defined as the estimated total number of individual animals of a species divided by the number of sightings of groups of that species. Marine mammal observers generally record best, high, and low group size estimates for each sighting. For species with highly variable group sizes, different methods can be used to derive a measure of "average group size" based on the observers' combined estimates. In addition, when survey data are used to estimate species abundance, various methods are often used to reduce the potential for bias (i.e., larger groups are easier to detect and can be over-represented in a sample) and group size estimates can be derived in a much more complex manner (see Buckland et al. 1993). Resulting average group size numbers are often integers and reported with a corresponding percent coefficient of variation (% CV) to represent the precision of the estimate. For purposes of estimating effects in this analysis, an approximate rounded average group size number is used. This number is not meant to be an accurate representation of average group size for calculating abundance and density but is used to account for the potential presence of rare animals during Navy training in the TMAA.

(e.g., sonar, pingers, EMATT) for purposes of this analysis in the TMAA. This average group size estimate was only used if there was no density data available for modeling or if modeling resulted in zero exposures for the species. Table 3.8-8 provides the average group size for rare species in the TMAA as derived or reported from the citations listed.

Table 3.8-8: Average Group Size for Rare Species in the TMAA

Species	Average Group Size - Rounded[1]	Total Encounters (number of individuals)	Reference
ESA Listed Cetacea			
Blue whale	1	15(15)	Calambokidis et al., (2009)
Humpback whale	2	11(20)	Rone et al., (2009)
North Pacific right whale	1	1(1)[2]	Angliss and Allen (2008)
Sei whale	4	-	Leatherwood et al., (1988)
Sperm whale	1[3]	-	Rone et al., (2009)
Non-ESA Listed Cetacea			
Baird's beaked whale	11[4]	n/a	Wade et al., (2003)
Gray whale	3	3(8)	Rone et al., (2009)
Harbor porpoise	2	30(89)	Rone et al., (2009)
Minke whale	2	2(3)	Rone et al., (2009)
Non-ESA Listed Pinniped			
California sea lion	1[5]	-	-
Harbor seal	1	2(2)	Rone et al., (2009)

1. Lacking otherwise published numbers for Average Group Size for marine mammals in the TMAA, the method for deriving Average Group Size for use in quantifying the potential for rare animals was to take survey data providing the total number of animals sighted and dividing that by the number of visual encounters for each species during that survey with the resulting number then rounded to a whole number.
2. Based on the sighting in GOA of one lone North Pacific right whale in with a group of humpbacks from Waite (2003).
3. Based on no sightings of family groups although numerous acoustic detections were made.
4. Based on sightings in Alaska waters (DoN 2006).
5. It is assumed given that California sea lions are very rare in GOA, that they would only be encountered individually even if a prey species was running.

Behavioral Responses

Behavioral responses to exposure from MFA and HFA sonar, other non-sonar acoustic sources, and at-sea explosions can range from no observable response to panic, flight and possibly stranding (Figure 3.8-12) (NOAA 2009). Recent behavioral response study field experiments with tagged beaked whales found their reactions to MFA sonar consisted of the animals stopping their clicking, producing fewer foraging buzzes than normal, and ending their dives in a long and an unusually slow ascent moving away from the sound source (Tyack 2009). It was further suggested based on these response studies that beaked whales may be "particularly sensitive to anthropogenic sounds, but there is no evidence that they have a special sensitivity to sonar compared with other signals" (Tyack 2009).

It has been long recognized that the intensity of the behavioral responses exhibited by marine mammals depends on a number of conditions including the age, reproductive condition, experience, behavior (foraging or reproductive), species, received sound level, type of sound (impulse or continuous) and duration of sound (Reviews by Richardson et al. 1995, Wartzok et al. 2003, Cox et al. 2006, Nowacek et al. 2007, Southall et al. 2007). Many behavioral responses may be short term (seconds to minutes) and of little immediate consequence for the animal such as simply orienting to the sound source. Alternatively, there may be a longer term response over several hours such as moving away from the sound source. In addition, some responses have the potential life function consequences such as leading to a stranding or a mother-offspring separation (Baraff and Weinrich 1994, Gabriele et al. 2001). Generally the louder the sound source the more intense the response although duration, context, and disposition of the animal are also very important (Southall et al. 2007). Exposure to loud sounds resulting from Navy training would be brief as the ship and other participants are constantly moving and the animal will likely be moving as well.

According to the severity scale response spectrum proposed by Southall et al. (2007) (Figure 3.8-12), responses classified as from 0-3 are brief and minor, those from 4-6 have a higher potential to affect foraging, reproduction, or survival and those from 7-9 are likely to affect foraging, reproduction and survival. Sonar and explosive mitigation measures (sonar power-down or shut-down zones and explosive exclusion zones) would likely prevent animals from being exposed to the loudest sonar sounds or explosive effects that could potentially result in TTS or PTS and more intense behavioral reactions (i.e. 7-9) on the response spectrum.

There are little data on the consequences of sound exposure on vital rates of marine mammals. Several studies have shown the effects of chronic noise (either continuous or multiple pulses) on marine mammal presence in an area exposed to seismic survey airguns or ship noise (e.g., Malme et al. 1984, McCauley et al. 1998, Nowacek et al. 2004). MFA sonar use in Navy ranges is not new and has occurred using the same basic sonar equipment and output for over approximately 30 years. Given this history the Navy believes that risk to marine mammals from sonar training is low.

Even for more cryptic species such as beaked whales, the main determinant of causing a stranding appears to be exposure in a limited egress area (a long narrow channel) with multiple ships. This would be consistent with the recent suggestion that beaked whales are not particularly sensitive to sonar but tend to move away from all anthropogenic noise (Tyack 2009). When animals are unable to avoid the exposure because of constructed bathymetry and multiple ships, in these specific circumstances and conditions MFA sonar is believed to have contributed to the stranding and mortality of a small number of beaked whales in locations other than the GOA. There are no limited egress areas (long narrow channels) or landmasses within the TMAA, therefore, it is unlikely that the proposed sonar use would result in any strandings. Although the Navy has substantially changed operating procedures to avoid the aggregate of circumstances that may have contributed to previous strandings, it is important that future unusual stranding events be reviewed and investigated so that any human cause of the stranding can understood and avoided.

There have been no known beaked whale strandings in the GOA associated with the use of MFA/HFA sonar by fisheries research activities or seismic research. There are critical contextual difference between the TMAA and areas of the world where beaked whale strandings have occurred (see Appendix F). While the absence of evidence does not prove there have been no impacts on beaked whales, decades of use of sonar in Navy concentration areas (e.g., Southern California, the Atlantic Coast, Gulf of Mexico) with no observed beaked whale strandings associated with MFA sonar, or indications of significant effects to species or populations of beaked whales has been given consideration.

0 -No observable response

1 -Brief orientation response (investigation / visual orientation)

2 -Moderate or multiple orientation behaviors
-Brief or minor cessation/ modification of vocal behavior
-Brief or minor change in respiration rates

3 -Prolonged orientation behavior
-Individual alert behavior
-Minor changes in locomotion speed, direction, and/or dive profile but no avoidance of sound source
-Moderate change in respiration rate
-Minor cessation or modification of vocal behavior (duration < duration of source operation), including the Lombard Effect

1-3 DEFINED BY NMFS AS NO MMPA BEHAVIORAL HARASSMENT

4 -Moderate changes in locomotion speed, direction, and/or dive profile, but no avoidance of sound source
-Brief, minor shift in group distribution
-Moderate cessation or modification of vocal behavior (duration approx duration of source operation)

5 -Extensive or prolonged changes in locomotion speed, direction, and/or dive profile but not avoidance of sound source
-Moderate shift in group distribution
-Change in inter-animal distance and/or group size (aggregation or separation)
-Prolonged cessation or modifications of vocal behavior (duration > duration of source operation)

6 -Minor or moderate individual and/or group avoidance of sound source
-Brief or minor separation of females and dependent offspring
-Aggressive behavior related to noise exposure (e.g., tail/flipper slapping, fluke display, jaw clapping/ gnashing teeth, abrupt directed movement, bubble clouds)
-Extended cessation or modification of vocal behavior
-Visible startle response
-Brief cessation of reproductive behavior

7 -Excessive or prolonged aggressive behavior
-Moderate separation of females and dependent offspring
-Clear anti-predator response
-Severe and/ or sustained avoidance of sound source
-Moderate cessation of reproductive behavior

8 -Obvious aversion and/or progressive sensitization
-Prolonged or significant separation of females and dependent offspring with disruption of acoustic reunion mechanisms
-Long-term avoidance of area (> source operation)
-Prolonged cessation of reproductive behavior

9 -Outright panic, flight, stampede, attach of conspecifics, or stranding events
-Avoidance behavior related to predator detection

7-9 DEFINED BY NMFS AS MMPA BEHAVIORAL HARASSMENT Plus subset behaviors in 4 to 6 depending on context of behavior

Figure 3.8-12: Marine Mammal Response Spectrum to Anthropogenic Sounds (Numbered severity scale for ranking observed behaviors from Southall et al. 2007)

TTS

A TTS is a temporary recoverable, loss of hearing sensitivity over a small range of frequencies related to the sound source to which it was exposed. The animal may not even be aware of the TTS and does not become deaf, but requires a louder sound stimulus (relative to the amount of TTS) to detect that sound within the affected frequencies. TTS may last several minutes to several days and the duration is related to the intensity of the sound source and the duration of the sound (including multiple exposures). Sonar exposures from ASW training are generally short in duration and intermittent (several sonar pings per minute from a moving ship), and with mitigation measures in place, TTS in marine mammals exposed to MFA or HFA sonar or other sound sources and at-sea explosions are unlikely to occur. There is currently no information to suggest that if an animal has TTS, that it will decrease the survival rate or reproductive fitness of that animal. TTS range from an SQS-53 sonar's 235 dB source level one second ping is approximately 584 ft (178 m) from the bow of the ship under nominal oceanographic conditions during the summer in the TMAA.

PTS

A PTS is non-recoverable, results from the destruction of tissues within the auditory system and occurs over a small range of frequencies related to the sound exposure. The animal does not become deaf but requires a louder sound stimulus (relative to the amount of PTS) to detect that sound within the affected frequencies. Sonar exposures are general short in duration and intermittent (several sonar pings per minute from a moving ship), and with mitigation measures in place, PTS in marine mammals exposed to MFA or HFA sonar is very unlikely to occur. There is currently no information to suggest that if an animal has PTS that it decrease the survival rate or reproductive fitness of that animal. The distance to PTS from an SQS-53 sonar's 235 dB source level and one second ping is approximately 33 ft (10 m) from the bow of the ship under nominal oceanographic conditions in the TMAA.

Population Level Effects

Some Navy training activities will be conducted in the same general areas across the 42,146 nm^2 (145,482 km^2) of the TMAA over a 21-day (maximum) exercise period, so marine mammal populations could be exposed to activities more than once over the period of the exercise. The acoustic analyses assume that short-term non-injurious sound levels predicted to cause TTS and/or non-TTS behavioral disruptions qualify as MMPA Level B harassment. Based on previous findings from NMFS, however, it is unlikely that most behavioral disruptions or instances of TTS will result in long-term significant effects (NMFS 2008, NOAA 2009). Mitigation measures reduce the likelihood of exposures to sound levels that would cause significant behavioral disruption (the higher levels of 7-9 in Figure 3.8-12), TTS or PTS. Based on acoustic modeling the Navy has estimated that a total of 420,342 marine mammals per year might be behaviorally disturbed resulting in MMPA Level B harassment from the proposed training activities in the TMAA. The Navy does not anticipate any mortality to result from the proposed training. It is unlikely that the short-term behavioral disruption would adversely affect the species or stock through effects on annual rates of recruitment or survival.

Acoustic Effects Analysis

The impacts on marine mammals from at-sea explosions are based on a modeling approach that considers several factors to ensure an accurate estimation of effects by species.

The impact areas of the at-sea explosions are derived from mathematical calculations and models that predict the distances to which threshold noise levels would travel. The equations for the models consider the amount of net explosive, the properties of detonations under water, and environmental factors such as depth of the explosion, overall water depth, water temperature, and bottom type.

The result of the analysis is an area known as the Zone of Influence (ZOI). A ZOI is based on an outward radial distance from the point of detonation, extending to the limit of a particular threshold level in a 360-degree area. Thus, there are separate ZOIs for mortality, injury (hearing-related injury and slight, nonfatal lung injury), and harassment (temporary threshold shift, or TTS, and sub-TTS). The ZOIs are also influenced by the body size and species of marine mammal exposed. Given the radius, and assuming noise spreads outward in a spherical manner, the entire area ensonified (i.e., exposed to the specific noise level being analyzed) is estimated. The radius is assumed to extend from the point of detonation in all directions, allowing calculation of the affected area.

The number of marine mammal takes is estimated by applying marine mammal density to the ZOI (area) for each detonation type. Species density for the more abundant marine mammals is presented in Tables 3.8-1 and 3.8-2. This derived density data were input into the modeling with factors applied to account for the species specific dive behaviors, as detailed in Appendix D and E. By combining marine mammal density and dive behaviors, a more accurate prediction of acoustic exposure is possible. The model-specific adjustments applied for each type of detonation are described in the following paragraphs.

At-sea explosives detonated underwater introduce loud, impulsive, broadband sounds into the marine environment. Three source parameters influence the effect of an explosive: the weight of the explosive, the type of explosive material, and the detonation depth. The net explosive weight (or NEW) accounts for the first two parameters. The NEW of an explosive is the weight of only the explosive material in a given round, referenced to the explosive power of TNT.

The detonation depth of an explosive is particularly important due to a propagation effect known as surface-image interference increasingly. For sources located near the sea surface, a distinct interference pattern arises from the coherent sum of the two paths that differ only by a single reflection from the pressure-release surface. As the source depth and/or the source frequency decreases, these two paths increasingly, destructively interfere with each other, reaching total cancellation at the surface (barring surface-reflection scattering loss).

For the TMAA, explosive sources having detonations in the water include the following: SSQ-110 EER sonobuoys, MK-82, MK-83, MK-84 bombs, 5” and 76 mm gunnery rounds, MK-48 torpedo, and the Maverick missile. The EER source can be detonated at several depths within the water column. For the modeling analysis, a relatively shallow depth of 65 ft (20 m) was used to optimize the likelihood of the source being positioned in a surface duct. A source depth of two meters was used for bombs and missiles that do not strike their target. The MK-48 torpedo detonates immediately below the target’s hull and a nominal depth of 50 ft (14 m) was used as its source depth in this analysis. For the gunnery rounds, a source depth of one foot was used. The NEW modeled for these sources are as follows:

- SSQ-110 sonobuoy - 4.4 lb (2 kg)
- MK-82 bomb - 238 lb (108 kg),
- MK-83 bomb - 416 lb (189 kg)
- MK-84 bomb – 945 lb (429 kg)
- 5” rounds – 9.5 lb (4.3 kg),
- 76 mm rounds – 1.6 lb (0.7 kg)
- MK-48 torpedo – 851 pounds (386 kg)
- Maverick missile – 78.5 lb (36 kg)

The exposures expected to result from these sources are computed on a per in-water explosive basis. The cumulative effect of a series of explosives can often be derived by simple addition if the detonations are spaced widely in time (exceeding 24 hours per the NMFS threshold for multiple successive explosions) or space, allowing for sufficient animal movements to ensure a different population of animals is considered for each detonation (NOAA 2009).

GUNEX

Modeling was completed for surface gunnery exercises that take place in the open ocean to provide gunnery practice for Navy ship crews. Exercises can involve a variety of surface targets that are either stationary or maneuverable. Gun systems employed against surface targets include the 5-inch, 76mm, 57mm, 25mm, 20mm, .50-caliber, and the 7.62mm (only a small percentage of the 5-inch and 76mm rounds are inert). The ZOI, for explosives when multiplied by the estimated animal densities and total number of events, provides exposure estimates for that animal species for the given gunnery system using live ordnance.

BOMBEX

Modeling was completed for three explosive weights involved in BOMBEX, each assumed detonation at 3.3-ft (1-m) depth. The NEW used in simulations of the MK82, MK83, and MK84 explosives are 192.2 lb (87.2 kg), 415.8 lb (188.6 kg), 944.7 lb (428.5 kg), respectively. The ZOI, when multiplied by the estimated animal densities and total number of events, provides exposure estimates for that animal species for the given bomb source.

SSQ-110 Sonobuoys

Modeling was completed for use of SSQ-110 sonobuoys, which have a charge totaling 4.4 lb (2 kg) for each of two detonations. The ZOI for the detonation is then multiplied by the estimated animal densities and total number of events, provides exposure estimates for that animal species for the use of SSQ-110 sonobuoys for each alternative.

Impact Thresholds

In addition to the impact thresholds described previously, this EIS/OEIS analyzes potential effects to marine mammals in the context of the MMPA, ESA (listed species only), and EO 12114 where applicable. The factors used to assess the significance of effects vary under these Acts and are discussed below.

For purposes of compliance with the MMPA, effects of the action were analyzed to determine if an alternative would result in Level A harassment or Level B harassment of marine mammals based on previous standards established by NMFS (NOAA 2009). For military readiness activities under the MMPA, the relevant definition of harassment is any act that:

- Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment).
- Disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered (Level B harassment) [16 U.S.C. 1362 (18)(B)(i)(ii)].
- For purposes of MMPA compliance, exceeding the modeled exposure of 0.5 animals presumes a “take” and requires Navy Action Proponents to seek authorization from the appropriate regulatory agency.

For purposes of ESA compliance, effects of the action were analyzed to make a determination of effect for listed species (for example, no effect or may affect). The definitions used in making the determination of effect under Section 7 of the ESA are based on the USFWS and NMFS *Endangered Species Consultation Handbook* (USFWS and NMFS 1998), and recent NMFS Biological Opinions involving the same activities and many of the same species in the Pacific (e.g., NMFS 2008, 2009b).

- "No effect" is the appropriate conclusion when a listed species or its designated critical habitat will not be affected, either because the species will not be present or because the project does not have any elements with the potential to affect the species or modify designated critical habitat. "No effect" does not include a small effect or an effect that is unlikely to occur.
- If effects are insignificant (in size) or discountable (extremely unlikely), a "may affect" determination is appropriate. Insignificant effects relate to the magnitude or extent of the impact (for example, they must be small and would not rise to the level of a take of a species).
- For ESA protected marine mammals, if quantitative analysis indicates a modeled exposure exceeds 0.05 protected marine mammals, then there is a presumption that the proposed activity "may affect" the protected marine mammal thus triggering consultation with the appropriate regulatory agency pursuant to reference.
- Discountable effects are those extremely unlikely to occur and based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.

For purposes of ESA compliance relative to listed critical habitats and as noted previously, there is no designated critical habitat in the TMAA.

Collisions with Whales

Vessel collisions are an acknowledged source of mortality and injury to all large whales. A discussion of the information available regarding collisions or "ship strikes" as related to individual large whale species in the TMAA has been presented in Sections 3.8.3 and 3.8.4.

Under the preferred alternative and with regard to annual Navy vessel traffic, the Navy has proposed providing the flexibility to conduct (as required) a second summer exercise within the TMAA between 2010 and 2015. Within the maximum two summer exercises, the length of the exercise, the number of vessels, and the allotted at-sea time within the TMAA during an exercise will be variable between years. These variations cannot be predicted given unknowns including the availability of participants for the annual exercise(s), which is a direct result of factors such as Navy responses to real-world events (e.g., tactical deployments, disaster relief, humanitarian assistance, etc.), planned and unplanned deployments, vessel availability due to funding and maintenance cycles, and logistic concerns with conducting an exercise in the GOA. The Navy predicts, however, there will be no increase required in excess of two annual summer exercises as described for Alternative 2 over the course of the 2010 and 2015 timeframe such that it is unlikely increases in steaming days would occur during this time period.

The following paragraphs present a context and assessment for the potential for Navy ship strikes in the TMAA. Accurate data regarding vessel collisions with whales is difficult for several reasons but mainly due to a lack of mandatory reporting by vessels other than the U.S. Navy and Coast Guard (Navy and Coast Guard report all whale collisions to NMFS as a standard procedure). As a result, historic trends, annual rates of collision, and, most importantly, the effect vessel collisions may have on particular stocks of whales or other marine mammals remain unknown.

The Navy requires reporting of all collisions involving marine mammals. While recognizing Navy activity in the TMAA has previously involved no more than an annual brief three-week period in the summer, there have been no known collisions, referred to as "ship strikes" by Navy vessels in Alaska waters over many years of operation.

Reviews of the record, involving mostly commercial vessel collisions between ships and whales have been published (e.g., Laist et al., 2001, Jensen and Silber 2004). However, Navy vessel operations differ from commercial vessels in a number of ways important to the prevention of whale collisions. Navy surface ships maintain a constant, 24/7 navigation watch with dedicated lookouts while underway. The Navy has developed a Marine Species Awareness Training, which is required for all lookouts and is designed to recognize marine mammal cues to assist in avoiding potential collisions with whales. In addition to lookouts, there are often other watchstanders such as ship officers and supervisory personnel, as well as lookouts responsible for safe navigation and avoidance of in-water objects (marine mammals, other vessels, flotsam, marine debris, etc.). There are numerous reports from Navy transits and exercises in other locations involving the detection of whales with vessels subsequently proactively maneuvering to avoid a collision with a whale. For the safety of the crew, stewardship of marine mammals, and to avoid damage to vessels, the Navy does what it can to avoid ship strikes.

For Alaska waters, the available whale-vessel collision data has been presented in an unpublished preliminary summary (Gabriele et al., manuscript on file). The summary presents an opportunistically collected record containing reports of 62 whale-vessel collisions between 1978 and 2006 with most occurring in Southeast Alaska. This report is likely biased toward near shore reports and inland waters of Southeast Alaska where the authors were located and where nearshore vessels and a population of humpback whales overlap. Only one collision was recorded within the TMAA (involving a fishing vessel/sperm whale). As is evident from the Alaska record, most known collisions in Alaska waters involve humpback whales, although worldwide historical records indicate fin whales were the most likely species to be struck (Laist et al 2001). Most of the TMAA is above deep water and well offshore, which is not the preferred habitat for humpback whales, but is an area where fin whales or other species may certainly be present.

The following Navy requirements are intended to reduce the likelihood of a collision with whales. Naval vessels will maneuver to keep at least 1,500 ft (500 yds) away from any observed whale in the vessel's path and avoid approaching whales head-on. These requirements do not apply if a vessel's safety is threatened, such as when change of course will create an imminent and serious threat to a person, vessel, or aircraft, and to the extent vessels are restricted in their ability to maneuver. Vessels will take all practicable steps to alert other vessels in the vicinity of the whale.

In summary, fin, humpback and other large whales may be present in the TMAA, but the sparse available data on whale-vessel collisions indicates that collisions are unlikely overall. The risk of collision is further reduced by the short duration of the exercise, Navy protocols for maintaining a lookout at all times, and maneuvering to avoid whales when possible. Given these factors, it is unlikely that Navy training activities in the TMAA would result in a collision with a whale.

3.8.7.7 No Action Alternative

Vessel Movements

Overview

Many of the ongoing and proposed activities within the TMAA involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels). Under the No Action Alternative there would be four military combatant surface ships participating in training activities plus up to approximately 19 contracted fishing vessels. Potential variations in these maximum number of vessels participating cannot be predicted given unknowns including the availability of vessels for the annual exercise(s), which is a direct result of factors such as Navy responses to real-world events (e.g., tactical deployments, disaster relief, humanitarian assistance, etc.), planned and unplanned deployments, vessel availability due to funding and maintenance cycles, and logistic concerns with conducting an exercise in the GOA.

Disturbance Associated with Vessel Movements

Vessel movements have the potential to affect marine mammals by directly striking or disturbing individual animals. The probability of vessel and marine mammal interactions occurring in the TMAA is dependent upon several factors including numbers, types, and speeds of vessels; the regularity, duration, and spatial extent of activities; the presence/absence and density of marine mammals; and protective measures implemented by the Navy. During training activities, speeds vary and depend on the specific training activity. In general, Navy vessels will move in a coordinated manner but separated by many miles in distance. These activities are widely dispersed throughout the TMAA, which is a vast area encompassing 42,146 nm^2 (145,458 km^2). Consequently, the density of Navy vessels within the TMAA at any given time is extremely low.

Marine mammals are frequently exposed to vessels traffic as a result of commercial fishing activities, research, ecotourism, commercial and private vessel traffic. The presence of vessels has the potential to alter the behavior patterns of marine mammals. It is difficult to differentiate between responses to vessel sound and visual cues associated with the presence of a vessel; thus, it is assumed that both play a role in prompting reactions from animals (NMFS 2008). Anthropogenic sound has increased in the marine environment over the past 50 years as a result of increased vessel traffic, marine dredging and construction, oil and gas drilling, geophysical surveys, sonar, and at-sea explosions (Richardson et al. 1995, NRC 2003). Vessel strikes are rare, but do occur and can result in injury (NMFS 2008).

Marine mammals react to vessels in a variety of ways and seem to be generally influenced by the activity the marine mammal is engaged in when a vessel approaches (Richardson et al. 1995). Some respond negatively by retreating or engaging in antagonistic responses while other animals ignore the stimulus altogether (Watkins 1986, Terhune and Verboom 1999). The ESA-listed marine mammal species (blue, fin, humpback, North Pacific right, sei, and sperm whales; and Steller sea lion) that occur in the TMAA are not generally documented to approach vessels in their vicinity. The predominant reaction is either neutral or avoidance behavior, rather than attraction behavior. If available, additional information regarding each listed species is provided below.

Blue and Sei Whales

There is little information on blue whale or sei whale response to vessel presence (NMFS 1998a, 1998b). Sei whales have been observed ignoring the presence of vessels and passing close to the vessel (Weinrich et al. 1986). The response of blue and sei whales to vessel traffic is assumed to be similar to that of the other baleen whales, ranging from avoidance maneuvers to disinterest in the presence of vessels. Any behavioral response would be short-term in nature.

Fin and Humpback Whales

Fin whales have been observed altering their swimming patterns by increasing speed, changing their heading, and changing their breathing patterns in response to an approaching vessel (Jahoda et al. 2003). Observations have shown that when vessels remain 328 ft (100 m) or farther from fin and humpback whales, they were largely ignored (Watkins et al. 1981). Only when vessels approached more closely did the fin whales in the study altered their behavior by increasing time at the surface and engaging in evasive maneuvers. The humpback whales did not exhibit any avoidance behavior (Watkins et al. 1981). However, in other instances humpback whales did react to vessel presence. In a study of regional vessel traffic, Baker et al. (1983) found that when vessels were in the area, the respiration patterns of the humpback whales changed. The whales also exhibited two forms of behavioral avoidance when vessels were between 0 and 6,562 ft (2,000 m) away (Baker et al. 1983): 1) horizontal avoidance (changing direction and/or speed) when vessels were between 6,562 ft (2,000 m) and 13,123 ft (4,000 m) away, or 2) vertical avoidance (increased dive times and change in diving pattern).

Based on existing studies, it is likely that fin and humpback whales would have little reaction to vessels that maintain a reasonable distance from the animals[2]. The distance that will provoke a response varies based on many factors including, but not limited to, vessel size, geographic location, and individual animal tolerance levels (Watkins et al. 1981, Baker et al. 1983, Jahoda et al. 2003). Should the vessels approach close enough to invoke a reaction, animals may engage in avoidance behaviors and/or alter their breathing patterns. Reactions exhibited by the whales would be temporary in nature. They would be expected to return to their pre-disturbance activities once the vessel has left the area.

North Pacific Right Whales

Although very little data exists examining the relationship between vessel presence and significant impact to North Pacific right whales, it is thought that any disturbance impacts would be minor and/or temporary in nature (NMFS 2005). In the North Pacific, ship strikes may pose a potential threat to North Pacific right whales. However, because of their rare occurrence and scattered distribution, it is impossible to assess the threat of ship strikes to this species at this time. For these reasons, NMFS has not identified ship collisions as major threat because the estimated annual rate of human-caused mortality and serious injury appears minimal (NMFS: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/rightwhale_northpacific.htm, accessed May 30, 2008). Through 2002, there were no reports of ship strikes of North Pacific right whales by large ships along the U.S. West Coast and Canada (Jensen and Silber 2003). In addition, North Pacific right whales are protected through measures such as the 500-yard (1,500-m) no-approach limit, which affords them additional protection and further alleviates any effect vessel traffic might have on behavior or distribution (NMFS 1997).

Sperm Whale

Sperm whales generally show little to no reaction to ships, except on close approaches (within several hundred meters); however, some did show avoidance behavior such as quick diving (Würsig et al. 1998). In addition, in the presence of whale watching and research boats, changes in respiration and echolocation patterns were observed in male sperm whales (Richter et al. 2006). Disturbance from boats did not generally result in a change in behavior patterns and is short-term in nature (Magalhães et al. 2002).

Killer Whale

In Washington and British Columbia beginning in the late 1970s, whale watching involving mainly killer whales has become an important regional tourist industry. Both commercial and private vessels engage in whale watching. The number of vessels engaged in this activity increased from a few boats and fewer than 1,000 passengers annually in the early 1980s to about 41 companies with 76 boats and more than 500,000 passengers annually in 2006 (Koski 2007). The growth of whale watching during the past 20 years has meant that killer whales in the region are experiencing increased exposure to vessel traffic. Not only do greater numbers of boats accompany the whales for longer periods of the day, but there has also been a gradual lengthening of the viewing season. Several studies have linked vessels with short-term behavioral changes in northern and southern resident killer whales (Kruse 1991, Kriete 2002, Williams et al. 2002, Bain et al. 2006), although whether it is the presence and activity of the vessel, the sounds of the vessel or a combination these factors is not well understood. Individual whales have been observed to react in a variety of ways to whale-watching vessels. Responses include swimming faster, adopting less predictable travel paths, making shorter or longer dives, moving into open water, and altering normal

[2] Regulations governing approach distances to humpback whales in Alaska waters were promulgated by NMFS in 2001 (NOAA 2001b).

patterns of behavior at the surface (Kruse 1991, Williams et al. 2002, Bain et al. 2006), while in some cases, no disturbance seems to occur. Avoidance tactics often vary between encounters and the sexes, with the number of vessels present and their proximity, activity, size, and “loudness” affecting the reaction of the whales (Williams et al. 2002). Avoidance patterns often become more pronounced as boats approach closer.

The potential impacts of whale watching on killer whales remain controversial and inadequately understood. Although numerous short-term behavioral responses to whale watching vessels have been documented, no studies have yet demonstrated a long-term adverse effect from whale watching on the health of any killer whale population in the northeastern Pacific (NMFS 2008). There are no reported instances of killer whale strikes, mortality, or injury reported because of these vessel activities (NMFS 2008).

Delphinids

Species of delphinids can vary widely in their reaction to vessels. Many exhibit mostly neutral behavior, but there are frequent instances of observed avoidance behaviors (Hewitt 1985, Würsig et al. 1998). In addition, approaches by vessels can elicit changes in behavior, including a decrease in resting behavior or change in travel direction (Bejder et al. 2006). Alternately, many of the delphinid species exhibit behavior indicating attraction to vessels. This can include solely approaching a vessel (observed in harbor porpoises and minke whales) (David 2002), but many species such as common, rough-toothed and bottlenose dolphins are frequently observed bow riding or jumping in the wake of a vessel (Norris and Prescott 1961, Shane et al. 1986, Würsig et al. 1998, Ritter 2002). While this is also a regular occurrence wit Navy vessels, in the past, this also occurred when Navy vessels when using mid-frequency active sonar (current mitigation measures now preclude this from occurring). These behavioral alterations are short-term and would not result in any lasting effects.

Summary

If vessel traffic related to the proposed activity passed near marine mammals, this would only occur on an incidental basis. Most of the studies mentioned previously examine the reaction of animals to vessels that approach and intend to follow or observe an animal (i.e., whale watching vessels, research vessels, etc.). Reactions to vessels not pursuing the animals, such as those transiting through an area or engaged in training exercises, may be similar but would likely result in less stress to the animal because they would not intentionally approach animals. In fact, Navy mitigation measures include several provisions to avoid approaching marine mammals (see Section 5.1.7 for a detailed description of mitigation measures). As previously noted, all quick avoidance maneuvers are short-term alterations and not expected to permanently impact an animal. Most studies have ascertained the short-term response to vessel sound and vessel traffic (Watkins et al. 1981, Baker, et al. 1983, Magalhães et al. 2002); however, the long-term implications of ship sound on marine mammals is largely unknown (NMFS 2007).

Marine mammals exposed to a passing Navy vessel may not respond at all, or they could exhibit a short-term behavioral response, but not to the extent where natural behavioral patterns would be abandoned or significantly altered. Human disturbance to wild animals may elicit similar reactions to those caused by natural predators (Gill et al. 2001, Beale and Monaghan 2004). Behavioral responses may also be accompanied by a physiological response (Romero 2004), although this is very difficult to study in the wild. Short-term exposures to stressors result in changes in immediate behavior (Frid 2003). Repeated exposure to stressors, including human disturbance such as vessel disturbance and anthropogenic sound, can result in negative consequences to the health and viability of an individual or population. Chronic stress can result in decreased reproductive success (Lordi et al. 2000, Beale and Monaghan 2004), decreased energy budget (Frid 2003), displacement from habitat (Southerland and Crockford 1993), and lower survival rates of offspring (Lordi et al. 2000). At this time, it is unknown what the long-term implications of chronic stress may be on marine mammal species.

Vessel movements under the No Action Alternative are not expected to result in chronic stress because, as discussed above, Navy vessel density in the TMAA would remain low and the Navy implements mitigation measures to avoid marine mammals. General disturbance associated with vessel movements may affect ESA-listed marine mammals. It is not likely that disturbance associated with vessel movements during training activities would result in effects to the life functions of marine mammals in the TMAA. This same disturbance is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, harm to marine mammals from vessel disturbance in nonterritorial seas (seaward of 12 nm [22 km]) would be minimal. The Navy is working with NMFS through the ESA consultation and MMPA permitting processes accordingly.

Vessel Collisions with Marine Mammals

Based on the implementation of Navy mitigation measures and the relatively low density of Navy ships in the TMAA, it is very unlikely that a vessel collision would occur under the No Action Alternative. It is therefore unlikely that vessel movements associated with training activities would result in effects to the life functions of marine mammals in the TMAA. Because the possibility cannot be categorically dismissed, a vessel collision may affect large whales (mysticetes and sperm whales) in the TMAA. Vessel movement may affect Steller sea lions but collisions are not likely. There are no training activities taking place in territorial seas (shoreline to 12 nm [22 km]). Vessel collisions in nonterritorial seas (seaward of 12 nm [22 km]) are not anticipated and would not cause significant harm to marine mammal stocks or populations in accordance with EO 12114. The Navy is working with NMFS through the ESA consultation and MMPA permitting processes accordingly.

Aircraft Overflights

Overview

Various types of fixed-wing aircraft and helicopters are used in training exercises throughout the TMAA. These aircraft overflights would produce airborne noise and some of this energy would be transmitted into the water. Marine mammals could be exposed to noise associated with subsonic and supersonic fixed-wing aircraft overflights and helicopter activities while at the surface or while submerged. In addition to sound, marine mammals could react to the shadow of a low-flying aircraft and/or, in the case of helicopters, surface disturbance from the downdraft.

Transmission of sound from a moving airborne source to a receptor underwater is influenced by numerous factors and has been addressed by Urick (1972), Young (1973), Richardson et al. (1995), Eller and Cavanagh (2000), Laney and Cavanagh (2000), and others. Sound is transmitted from an airborne source to a receptor underwater by four principal means:

- Direct path, refracted upon passing through the air-water interface;
- Direct-refracted paths reflected from the bottom in shallow water;
- Lateral (evanescent) transmission through the interface from the airborne sound field directly above; and
- Scattering from interface roughness due to wave motion.

Aircraft sound is refracted upon transmission into water because sound waves move faster through water than through air (a ratio of about 0.23:1). Based on this difference, the direct sound path is totally reflected if the sound reaches the surface at an angle more than 13 degrees from vertical. As a result, most of the acoustic energy transmitted into the water from an aircraft arrives through a relatively narrow cone with a 26 degree apex angle extending vertically downward from the aircraft (Figure 3.8-13). The intersection of this cone with the surface traces a "footprint" directly beneath the flight path, with the width of the footprint being a function of aircraft altitude.

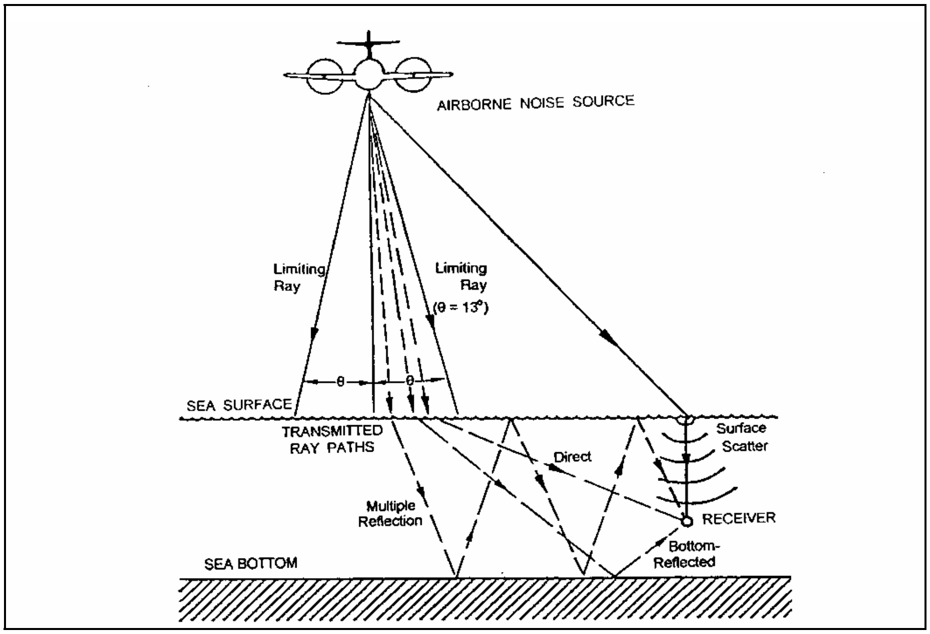


Figure 3.8-13: Characteristics of Sound Transmission through Air-Water Interface

The sound pressure field is actually doubled at the air-to-water interface because the large difference in the acoustic properties of water and air. For example, a sonic boom with a peak pressure of 10 pounds per square foot (48.8 kg/square meter [m^2]) at the sea surface becomes an impulsive wave in water with a maximum peak pressure of 20 pounds per square foot (97.6 kg/m^2). The pressure and sound levels then decrease with increasing depth.

Eller and Cavanagh (2000) modeled estimates of SPL as a function of time at selected underwater locations (receiver animal depths of 7 ft [2 m], 33 ft [10 m], and 164 ft [50 m]) for F-18 aircraft subsonic overflights (250 knots [463 km/hr]) at various altitudes (984 ft [300 m], 3,281 ft [1,000 m], and 9,842 ft [3,000 m]). As modeled for all deep water scenarios, the sound pressure levels ranged from approximately 120 to 150 dB re 1 µPa] in water. They concluded that it is difficult to construct cases (for any aircraft at any altitude in any propagation environment) for which the underwater sound is sufficiently intense and long lasting to cause harm to any form of marine life.

The maximum overpressures calculated for FA-18 aircraft supersonic overflights range from 5.2 pounds per square foot (psf) (25.4 kg/m^2) at 10,000 ft (3,048 m) to 28.8 psf (140.6 kg/m^2) at 1,000 ft (305 m) (Ogden 1997). Considering an extreme case of a sonic boom that generates maximum overpressure of 50 psf (244.1 kg/m^2) in air, it would become an impulsive wave in water with a maximum peak pressure of 100 psf (488.2 kg/m^2) or about 0.7 psi (0.05 kg/cm^2). Therefore, even a worst-case situation for sonic booms would produce a peak pressure in water well below the level that would cause harassment or injury to marine mammals (Laney and Cavanagh, 2000).

Fixed-Wing Aircraft Overflights

Approximately 300 fixed-wing sorties would occur in the TMAA annually under the No Action and Alternative 1. Many of these sorties will generally take place above 30,000 ft (9,144 m). All aircraft overflights between the shore and 12 nm (22 km) from land would occur at altitudes at or above 15,000 ft (915 m) and have no effect on marine mammals. While fixed-wing aircraft activities can occur in Special Use Airspace throughout the Alaska Training Area, a majority of the sorties are associated with Navy Air Combat Maneuver (ACM) training, will take place in the TMAA. Under the No Action Alternative, approximately 300 ACM sorties would occur annually (average of 21 sorties per day). Altitudes range from approximately 6,000 ft (1,920 m) to 30,000 ft (9,144 m) and typical airspeeds range from very low (less than 100 knots [185.2 km/hr]) to high subsonic (less than 600 knots [1,111.2 km/hr]). ACM training in the TMAA will also involve supersonic flight which produces sonic booms, but this would not occur below 15,000 ft (4,572 m) AMSL.

Exposure to fixed-wing aircraft noise would be brief (seconds) as an aircraft quickly passes overhead. Exposures would be infrequent based on the transitory and dispersed nature of the overflights; repeated exposure to individual animals over a short period of time (hours or days) is extremely unlikely. Furthermore, the sound exposure levels would be relatively low to marine mammals that spend the majority of their time underwater.

Most observations of cetacean responses to aircraft overflights are from aerial scientific surveys that involve aircraft flying at relatively low altitudes and low airspeeds. It should be noted that most of the aircraft overflight exposures analyzed in the studies mentioned above are different than Navy aircraft overflights. Survey and whale watching aircraft are expected to fly at lower altitudes than typical Navy fixed-wing overflights. Exposure durations would be longer for aircraft intending to observe or follow an animal. These factors might increase the likelihood of a response to survey or whale watching aircraft.

Mullin et al. (1991) reported that sperm whale reactions to aerial survey aircraft (standard survey altitude of 750 ft [229 m]) were not consistent. Some sperm whales remained on or near the surface the entire time the aircraft was in the vicinity, while others dove immediately or a few minutes after the sighting.

Smultea et al. (2001) reported that a group of sperm whales responded to a circling aircraft (altitude of 800 ft [244 m] to 1,100 ft [335 m]) by moving closer together and forming a fan-shaped semi-circle with their flukes to the center and their heads facing the perimeter. Several sperm whales in the group were observed to turn on their sides, to apparently look up toward the aircraft. Richter et al. (2003) reported that the number of sperm whale blows per surfacing increased when recreational whale watching aircraft were present, but the changes in ventilation were small and probably of little biological consequence. The presence of whale watching aircraft also apparently caused sperm whales to turn more sharply, but did not affect blow interval, surface time, time to first click, or the frequency of aerial behavior (Richter et al. 2003). A review of behavioral observations of baleen whales indicates that whales will either demonstrate no behavioral reaction to an aircraft or, occasionally, display avoidance behavior such as diving (Koski et al. 1998). Smaller delphinids also generally display a neutral or startle response (Würsig et al. 1998). Species, such as *Kogia* spp. and beaked whales, that show strong avoidance behaviors with ship traffic, also exhibit disturbance reactions to aircraft (Würsig et al. 1998). Although there is little information regarding reactions to aircraft overflights for other cetacean species, it is expected that reactions would be similar to those described above; either no reaction or quick avoidance behavior.

Marine mammals exposed to a low-altitude fixed-wing aircraft overflights could exhibit a short-term behavioral response, but not to the extent where natural behavioral patterns would be abandoned or significantly altered. Fixed-wing aircraft overflights are not expected to result in chronic stress because it is extremely unlikely that individual animals would be repeatedly exposed to low altitude overflights. Fixed-wing aircraft overflights may affect ESA-listed marine mammals. It is not likely that aircraft overflights associated with training activities would result in effects to the life functions of marine mammals in the TMAA. This same disturbance is not expected to result in Level A or Level B harassment as defined by the MMPA. High-altitude fixed-wing aircraft overflights over nonterritorial seas (seaward of 12 nm [22 km]) would not cause significant harm to marine mammals in accordance with EO 12114. The Navy is working with NMFS through the ESA consultation and MMPA permitting processes accordingly.

Helicopter Overflights

Approximately 32 training events could involve helicopters in the TMAA annually under the No Action Alternative. Helicopter overflights can occur throughout the TMAA. Unlike fixed-wing aircraft, helicopter training activities can occur at low altitudes (75 ft [23 m] to 100 ft [30 m]), which increases the likelihood that marine mammals would respond to helicopter overflights. However, the only places that helicopters are below 500 ft [152 m] above ground level (AGL) over water is during training when personnel jump from the helicopter into water from 75 ft [23 m] to 100 ft [30 m] above the surface, when doing Deck Landing Qualifications, or when using dipping sonar. Otherwise, helicopters are 500 ft [152 m] AGL or higher while in transit. There are no haul outs or rookeries in the TMAA and none of these overflight activities in the TMAA would take place near a haul out or rookery location.

Very little data are available regarding reactions of cetaceans to helicopters. One study observed that sperm whales showed no reaction to a helicopter until the whales encountered the downdrafts from the helicopter rotors (Clarke 1956). Other species such as bowhead whale and beluga whales show a range of reactions to helicopter overflights, including diving, breaching, change in direction or behavior, and alteration of breathing patterns, with belugas exhibiting behavioral reactions more frequently than bowheads (Patenaude et al. 2002). These reactions were less frequent as the altitude of the helicopter increased to 492 ft (150 m) or higher.

Helicopters are used in studies of several species of seals hauled out and is considered an effective means of observation (Gjertz and Børset 1992, Bester et al. 2002, Bowen et al. 2006), although they have been known to elicit behavioral reactions such as fleeing (Hoover 1988). Jehl and Cooper (1980) indicated that low-flying helicopters, humans on foot, sonic booms, and loud boat noises were the most disturbing influences to pinnipeds. In other studies, harbor and other species of seals and sea lions showed no reaction to helicopter overflights (Gjertz and Børset 1992). Among the pinnipeds, harbor seals are the most likely to startle; no serious disturbance was recorded among northern elephant seals. Numerous observations of marine mammal reactions (or lack of reaction) to aircraft have been reported. In most cases, airborne or waterborne noise from aircraft was the apparent stimulus (Richardson et al. 1995). Other studies have shown less drastic reactions. Hoover (1988) reported strong reactions to aircraft below 200 ft (61 m), but minimal reaction to aircraft above 250 ft (76 m). Other studies have suggested that harbor seals can become sensitized to overflights and show little or no reaction after frequent exposure (Frost and Lowry 1993, Bigg as cited in Johnson et al. 1989). Harbor seals have been noted to react to aircraft flyovers when on the beach, however, Navy fixed wing aircraft would be at high altitude over harbor seal haul out locations and within established air transit routes. In the case of helicopter flyovers of less than 393 ft (120 m), mothers have abandoned newborn pups and retreated into the water. This behavior can result in permanent separation of newborn pups and subsequent death (Johnson 1967). Helicopters overflights of rookeries would not occur in the TMAA as there are no haul out locations within the TMAA.

If animals do flush into the water, they may return to the haul-out site immediately, stay in the water for a length of time and then return to the haul-out, or temporarily haul-out at another site. Many factors contribute to the degree of behavioral modification, if any, including seasonality, group composition of the pinnipeds, type of activity they are engaged in, and noises they may be accustomed to experiencing. Short-term reactions such as startle or alert reactions are not likely to disrupt behavior patterns such as migrating, breeding, feeding and sheltering, nor would they be likely to result in serious injury to marine mammals. However, if startle reactions were accompanied by large-scale movements of marine mammals, such as stampedes into the water, the disruption could result in injury of individuals, especially if pups were present.

Marine mammals exposed to a low-altitude helicopter overflights under the No Action Alternative could exhibit a short-term behavioral response, but not to the extent where natural behavioral patterns would be abandoned or considerably altered. Helicopter overflights are not expected to result in chronic stress because it is extremely unlikely that individual animals would be repeatedly exposed. Helicopter overflights can occur throughout the TMAA, but will not be in close proximity land and therefore far from known haul out areas and established rookeries. In addition, the Navy complies with restrictions prohibiting fixed wing aircraft or helicopter overflight or surface training activities within 3,000 ft (914 m) of Steller sea lion critical habitat (NMFS 1993), rookeries or pinniped haulout areas (DoN 2002c). These mitigation measures minimize adverse reactions of seals and Steller sea lions to training activities.

As such, helicopter overflights in the TMAA may affect ESA-listed marine mammals. These overflights are not expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that helicopter flights associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, harm to marine mammals from helicopter overflights over nonterritorial seas (seaward of 12 nm [22 km]) would be minimal. The Navy is working with NMFS through the ESA consultation and MMPA permitting processes accordingly.

Non-explosive Practice Ordnance

Current Navy training activities include firing a variety of weapons that employ a variety of non-explosive training rounds, including naval gun shells, cannon shells, and small caliber ammunition. As part of this training, Navy regulations require visual clearance before the training exercise of any range where ordnance (including non-explosive inert practice ordnance) is to be dropped. This analysis focuses on non-explosive training rounds, while potential effects of explosive munitions in the water are analyzed below in the explosions section. Missiles used in air to air training events at sea, although part of a live fire event, are designed to detonate in the air and do not constitute an at-sea explosion occurring in water as analyzed in this document.

The number of non-explosive practice ordnance events by type of projectile occurring for the No Action Alternative is presented in Table 2-8. Non-explosive practice ordnance includes naval gunshells (20mm, 25mm, 57mm, 76mm, and 5-inch projectiles) and small arms rounds (7.62mm and .50-caliber projectiles). Annually, there would be about 10,524 inert naval gunshells and about 5,000 small arms projectiles expended into the ocean with the No Action Alternative.

Direct ordnance strikes and disturbance associated with sound from firing are potential stressors to other listed marine mammals. Ingestion of expended ordnance is not a potential concern for marine mammals given it should sink to the ocean floor very quickly.

The potential for marine mammals to be struck by fired ordnance is extremely low given the density of marine mammals in the TMAA and the rapid loss of velocity once entering the water. The probability of a direct ordnance strike is further reduced by Navy mitigation measures, which require the area be clear of marine mammals before ordnance is used (see Section 5.1.7). Non-explosive ordnance may affect marine mammals although it is not likely that use of non-explosive ordnance associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance EO12114, non-explosive ordnance use in nonterritorial seas (seaward of 12 nm [22 km]) would not cause significant harm to marine mammals.

Weapons Firing Disturbance

Transmitted Gunnery Sound

A gun fired from a ship on the surface of the water propagates a blast wave away from the gun muzzle. This spherical blast wave reflects off and diffracts around objects in its path. As the blast wave hits the water, it reflects back into the air, transmitting a sound pulse back into the water in proportions related to the angle at which it hits the water.

Propagating energy is transmitted into the water in a finite region below the gun. A critical angle (about 13°, as measured from the vertical) can be calculated to determine the region of transmission in relation to a ship and gun (DoN 2006).

The largest proposed shell size for these activities is a 5-inch shell. This will produce the highest pressure and all analysis will be done using this as a conservative measurement of produced and transmitted pressure, assuming that all other smaller ammunition sizes would fall under these levels.

Aboard the USS Cole in June 2000, a series of pressure measurements were taken during the firing of a five-inch gun. Average pressure measured approximately 200 decibels (dB) with reference pressure of one micro Pascal (dB re 1 µPa) at the point of the air and water interface. Based on the USS Cole data, down-range peak pressure levels were calculated to be less than 186 dB re 1 µPa at 328 ft (100 m) (DoN 2000) and as the distance increases, the pressure would decrease.

In reference to the energy flux density (EFD) harassment criteria, the EFD levels (greatest in any 1/3 octave band above 0.01 kHz) of a 5-inch gun muzzle blast were calculated to be 190 dB with reference pressure of one micropascal squared in one second (dB re 1 μPa^2-sec) directly below the gun muzzle decreasing to 170 dB re 1 μPa^2-sec at 328 ft (100 m) into the water (DoN 2006). The rapid dissipation of the sound pressure wave coupled with the mitigation measures implemented by the Navy (see Section 5.1.7 for details) to detect marine mammals in the area prior to conducting activities, would likely result in a blast from a gun muzzle having no effect, however, the sound from gunfire may affect marine mammal species listed under the ESA. In with EO 12114, there would be no significant harm to marine mammals resulting from transmitted gunnery sound during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

Sound Transmitted Through Ship Hull

A gun blast will also transmit sound waves through the structure of the ship which can propagate into the water. The 2000 study aboard the USS Cole also examined the rate of sound pressure propagation through the hull of a ship (DoN 2000). The structurally borne component of the sound consisted of low-level oscillations on the pressure time histories that preceded the main pulse, due to the air blast impinging on the water (DoN 2006).

The structural component for a standard round was calculated to be 6.19 percent of the air blast (DoN 2006). Given that this component of a gun blast was a small portion of the sound propagated into the water from a gun blast, and far less than the sound from the gun muzzle itself, the transmission of sound from a gun blast through the ship's hull likely would have no effect, but may affect species listed under the ESA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from sound transmitted through a ship hull during training exercises in nonterritorial seas (seaward of 12 nm [22 km]). Furthermore, performing visual clearance of the range prior to conducting training exercises further reduce the likelihood of practice ordnance hitting marine mammals.

Explosive Ordnance and At-Sea Explosions

The number of high explosive events by type of ordnance occurring for the No Action Alternative is presented in Table 2-8. In addition to 30 5-inch and 10 76mm live rounds, a total of 48 high-explosive bombs (MK-82, MK-83 and MK-84 types) will be detonated in the water annually.

The modeled explosive exposure harassment numbers by species (as derived using the methods described in Section 3.8.6.5) and harassment exposures for rare species (few in number in the TMAA) are presented in Table 3.8-9. The table quantifies MMPA Level B harassment from behavioral disturbance and MMPA Level A harassment from potential injury to marine mammals.

For at-sea explosions under the No-Action Alternative, quantification from modeling, accounting for rare species for which modeling was not possible, and for which modeling provided an estimate of zero exposures, indicates 80 MMPA Level B harassments from sub-TTS for MSE. The modeling indicates 22 MMPA Level B harassments from TTS. Under the No Action Alternative from at-sea explosions, quantification from modeling and accounting for rare species indicates a total of 102 MMPA Level B harassments annually.

These exposure modeling results are estimates of marine mammal at-sea explosion sound exposures without consideration of standard operating procedures and mitigation procedures. The implementation of the mitigation presented in Section 5.2.1 will reduce the potential occurrence for some of these modeled marine mammal exposures and harassments as a result of area clearance procedures (NMFS 2008). For example, modeling for at-sea explosions under the No Action Alternative also indicates potential for one MMPA Level A harassment from slight injury and no annual exposures that could cause severe injury or mortality. This slight injury exposure should not occur given it is predicted for Dall's porpoise, which should be readily detectable given the species general large group size and characteristic porpoising behavior.

Without consideration of mitigation measures, modeling and accounting for rare species indicates at-sea explosion exposures with the No Action Alternative may affect ESA listed blue, fin, humpback, North Pacific right, sei, and sperm whales, and Steller sea lions. Although modeling was not possible for rare species as defined in this analysis, it is unlikely these few animals would co-occur in the TMAA during the short duration of the training and in areas cleared of marine mammals.

Table 3.8-9: No Action Alternative Annual At-Sea Explosions Exposures Summary

Species	Level B Harassment		Level A Harassment	Mortality
	Sub-TTS 177 dB re 1μPa^2-s	TTS 182 dB / 23 psi	50 percent TM Rupture 205 dB Slight Lung Injury or 23 psi-ms	Onset massive Lung Injury or Mortality 31 psi-ms
ESA Species				
Blue whale	1*	0	0	0
Fin whale	5	3	0	0
Humpback whale	2*	0	0	0
North Pacific Right whale	1*	0	0	0
Sei whale	4*	0	0	0
Sperm whale	1*	0	0	0
Steller sea lion	1	0	0	0
Non-ESA Listed Species				
Baird's beaked whale	11*	0	0	0
Cuvier's beaked whale	1	0	0	0
Dall's porpoise	29	13	1	0
Gray whale	3*	0	0	0
Harbor Porpoise	2*	0	0	0
Killer whale	1	0	0	0
Minke whale	2*	0	0	0
Pacific white-sided dolphin	3	2	0	0
Stejneger's beaked whale	1	0	0	0
California sea lion	1*	0	0	0
Harbor seal	1*	0	0	0
Northern elephant seal	1	0	0	0
Northern fur seal	9	4	0	0
Total	**80**	**22**	**1**	**0**

Notes: dB = decibel, dB re 1μPa^2-s = decibels referenced to 1 micropascal squared per second, ESA = Endangered Species Act, psi = pound per square inch, psi-ms = pounds per square inch per millisecond, PTS = Permanent Threshold Shift, TM = Tympanic membrane, TTS = Temporary Threshold Shift; * = Accounting for rare animals.

The implementation of the mitigation and monitoring procedures as addressed in Section 5.1.7 will further minimize the potential for marine mammal exposures to at-sea explosions. When reviewing the acoustic exposure modeling results, it is also important to understand that the estimates of marine mammal exposures are presented without consideration of standard protective measure operating procedures. Section 5.1.7 presents details of the mitigation measures currently used for ASW activities including detection of marine mammals and power down procedures if marine mammals are detected within one of the safety zones. The Navy will work through the MMPA incidental harassment regulatory process to discuss the mitigation measures and their potential to reduce the likelihood for incidental harassment of marine mammals. It is not likely that any exposures from training activities associated with at-sea explosions would result in effects to the life functions of marine mammals in the TMAA.

Active Sonar

There would be no effects to marine mammals from active sonar for the No Action Alternative. For the No Action Alternative, there is no use of active sonar for ASW Training, no ASW Tracking Exercise – Maritime Patrol Aircraft, Extended Echo Ranging (EER) ASW, Surface Ships ASW, or Submarine ASW TRACKEX.

Expended Materials

The Navy expends a variety of materials during training exercises. Under the No Action Alternative, 15,982 expendable items may be used. The types and quantities of materials expended and information regarding fate and transport of these materials within the marine environment are discussed in Section 3.2 (Expended Materials), and Section 3.3 (Water Resources). The analyses in these sections determined that most expended materials rapidly sink to the seafloor where they become encrusted by natural processes or are incorporated into the seafloor, with no substantial accumulations in any particular area and no significant negative effects to water quality or marine benthic communities. Given that materials expended during training do not remain at the surface and are generally used in areas where the water depth is beyond that of foraging marine mammals, it is unlikely expended materials would be later encountered by any marine mammal.

Ordnance Related Materials

Ordnance related materials include various sizes of non-explosive training rounds and shrapnel from explosive rounds. Under the No Action Alternative, 15,706 items of ordnance or related materials would be expended. These solid metal materials would quickly move through the water column and settle to the sea floor. These materials would become encrusted by natural processes and incorporated into the seafloor, with no significant accumulations in any particular area and no negative effects to water quality. Ingestion of expended ordnance is not expected to occur in the water column because it is assumed the ordnance (which is composed of dense metal) would quickly sink. However, benthic foraging marine mammals could be exposed to expended ordnance through ingestion. Some materials such as an intact non-explosive training bomb would be too large to be ingested by a marine mammal, but many materials such as cannon shells, small caliber ammunition, and shrapnel could be ingested. Records indicate that generally metal debris ingested by marine mammals is small (e.g., fishhooks, bottle caps, metal spring; Walker and Coe 1990). The effects of ingesting solid metal objects on marine mammals are unknown. Extensive literature searches reveal no studies related to potential toxic effects of ordnance ingestion by marine mammals. Ingestion of marine debris in general can cause digestive tract blockages or damage the digestive system (Stamper et. al. 2006, Gorzelany 1998). Relatively small objects with smooth edges such a cannon shell or small caliber ammunition might pass through the digestive tract without causing harm, while a piece of metal shrapnel with sharp edges would be more likely to cause damage.

The potential for ordnance ingestion depends on species-specific feeding habitats and where ordnance use will occur. The blue, fin, and sei whales and Steller sea lion feed at the surface or in the water column and would not ingest ordnance from the bottom. Activities involving ordnance use will most likely occur in the open ocean beyond the shelfbreak areas above in deep water (> 3,280 ft [1,000 m] depth).

While humpback whales feed predominantly by lunging through the water after krill and fish, there have been instances of humpback whales disturbing the bottom in an attempt to flush prey, the northern sand lance (*Ammodytes dubius*) (Hain et al. 1995). Right whales can also be bottom feeders, however, North Pacific right whales and Humpback whales are not expected to ingest ordnance because abundant prey is available in the water column in the TMAA. Ordnance ingestion under the No Action Alternative would have no effect on the ESA listed blue whales, fin whales, humpback whales, North Pacific right whales, sei whales, and Steller sea lions.

Although sperm whales feed predominantly on cephalopods, they also frequently feed on or near the bottom (Whitehead et al. 1992). In doing so, animals may ingest nonfood items such as rocks and sand (NMFS 2006a). Sperm whales are known to incidentally ingest foreign objects while foraging (Walker and Coe 1990), suggesting that the potential exists to ingest debris that has settled on the ocean floor as a result of the proposed activities. Sperm whales display a strong offshore preference (Rice 1989) and are mostly associated with waters over the continental shelf edge, continental slope, and offshore waters (CETAP 1982, Hain et al. 1985, Smith et al. 1996, Waring et al. 2001, Davis et al. 2002). Although the possibility exists for ingestion of expended ordnance, the potential that exposed ordnance would be at a depth where it could be encountered, that it would not be buried, and that in those very rare events the animal would ingest that ordnance creates so unlikely a series of events that the potential is discountable. Ordnance ingestion under the No Action Alternative under the ESA may affect sperm whales. However, it is not likely that ordnance ingestion would result in effects to the life functions of marine mammals in the TMAA.

Most other nonlisted baleen and toothed whales, and other pinnipeds, which feed at the surface or in the water column, would not be expected to ingest ordnance from the bottom. Gray and beaked whales are, however, known to be bottom feeders. The habitat preference of gray whales with an occurrence being inshore of the shelfbreak, is not an area where ordnance use is likely to occur. Beaked whales have exhibited bottom feeding behavior using suction feeding techniques (MacLeod et al. 2003) and are known to incidentally ingest foreign objects while foraging (Walker and Coe 1990). Although the possibility exists for ingestion of expended ordnance, the potential that exposed ordnance would be encountered and that in that very rare event the animal would ingest that ordnance is discountable. Ordnance related materials are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, ordnance related materials would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Target Related Materials

A variety of at-sea targets are used ranging from high-technology, remotely operated airborne and surface targets (such as airborne drones and Seaborne Powered Targets) to low-technology floating at-sea targets (such as inflatable targets) and towed banners. Many of the targets are designed to be recovered for reuse and are not destroyed during training. There are 64 target related items used under the No Action Alternative. The expendable targets used in the TMAA are the Tactical Air Launched Decoy (TALD), Killer Tomatoes, SPAR, BQM-74E unmanned aircraft, LUU-2B/B illuminating flares, and the MK-58 Marine Marker. Flares and Marine Markers are generally small in size, and sink to the bottom. Killer Tomatoes, SPAR, and BQM-74 are recovered after use. TALDs are approximately 7 ft (2 m) long and weigh approximately 400 lb (180 kg). Because of these characteristics, they present an unlikely ingestion hazard to marine mammals.

As discussed above for ordnance-related materials, species that feed on or near the bottom (which are the sperm whales and beaked whales) may encounter an expended target while feeding; however, the size of the target would suggest ingestion by any listed species it is unlikely. The use of targets under the No Action Alternative may affect listed marine mammals. It is not likely that use targets associated with training activities would result in effects to the life functions of marine mammals in the TMAA. Targets are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, targets would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Chaff

As detailed in Section 3.2.1.1, chaff consists of aluminum-coated fibers used as an electronic countermeasure designed to reflect radar waves and obscure aircraft, ships, and other equipment from radar tracking sources. Upon deployment, the chaff fibers are widely dispersed in the air and eventually land in the water and sink to the ocean floor.

Chaff will only be used during Electronic Combat (EC) exercises and mainly by fixed wing aircraft and as projectiles from ships. Under the No Action Alternative, 540 lb (245 kg) of chaff would be used annually. The only hazardous material associated with chaff is the pyrotechnic deployment charge (approximately 0.02 oz [0.48 g] of pyrotechnic material for each charge). Chaff consists of aluminum-coated polymer fibers inside of a launching mechanism. Upon deployment, the chaff and small pieces of plastic are expended. Chaff may be deployed mechanically or pyrotechnically. Mechanical deployment results in expended paper materials, along with the chaff. Pyrotechnic deployment uses a small explosive cartridge to eject the chaff from a small tube that does not affect water or sediment quality because most of the material is consumed during combustion and the remaining amounts are be dispersed over a large area. Chaff fibers are widely dispersed on deployment. Chaff settling on the ocean surface may temporarily raise turbidity, but will quickly disperse with particles eventually settling to the ocean floor.

As first presented in DoN (2009), the dispersion characteristics of chaff make it likely that marine mammals would occasionally come in direct contact with chaff fibers while at the water's surface and while submerged, but such contact would be inconsequential. Chaff is similar in form to fine human hair with the fibers being flexible and soft. Evaluation of the potential for chaff to be inhaled by humans, livestock, and animals found that the fibers are too large to be inhaled into the lung (Arfsten et al. 2002, Hullar et al. 1999, USAF 1997). Although these reviews did not specifically consider the respiratory system of large whales, any effects of chaff inhalation on marine mammals are considered insignificant given the dispersal of chaff fibers resulting in very low concentration in the air.

While no studies have been conducted to evaluate the effects of chaff ingestion on marine mammals, the effects are expected to be insignificant and discountable based the low concentrations when dispersed, the small size of chaff fibers, available data on the toxicity of chaff components (silicon dioxide and aluminum), and evidence indicating the lack of significant accumulation of aluminum in sediments after prolonged training (DoN 2009). Silicon and aluminum are two of the most abundant elements in the earth's crust. Marine mammals, such as gray whales that forage on the bottom, routinely ingest sediment containing these elements. The aluminum concentrations in brain tissue of gray whales are within the range for terrestrial mammals that may receive high concentrations of aluminum in their diets, suggesting a broad range in tolerance to aluminum in mammals (Varanasi et al. 1993, Tilbury 2002, DoN 2009). Chaff cartridge plastic end-caps and pistons would also be expended into the marine environment, where they would sink and could potentially be ingested by marine mammals. Based on the low concentration of these components in the TMAA, it is very unlikely a marine mammal would encounter a plastic end-cap or piston from the chaff cartridge. Even in the very unlikely event one of these components was encountered and then consumed by a marine mammal, the small size of chaff end-caps and pistons (1.3 inch [33 mm] diameter and 0.13 inch [3.3 mm] thick) would suggest it would likely pass through the digestive tract and be voided without causing harm.

Under ESA, chaff use under the No Action Alternative may affect blue, fin, humpback, North Pacific right, sei, and sperm whales but these effects are insignificant and discountable. Use of chaff is not expected to result in Level A or Level B harassment as defined by the MMPA and would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

Marine Markers

The MK-58 marine marker produces chemical flames and regions of surface smoke and is used in various training exercises to mark a surface position to simulate divers, ships, and points of contact on the surface of the ocean. When the accompanying cartridge is broken, an area of smoke is released. The smoke dissipates in the air having little effect on the marine environment. The marker burns similar to a flare, producing a flame until all burn components have been used. While the light generated from the marker is bright enough to be seen up to 3 mi (5 km) away in ideal conditions, the resulting light would either be reflected off the water's surface or would enter the water and attenuate in brightness over depth. The point source of the light would be focused and be less intense than if an animal were to look to the surface and encounter the direct path of the sun. The MK-58 is composed of tin and contains two red phosphorus pyrotechnic candles and a seawater-activated battery. The MK-58 marine marker is 22 inch (0.5 m) long and 5 inch (0.1 m) in diameter, weighs 13 lb (6 kg), and produces a yellow flame and white smoke for a minimum of 40 min and a maximum of 60 min (The Ordnance Shop 2007). The marker itself is not designed to be recovered and would eventually sink to the bottom and become encrusted and/or incorporated into the sediments. Approximately 20 marine markers would be used in the TMAA per year under the No Action Alternative.

It is unlikely that marine mammals would be exposed to any chemicals that produce either flames or smoke because these components are consumed in their entirety during the burning process. Animals are unlikely to approach and/or get close enough to the flame to be exposed to any chemical components.

Expended marine markers are a potential ingestion hazard for marine mammals while they are floating or after they sink to the bottom. However, the probability of ingestion is extremely low based on the low number of marine markers expended per year (20) versus the large operational area of the TMAA. Marine marker ingestion under the No Action Alternative will not affect ESA-listed marine mammals. The use of marine markers is not expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that use of marine markers associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of marine markers during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

Tactical Air Launched Decoys (TALDs)

Under the No Action Alternative, eight TALDs would be used annually. A TALD is an aircraft shaped target approximately 7 ft 8 in (2.3 m) long and weighs approximately 400 lb (180 kg). TALDs operate as an expendable vehicle with no recovery capabilities, and use lithium sulfur dioxide batteries. An important component of the thermal battery is a hermetically-sealed casing of welded stainless steel 0.03 to 0.1-in thick that is resistant to the battery electrolytes. As discussed in Section 3.2, in the evaluation of the potential effects associated with seawater batteries, it is expected that in the marine environment, lithium potentially released from these batteries would be essentially nontoxic in seawater. Because of these factors, lithium batteries would not adversely affect marine mammals.

Pieces of expended TALDS (if any) are a potential ingestion hazard for marine mammals after they sink to the bottom. However, the probability of ingestion is extremely low based on size of the likely pieces (if any) the low number of TALDS expended per year (8), and the large operational area of the TMAA. TALD ingestion under the No Action Alternative may affect ESA-listed marine mammals. The use of TALDS is not expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that use of TALDS associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of TALDS during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

BQM-74E

The BQM-74E is a remote-controlled, subsonic, jet-powered aerial target that can be launched from the air or surface and recovered on land or at sea. It is powered by a jet engine, and thus contains oils, hydraulic fluid, batteries, and explosive cartridges. The hazardous materials of concern include propellant, petroleum products, metals, and batteries; however, the hazardous materials in aerial targets would be mostly consumed during training use.

Although BQM-74Es are recovered, pieces of expended BQM-74Es (if any) are a potential ingestion hazard for marine mammals after they sink to the bottom. However, the probability of ingestion is extremely low based on the low number of BQM-74Es expended per year (2) versus the large operational area of the TMAA. BQM-74E ingestion under the No Action Alternative may affect ESA-listed marine mammals. The use of BQM-74Es is not expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that use of BQM-74Es associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of BQM-74Es during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

Sonobuoys

One sonobuoy type, a SSQ-036 BT (a temperature sensor with no active emissions), would be used under this alternative. Sonobuoys are deployed by either surface vessels or aircraft to monitor the environment, to passively detect sounds created by submarines and/or surface vessels, or to actively detect submerged or surface vessels by generating their own sonar signals. Sonobuoys are temporary devices that are activated once they contact ocean water. When their operating service life is attained, the sonobuoy shuts down and sinks to the ocean bottom to decompose. Under the No Action Alternative, up to 24 SSQ-036 BT sonobuoys would be deployed in the TMAA.

Aircraft-launched sonobuoys, flares, and markers deploy nylon parachutes of various sizes. At water impact, the parachute assembly is expended and sinks, as all of the material is negatively buoyant. Metallic components are heavy and will sink rapidly. Parachute and cord are lighter and sink more slowly but are weighted to insure they will do so. While these materials are sinking through in the water column, they represent a potential entanglement risk to passing marine mammals in the area. An estimated 24 sonobuoys, 12 flares, and 20 markers will be expended under the No Action Alternative (see Table 2-8). Given this number of sonobuoys, flares, and markers deployed, the large size of the TMAA, and the relatively low density of marine mammals in the area, the risk of a marine mammal encounter with a parachute assembly, and other expended debris is unlikely. Entanglement and the eventual drowning of a marine mammal in a parachute assembly would be unlikely, since such an event would require the parachute to land directly on an animal, or the animal would have to swim into it before it sinks. The expended material will accumulate on the ocean floor and will be covered by sediments over time, remaining on the ocean floor and reducing the potential for entanglement. If bottom currents are present, the canopy may billow and pose an entanglement threat to marine animals with bottom-feeding habits; however, the probability of a marine mammal encountering a submerged parachute assembly and the potential for accidental entanglement in the canopy or suspension lines is considered to be unlikely.

Expended sonobuoys are a potential ingestion hazard for marine mammals while they are floating, while they are descending to the seafloor, or after they sink to the bottom although this seems extremely unlikely. The probability of ingestion is also low based on the number of sonobuoys expended per year (24) compared to the size of the TMAA. It is not likely that sonobuoy ingestion would result in effects to the life functions of marine mammals in the TMAA. Sonobuoy ingestion under the No Action Alternative may affect ESA-listed marine mammals because it cannot be discounted. The use of sonobuoys is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, harm to marine mammals resulting from use of passive sonobuoys during training exercises in nonterritorial seas (seaward of 12 nm [22 km]) would also be minimal.

Critical Habitats

There are no critical habitats in the TMAA. Provisions of the ESA require a determination of whether proposed federal actions may destroy or adversely modify critical habitat. Critical habitat designation is based on the presence and condition of certain physical and biological habitat factors called primary constituent elements (PCEs) that are considered essential for the conservation of the listed species (USFWS and NMFS 1998, ESA §3[5][A][i], 50 C.F.R. §424.12[b]). There are no designated Critical Habitat PCEs in the TMAA.

Therefore, in accordance with ESA consultation provisions to assess potential effects of Proposed Action to critical habitat, it is concluded that Navy activities will have no effect on any critical habitats.

3.8.7.8 Alternative 1

Vessel Movements

Under Alternative 1, the number of Navy vessels would increase by four (three surface vessels and one submarine) for a total of eight Navy vessels, a 50 percent increase over the No Action Alternative. This increase would include both training and transit activities for Alternative 1. Contracted support vessels would remain at 19. The total increase in vessel activity equates to a 17 percent increase over the No Action Alternative. These changes would result in increased potential for short-term behavioral reactions to naval vessels. Potential for collision would increase slightly compared to the No Action Alternative; however, Navy mitigation measures would reduce the probability and collisions would remain unlikely. Vessel movements are not expected to result in effects to the life functions of marine mammals. Vessel movements under Alternative 1 may affect ESA-listed marine mammals. Vessel movements are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, vessel movements would cause minimal harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Aircraft Overflights

Alternative 1 would have no increase in the 300 fixed-wing aircraft sorties under the No Action, but would add six training events as described in Table 2-7. Alternative 1 would also add 26 helicopter events associated with ASW, Deck Launch Qualifications, and Air-to-Surface training. Peak noise levels generated by the MH-60R/S helicopters would be similar to the noise levels generated with the No Action Alternative.

The additional overflights may result in increased instances of behavioral disturbance due to sound, shadow-effects, and/or, in the case of helicopters, water column disturbance. As with the No Action Alternative, the responses would be limited to short-term behavioral or physiological reactions. It is not likely that exposures to aircraft overflights associated with training activities would result in effects to the life functions of marine mammals in the TMAA. Aircraft overflights under Alternative 1 may affect ESA-listed marine mammals. Aircraft overflights of the TMAA are not expected to result in Level A or Level B harassment as defined by the MMPA. Furthermore, aircraft overflights would not cause notable harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]) in accordance with EO 12114. All aircraft overflights between the shore and 12 nm (22 km) from land would occur at altitudes at or above 15,000 ft (915 m) and would have no effect on marine mammals.

Non-explosive Practice Ordnance

The number of non-explosive practice ordnance events by type of projectile occurring for Alternative 1 is presented in Table 2-8. Non-explosive practice ordnance includes naval gunshells (20mm, 25mm, 57mm, 76mm, and 5-in projectiles) and small arms rounds (7.62mm and .50-caliber projectiles). Under Alternative 1, there would be about 13,132 naval gunshells and about 5,700 small arms projectiles expended into the ocean. Compared to the No Action Alternative, this equates to an increase of about 24 percent and 14 percent respectively, in naval gunshells and small arms projectiles.

These changes would result in increased potential exposure of marine mammals to ordnance strikes; however, Navy standard operating procedures and mitigation measures would reduce the probability of strikes by modifying activities when marine mammals are known to be in the area. It is not likely that use of non-explosive ordnance associated with training activities would result in effects to the life functions of marine mammals in the TMAA. There should be no effect from use of non-explosive practice ordnance, but it may affect ESA-listed marine mammals under Alternative 1. Non-explosive ordnance use is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, non-explosive practice ordnance would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Explosive Ordnance (At-Sea Explosions)

The number of explosive events by type of ordnance occurring for Alternative 1 is presented in Table 2-8. In addition to 42 5-inch and 14 76mm live rounds, a total of 72 high-explosive bombs (MK-82, MK-83 and MK-84 types) will be detonated in the water annually. Detonation of bombs represents an increase of 40 percent for live gunfire and 150 percent for bomb detonations compared to the No Action Alternative. These changes would represent an increased potential for marine mammals exposure to detonation concussion effects and behavioral disturbance.

SSQ-110 Sonobuoys (IEER; At-Sea Explosions)

Also introduced under Alternative 1 would be the use of the Extended Echo Ranging (EER) system using approximately 40 SSQ-110 active and 40 passive SSQ-101 Air Deployable Active Receiver (ADAR) (in pairs). These are used by Maritime Patrol Aircraft (MPA) (P-3 or P-8 aircraft) when conducting “large area” searches for submarines. The SSQ-110’s active component contains a small explosive charge that generates acoustic energy when detonated (Note: for this reason effects from use of SSQ-110 are covered under this section dealing with at-sea explosions). If an underwater target is within range, the echo is received by the passive ADAR sonobuoy and transmitted to the aircraft. The sonobuoy pairs are dropped from a MPA in a predetermined pattern with a few buoys covering a very large area. Upon command from the aircraft, the ribbon charge is released and subsequently detonated, generating a “ping.” There is only one detonation in the pattern of buoys at a time. Under Alternative 1, approximately 40 of the SSQ-110 would be used for training in the TMAA.

Proposed for replacement of the SSQ-110 (EER/IEER) is the SSQ-125 Acoustic Extended Echo Ranging (AEER) system, which is similar to the existing EER/IEER system in that it will be used for the same purpose and will use the same ADAR sonobuoy as the acoustic receiver. However, instead of using an explosive SSQ-110 as an impulsive source for the active acoustic wave, the AEER system will use a battery powered (electronic) source for the SSQ 125 sonobuoy. The output and operational parameters for the SSQ-125 sonobuoy (source levels, frequency, wave forms, etc.) are classified; however, this sonobuoy is intended to replace the SSQ-110’s use of explosives. Acoustic impact analysis for the SSQ-125 in this document was not undertaken given the deployment year is still uncertain. Given SSQ-125 is an acoustic source, it is assumed the potential to affect marine mammals is less than that of the explosive SSQ-110 buoys and that the analysis presented for SSQ-110 in this EIS/OEIS likely provides an overestimate of potential effects to marine mammals.

The modeled explosive exposure harassment numbers by species and harassment exposures for rare species or those few in number are presented in Table 3.8-10. The table quantifies MMPA Level B harassments from behavioral disturbance and MMPA Level A harassments from potential injury to marine mammals from Alternative 1.

Table 3.8-10: Alternative 1 Annual At-Sea Explosion Exposures Summary

Species	MMPA Level B Harassment		MMPA Level A Harassment	Mortality
	Sub-TTS 177 dB re 1μPa^2-s	TTS 182 dB / 23 psi	50 percent TM Rupture 205 dB Slight Lung Injury or 23 psi-ms	Onset massive Lung Injury or Mortality 31 psi-ms
ESA Species				
Blue whale	1*	0	0	0
Fin whale	7	2	0	0
Humpback whale	2*	0	0	0
North Pacific Right whale	1*	0	0	0
Sei whale	4*	0	0	0
Sperm whale	1*	0	0	0
Steller sea lion	1	1	0	0
Non-ESA Listed Species				
Baird's beaked whale	11*	0	0	0
Cuvier's beaked whale	1	0	0	0
Dall's porpoise	42	19	1	0
Gray whale	3*	0	0	0
Harbor Porpoise	2*	0	0	0
Killer whale	2	1	0	0
Minke whale	2*	0	0	0
Pacific white-sided dolphin	6	3	0	0
Stejnger's beaked whale	1	0	0	0
California sea lion	1*	0	0	0
Harbor Seal	1*	0	0	0
Northern elephant seal	2	1	0	0
Northern fur seal	12	7	0	0
Total	**103**	**34**	**1**	**0**

Notes: dB = decibel, dB re 1μPa^2-s = decibels referenced to 1 micropascal squared per second, ESA = Endangered Species Act, psi = pound per square inch, psi-ms =pounds per square inch per millisecond, PTS = Permanent Threshold Shift, TM = Tympanic membrane, TTS = Temporary Threshold Shift; * = Accounting for rare animals.

At-Sea Explosions Summary

For at-sea explosions under Alternative 1, quantification from modeling and accounting for rare species indicates 103 MMPA Level B harassments from sub-TTS for MSE. The modeling indicates 34 MMPA Level B harassments from TTS. Under Alternative 1 for at-sea explosions, quantification from modeling and accounting for rare species, indicates a total of 137 MMPA Level B harassments annually. These exposure modeling results are estimates of marine mammal at-sea explosion sound exposures without consideration of standard operating procedures and mitigation procedures. The implementation of the mitigation presented in Section 5.2.1 will reduce the potential occurrence for some of these modeled marine mammal exposures and harassments as a result of area clearance procedures for harassments (NMFS 2008). Modeling for at-sea explosions under Alternative 1 also indicates potential for one MMPA

Level A harassment from slight injury and no annual exposures that could cause severe injury or mortality. This slight injury exposure should not occur given it is predicted for Dall's porpoise, which should be readily detectable given the species general large group size and characteristic porpoising behavior.

Behavioral effects modeling, accounting for rare species for which modeling was not possible, and for which modeling provided an estimate of zero exposures, indicates at-sea explosion exposures under Alternative 1 may affect ESA listed blue, fin, humpback, North Pacific right, sei, and sperm whales, and Steller sea lions. It is not likely that use of ordnance or SSQ-110 sonobuoys associated with training activities would result in effects to the life functions of marine mammals in the TMAA.

Active Sonar for ASW Training

Sonar use for ASW did not occur under the No Action alternative. Under Alternative 1, mid- and high frequency active sonar use would be undertaken including SQS-53 (289 hours) and SQS-56 (26 hours) surface ship sonars, the BQQ-10 (24 hours) and BQS-15 (12 Hours) submarine sonars, plus SSQ-62 sonobuoys (133 ea; Note: use of SSQ-110 [EER] sonobuoys are covered under the section dealing with at-sea explosions), and 96 dips of helicopter dipping sonar that would be deployed (Table 3.8-11).

Table 3.8-11: Annual Sonar Hours and Sources for Alternative 1

	SQS 53 Sonar [a]	SQS-56 Sonar [a]	BQQ-10 Sonar [a]	BQS-15 Sonar [a]	SSQ-62 DICASS Sonobuoy[b]	AQS 22 Dipping Sonar[c]
Alternative 1	289	26	24	12	133	96

Notes: a = Number reflects hours of operations not total transmission time, representative for all variants of system. b = Number is counted by buoy, c = Number is counted as individual use "dips" of the system

Non-Sonar Acoustic Sources Used During Training

In addition to the use of mid- and high frequency sonar, additional non-sonar acoustic sources used during training under the proposed alternatives. For Alternative 1, this would include components of the Portable Undersea Tracking Range, including MK-84 Range Tracking Pingers (40 ea) and Transponders (40 ea), and other sources consisting of MK-39 EMATT targets (6 ea) and SUS MK-84 signaling devices (12 ea). Use of these sources did not occur under the No Action Alternative. Each of these acoustic sources is described in the following paragraphs with the total proposed use under Alternative 1 provided in Table 3.8-12.

Table 3.8-12: Annual Non-Sonar Acoustic Sources for Alternatives 1

	MK-84 PUTR Tracking Pingers [a]	PUTR Transponders [a]	MK-39 EMATT targets[b]	SUS MK-84 signaling devices[b]
Alternative 1	40	40	6	12

Notes: a = This number reflects hours of operation for the PUTR system under average conditions and is not total transmission time of the components. b = Number is counted by device.

Portable Undersea Tracking Range (PUTR) – MK-84 Pingers and Transponders

The use of Portable Undersea Tracking Range (PUTR) is proposed to support ASW training under the proposed alternatives. The PUTR is a self-contained, portable, undersea tracking system that employs modern technologies to support coordinated undersea warfare training for Forward Deployed Naval Forces. PUTR will be available in two variants to support both shallow and deep water remote activities in keeping with Navy requirements to exercise and evaluate weapons systems and crews in the environments that replicate potential combat areas. The system will be capable of tracking submarines, surface ships, weapons, targets, and Unmanned Underwater Vehicles (UUVs) and distribute the data to a data processing and display system, either aboard ship, or at a shore site. No specific area for use of a PUTR system has been identified in the TMAA.

The PUTR functions by the use of MK-84 tracking pingers affixed to vessels and targets with anchored transponders detecting the pinger signals and relaying those signals to a hydrophone on a buoy or stationary vessel serving as a hub for relay to range controllers via radio. The pingers in the TMAA were modeled as using having a 12.9 kHz, 15 millisecond signal at 194 dB re 1µPa every two seconds. The transponders were modeled as in 1,800 m depth and operating at 8.8 kHz with each pinger report assumed to be 15 milliseconds duration. The transponder spacing is designed so that four transponders will hear each pinger signal. Therefore, for every pinger signal there will be four transducer reports – one ping every two seconds is representative. However, not every ping will be heard. The design of the PUTR assumes 63% (5 in 8) will be received by the transducer. It is therefore assumed that of the 30 pinger signals per minute (per pinger), an average of 19 (63%) pinger signals will be received by four transponders and therefore generate 76 pinger signal reports from transponders to the range relay hub.

MK-39 Expendable Mobile Anti-Submarine Warfare Training Target (EMATT)

An Expendable Mobile Anti-Submarine Warfare Training Target (EMATT) is a device approximately two feet in length and three inches in diameter looking like a small torpedo. EMATT can be launched by hand from a surface vessel or deployed from a submarine or aircraft. EMATTs are programmed to move through the water and provide acoustic broadband noise and magnetic signals that mimic a submarine. For modeling, a speed of five knots and a depth of 100 meters was modeled as representative with the acoustic output a continuous tone 900 Hz at 130 db for four hours.

SUS MK-84 Signaling Devices

The SUS MK-84 signaling device is a small bomb shaped device that can be deployed from aircraft and ships and is used to communicate with submarines. Two seconds after the SUS MK-84 enters the water, it begins emitting a coded signal for approximately 70 seconds. Depending on the mode selected, the tone alternates between two frequencies (3.3 kHz and 3.5 kHz) in a one to three second interval, or operates at at the single 3.5 kHz frequency. For modeling, a total of 35 pings at 3.4 kHz and a source level of 160 dB/uPa for two seconds each at one second intervals at 50 meters depth was modeled to be representative of the device.

Quantification from acoustic impact modeling for active sonar and other non-sonar acoustic sources use under Alternative 1 and possible exposures for rare animals indicates 215,053 MMPA Level B harassments from non-TTS (Table 3.8-13). The modeling also indicates 466 MMPA Level B harassments from TTS. Without consideration of the reduction expected from implementation of mitigation measures, the total MMPA Level B harassments for active sonar use is 215,519 under Alternative 1.

Table 3.8-13: Alternative 1 Annual Sonar and Non Sonar Acoustic Exposures Summary

Species	MMPA Level B Harassment		MMPA Level A Harassment
	Non-TTS	TTS	PTS
ESA Species			
Blue whale	1*	0	0
Fin whale	5,501	11	0
Humpback whale	694	3	0
North Pacific Right whale	1*	0	0
Sei whale	4*	0	0
Sperm whale	164	0	0
Steller sea lion	5,553	1	0
Non-ESA Listed Species			
Baird's beaked whale	243	1	0
Cuvier's beaked whale	1,151	3	0
Dall's porpoise	102,750	384	1
Gray whale	192	1	0
Harbor Porpoise	5,438	0	0
Killer whale	5,301	20	0
Minke whale	341	1	0
Pacific white-sided dolphin	8,456	30	0
Stejneger's beaked whale	1,151	3	0
California sea lion	1*	0	0
Harbor seal	1*	0	0
Northern elephant seal	1,031	0	0
Northern fur seal	77,079	8	0
Total	**215,053**	**466**	**1**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 µPa^2-s; PTS = 215 dB, re 1 µPa^2-s; Northern elephant seal TTS = 204 re 1 µPa^2-s, PTS = 224 re 1 µPa^2-s; Otariids TTS = 206 re 1 µPa^2-s, PTS = 226 re 1 µPa^2-s; * = Accounting for rare animals.

Notes: ESA = Endangered Species Act; MMPA = Marine Mammal Protection Act, PTS = Permanent Threshold Shift, TTS = Temporary Threshold Shift

Without consideration of the reduction expected from implementation of mitigation measures, modeling indicates potential for one MMPA Level A harassment under Alternative 1 for acoustic sources. This one exposure should not occur given it is predicted for Dall's porpoise, which should be readily detectable given their general large group size and characteristic porpoising behavior. The implementation of the mitigation procedures presented in Section 5.1.7 will also reduce the potential occurrence for some of the modeled MMPA Level B marine mammal exposures and harassments (NMFS 2008).

Behavioral effects modeling indicates sonar use under Alternative 1 may affect ESA listed blue, fin, humpback, North Pacific right, sei, and sperm whales, and Steller sea lions. It is not likely that use of acoustic sources associated with training activities would result in effects to the life functions of marine mammals in the TMAA based on previous NMFS Biological Opinions for the same actions in other locations (NMFS 2008, 2009b; NOAA 2009). In accordance with EO 12114, non-explosive practice ordnance would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Expended Materials

Under the Alternative 1, 20,223 expendable items may be used resulting in a 26 percent increase over the No Action. The types and quantities of materials expended and information regarding fate and transport of these materials within the marine environment are discussed in Section 3.2 (Expended Materials), and Section 3.3 (Water Resources). The analyses in these sections determined that most expended materials rapidly sink to the seafloor where they become encrusted by natural processes or are incorporated into the seafloor, with no substantial accumulations in any particular area and no significant negative effects to water quality or marine benthic communities. Given that materials expended during training do not remain at the surface and are generally used in areas where the water depth is beyond that of foraging marine mammals, it is unlikely expended materials would later be encountered by any marine mammal.

Portable Undersea Tracking Range (PUTR) Materials

Upon deployment of the PUTR, clump weights are used to anchor up to 7 transponders in place. As a result of these anchor weights, there would be direct localized impact to bottom habitat; however, this should have no impact on marine mammals. Sediments stirred up by the clump weight anchors should only result in a temporary and localized turbidity. Upon completion of the exercise, the transponders are recovered, which eliminates any potential impacts associated with hazardous materials such as batteries and electronic components associated with the PUTR system. The clump weights are not recovered, and since they are composed of inert material (such as iron, chain, or concrete), they are not a potential source of contaminants. The expending of PUTR anchor weights under Alternative 1 is not likely to have an impact on marine mammals.

Ordnance-Related Materials

The number of ordnance related materials used in the TMAA would increase under Alternative 1 (Table 2-8) to 19,101, increasing by approximately 21 percent from current conditions.

Ingestion of ordnance under Alternative 1 may affect sperm whales. Ordnance-related materials under Alternative 1 should have no effect on ESA listed blue whales, fin whales, humpback whales, North Pacific right whales, sei whales, Steller sea lions or other marine mammals in the TMAA based on the feeding habits of these species. Ordnance-related materials would not be expected to result in MMPA Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, ordnance-related materials would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Target Related Materials

The number of targets and target-related material used in the TMAA would increase to 125 or by about 95 percent over the No Action. There would be the introduction of Expendable Mobile Anti-Submarine Warfare Training Target (EMATT) under Alternative 1. As discussed above for the No Action Alternative, species that feed on or near the bottom (which are the sperm whales and beaked whales) may encounter an expended target while feeding; however, the size of the target would generally prohibit any listed species from ingesting it. Therefore, the use of targets under Alternative 1 likely would have no effect, but may affect ESA listed marine mammals. Targets would not be expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with E.O. 12114, targets would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Chaff

Under Alternative 1, there would be no change in the quantity of chaff used (540 lbs/245 kg) for the No Action. As detailed in Section 3.2.1.1, chaff consists of aluminum-coated fibers used as an electronic countermeasure designed to reflect radar waves and obscure aircraft, ships, and other equipment from radar tracking sources. Upon deployment, the chaff fibers are widely dispersed in the air and eventually land in the water and sink to the ocean floor.

As first presented in DoN (2009), the dispersion characteristics of chaff make it likely that marine mammals would occasionally come in direct contact with chaff fibers while at the water's surface and while submerged, but such contact would be inconsequential. Chaff is similar in form to fine human hair with the fibers being flexible and soft. Evaluation of the potential for chaff to be inhaled by humans, livestock, and animals found that the fibers are too large to be inhaled into the lung (Arfsten et al. 2002, Hullar et al. 1999, USAF 1997). Although these reviews did not specifically consider the respiratory system of large whales, any effects of chaff inhalation on marine mammals are considered insignificant given the dispersal of chaff fibers resulting in very low concentration in the air.

While no studies have been conducted to evaluate the effects of chaff ingestion on marine mammals, the effects are expected to be insignificant and discountable based the low concentrations when dispersed, the small size of chaff fibers, available data on the toxicity of chaff components (silicon dioxide and aluminum), and evidence indicating the lack of significant accumulation of aluminum in sediments after prolonged training (DoN 2009). Silicon and aluminum are two of the most abundant elements in the earth's crust. Marine mammals, such as gray whales that forage on the bottom, routinely ingest sediment containing these elements. The aluminum concentrations in brain tissue of gray whales are within the range for terrestrial mammals that may receive high concentrations of aluminum in their diets, suggesting a broad range in tolerance to aluminum in mammals (Varanasi et al. 1993, Tilbury 2002, DoN 2009). Chaff cartridge plastic end-caps and pistons would also be expended into the marine environment, where they would sink and could potentially be ingested by marine mammals. Based on the low concentration of these components in the TMAA, it is very unlikely a marine mammal would encounter a plastic end-cap or piston from the chaff cartridge. Even in the very unlikely event one of these components was encountered and then consumed by a marine mammal, the small size of chaff end-caps and pistons (1.3 inch [33 mm] diameter and 0.13 inch [3.3 mm] thick) would suggest it would likely pass through the digestive tract and be voided without causing harm.

Under ESA, chaff use under the Alternative 1 may affect blue, fin, humpback, North Pacific right, sei, and sperm whales but these effects are insignificant and discountable. Use of chaff is not expected to result in Level A or Level B harassment as defined by the MMPA and would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

Marine Markers

The number of marine markers used in the TMAA would increase under Alternative 1 to 60 per year. The probability of a marine mammal ingesting an expended marine marker would be essentially the same as under the No Action Alternative (using 20 markers). Marine marker ingestion under Alternative 1 may affect ESA-listed marine mammals. The use of marine markers is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of marine markers during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

TALDS

The number of TALDS used in the TMAA would increase under Alternative 1 to 12 per year. The probability of a marine mammal ingesting pieces of an expended TALD would be essentially the same as under the No Action Alternative (using 8 TALDS). TALD ingestion under Alternative 1 may affect ESA-listed marine mammals. The use of TALDS is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of TALDS during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

BQM-74Es

The number of BQM-74Es used in the TMAA under Alternative 1 would remain at 2 per year. The probability of a marine mammal ingesting pieces of an expended BQM-74E would be the same as under the No Action Alternative. BQM-74E ingestion under Alternative 1 may affect ESA-listed marine mammals. The use of BQM-74Es is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of BQM-74Es during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

EMATT

There was no use of EMATTs under the No Action Alternative. The use of up to 6 EMATTs could occur under Alternative 1 in support of ASW Training. An EMATT is a small device (approximately 2 ft in length and 3 inches in diameter) shaped like a torpedo that can be launched by hand from a surface vessel or deployed from a submarine or aircraft. EMATTs are programmed to move through the water and provide acoustic and other sensor that mimic a submarine. At the end of its use, an EMATT will sink to the floor of the ocean. Expended EMATTs are unlikely to result in any physical impacts to the sea floor. Expended EMATTs would sink into a soft bottom or would lie on a hard bottom, where they may provide a substrate for benthic colonization and may be covered eventually by shifting sediments.

DICASS, SUS MK-84, and Passive Sonobuoys

There was no use of active sonobuoys under the No Action Alternative, however, the number of SSQ-36 expendable Bathythermograph (BT) sonobuoys would increase from 24 under current conditions to 60 under Alternative 1. The use of passive and active sonobuoys for ASW is proposed under Alternative 1. Introduced for the first time under Alternative 1, approximately 133 active (SSQ-62 DICASS) acoustic sonobuoys would be deployed in the TMAA annually and approximately 500 passive SSQ-53 Directional Frequency and Ranging (DIFAR) sonobuoys would be used in conjunction with the DICASS sonobuoys. Approximately 60 SSQ-77 Very Long Range Acoustic Detection (VLAD) passive sonobuoys would also be used under Alternative 1. Approximately 12 SUS MK-84 signaling devices would be used under Alternative 1.

Entanglement impacts to marine mammals from sonobuoys and other expended debris are unlikely. The assemblies would sink and the density of such debris in the TMAA would be a very low concentration. Expended sonobuoys are a potential ingestion hazard for marine mammals while they are floating, while they are descending to the seafloor, or after they sink to the bottom. However, the probability of ingestion is extremely low based on the low number of sonobuoys expended per year (745) across the TMAA. Sonobuoy ingestion under Alternative 1 may affect ESA-listed marine mammals. The use of passive sonobuoys is not expected to result in Level A or Level B harassment as defined by the MMPA. Effects of active sonobuoys are addressed as part of the sonar analysis. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of passive sonobuoys during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

Critical Habitats

There is no critical habitat located or PCEs in the TMAA. Therefore, in accordance with ESA consultation provisions to assess potential effects of proposed actions to critical habitat, it is concluded that Navy activities of Alternative 1 will have no effect on any critical habitat.

3.8.7.9 Alternative 2

Vessel Movements

Under Alternative 2, the number of vessels would remain the same as under Alternative 1. However, The Navy has proposed providing the flexibility to conduct (as required) a second summer exercise within the TMAA between 2010 and 2015. Within the maximum two summer exercises, the length of the exercise, the number of vessels, and the allotted at-sea time within the TMAA during an exercise will be variable between years. These variations cannot be predicted given unknowns including the availability of participants for the annual exercise(s), which is a direct result of factors such as Navy responses to real-world events (e.g., tactical deployments, disaster relief, humanitarian assistance, etc.), planned and unplanned deployments, vessel availability due to funding and maintenance cycles, and logistic concerns with conducting an exercise in the GOA. The Navy predicts, however, there will be no increase required in excess of two annual summer exercises as described for Alternative 2 over the course of the 2010 and 2015 timeframe such that it is unlikely increases in steaming days would occur during this time period.

The additional vessel movements under Alternative 2 would result in a small increased potential for short-term behavioral reactions to naval vessels. Potential for collision would increase slightly compared to the No Action Alternative during each of two possible summertime exercises; however, Navy mitigation measures would reduce the probability and vessel collisions with whales remains unlikely. Vessel movements under Alternative 2 may affect ESA-listed marine mammals. Vessel movements are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, vessel movements would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]) in accordance with EO 12114.

Aircraft Overflights

Alternative 2 would include 600 fixed-wing aircraft sorties (a 100 percent increase over the No Action). There would be 118 events involving helicopters in the TMAA compared to 32 under the No Action Alternative (existing conditions). The number of aircraft sorties and events using helicopter are double for Alternative 2 as compared to Alternative 1 and would occur in the same locations. As a result, the potential for marine mammals to be exposed to overflights would increase compared to baseline conditions. Some training would involve supersonic flight, resulting in sonic booms, but such airspeeds are infrequent and occur above 30,000 ft (9,144 m) and at least 30 nm (56 km) offshore, further reducing their potential for noise impacts. Peak noise levels generated by individual SH-60 helicopters would be similar to the noise levels generated with the No Action Alternative.

The additional overflights may result in increased instances of behavioral disturbance due to sound, shadow-effects, and/or, in the case of helicopters, water column disturbance. Similar to the No Action Alternative, the responses would be limited to short-term behavioral or physiological reactions. It is not likely that exposures to aircraft overflights associated with training activities would result in effects to the life functions of marine mammals in the TMAA. Aircraft overflights under Alternative 2 may affect ESA-listed marine mammals. Aircraft overflights are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO12114, aircraft overflights would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]). All aircraft overflights between the shore and 12 nm (22 km) from land would occur at altitudes at or above 15,000 ft (915 m) and would have no effect on marine mammals.

Non-explosive Practice Ordnance

The total number of non-explosive practice projectiles would increase with Alternative 2. The number of non-explosive practice ordnance events by type of projectile occurring for Alternative 2 is presented in Table 2-7. Non-explosive practice ordnance includes naval gunshells (20mm, 25mm, 57mm, 76mm, and 5-in projectiles) and small arms rounds (7.62mm and .50-caliber projectiles). Under Alternative 2, there would be about 27,176 naval gunshells and about 11,400 small arms projectiles expended into the ocean. Compared to the No Action Alternative, there would be increases of about 157 percent and 128 percent respectively, in naval gunshells and small arms projectiles.

These changes would result in increased potential exposure of marine mammals to non explosive practice ordnance strikes; however, Navy standard operating procedures and mitigation measures would reduce the probability of strikes by modifying training activities when marine mammals are known to be in the area. It is not likely that use of non-explosive ordnance associated with training activities would result in effects to the life functions of marine mammals in the TMAA. There should be no effect from use of non-explosive practice ordnance, but it may affect ESA-listed marine mammals under Alternative 2. Non-explosive ordnance use is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, non-explosive practice ordnance would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Explosive Ordnance (At-Sea Explosions)

The number of high explosive events by type of ordnance occurring for Alternative 2 is presented in Table 2-8. In addition to 84 5-inch and 28 76mm live rounds, a total of 144 high-explosive bombs (MK-82, MK-83 and MK-84 types), and two MK-48 torpedoes will be detonated in the water annually. Much of this increase in at-sea explosions is due to the introduction of two proposed SINKEX events per year. While recognizing a SINKEX event concentrates explosives at a single location that has been observed to be free of marine mammals and sea turtles, this represents a 580 percent increase in live gunfire and a 206 percent increase for bomb detonations in the water as compared to the No Action Alternative. These changes would represent an increased potential for marine mammals exposure to detonation concussion effects from ordnance use and behavioral disturbance. In addition, under Alternative 2 approximately 80 of the SSQ-110 sonobuoys, which have an explosive as a sound source, would be used for training in the TMAA.

SINKEX

In addition to the events noted above, under Alternative 2 the potential to conduct a SINKEX training event during each of the two possible summer exercise periods is also proposed. During a SINKEX, a decommissioned vessel is towed to a deep-water location and sunk using a variety of ordnance containing high explosives that may include missiles, bombs, and gunfire. For each SINKEX, there may be up to 17 missiles, 10 non-inert bombs, and 400 explosive rounds of 5-inch gunfire used during the event. For modeling purposes it was assumed that all missiles except a portion of the Maverick missiles fired would hit the target vessel. Approximately one third of the non-guided munitions used (one Maverick missile, three bombs, and 120 of the 5-inch rounds) were modeled as missing the target vessel and exploding in the water (for details, see Appendix D). SINKEX may also include the use of one MK-48 torpedo, which can be used at the end of SINKEX if the target is still afloat.

Aspects of the SINKEX event that have potential effects on marine mammals (e.g., vessel movement, aircraft overflights, gunfire firing noise, munitions constituents) have been analyzed separately in previous sections. If a marine mammal remained in the immediate vicinity of the SINKEX, ordnance missed the target vessel, and then impacts the water at or near a marine mammal, behavioral disturbance, injury, or mortality could occur. SINKEX under Alternative 2 is, however, not likely to result in injury or mortality given the assumption that marine mammals will not remain in the vicinity of the activities surrounding a SINKEX event and that mitigation involving area clearance requirements during the lengthy set-up to safely conduct a SINKEX (see Section 5.2.1.2) will reduce the likelihood that animals would be in the vicinity during the event. The modeled explosive exposure harassment numbers by species are presented in Table 3.8-14. The table quantifies MMPA Level B harassment from behavioral disturbance and MMPA Level A harassment from potential injury to marine mammals.

Table 3.8-14: Alternative 2 Annual At-Sea Explosion Exposures Summary

Species	MMPA Level B Harassment		MMPA Level A Harassment	Mortality
	Sub-TTS 177dB dB re 1μPa^2-s (MSE)	TTS 182 dB / 23 psi	50 percent TM Rupture 205 dB Slight Lung Injury or 23 psi-ms	Onset massive Lung Injury or Mortality 31 psi-ms
ESA Species				
Blue whale	1*	0	0	0
Fin whale	13	5	0	0
Humpback whale	1	0	0	0
North Pacific Right whale	1*	0	0	0
Sei whale	4*	0	0	0
Sperm whale	1*	0	0	0
Steller sea lion	2	1	0	0
Non-ESA Listed Species				
Baird's beaked whale	1	0	0	0
Cuvier's beaked whale	3	1	0	0
Dall's porpoise	84	37	2	1
Gray whale	3*	0	0	0
Harbor Porpoise	2*	0	0	0
Killer whale	4	2	0	0
Minke whale	2*	0	0	0
Pacific white-sided dolphin	12	6	1	0
Stejnger's beaked whale	4	1	0	0
California sea lion	1*	0	0	0
Harbor Seal	1*	0	0	0
Northern elephant seal	4	1	0	0
Northern fur seal	26	16	1	0
Total	**170**	**70**	**4**	**1**

Notes: dB = decibel, dB re 1μPa2-s = decibels referenced to 1 micropascal squared per second, ESA = Endangered Species Act, MMPA = Marine Mammal Protection Act, MSE = Multiple Successive Explosions, psi = pound per square inch, psi-ms = pounds per square inch per millisecond, TM = Tympanic membrane, TTS = Temporary Threshold Shift; * = Accounting for rare animals.

Without consideration of target area clearance procedures as standard mitigation, quantification from behavioral effects modeling, accounting for rare species indicates at-sea explosion exposures under Alternative 2 may affect ESA listed blue, fin, humpback, North Pacific right, sei, and sperm whales, and

Steller sea lions. For large whales, exposures in vicinity to a source are unlikely to occur given the sightability of species such as blue, fin, humpback, North Pacific right, sei, and sperm whales.

For at-sea explosions under Alternative 2, quantification from modeling and accounting for rare species indicates 170 MMPA Level B harassments from sub-TTS for MSE. The modeling indicates 70 MMPA Level B harassments from TTS. Under Alternative 2 for at-sea explosions, quantification from modeling and accounting for rare species, indicates a total of 240 MMPA Level B harassments annually.

Quantification from modeling also indicates potential for four MMPA Level A harassments from slight injury and one estimated exposure that could result in severe injury or mortality. The exposure modeling results are an estimate of marine mammal at-sea explosion sound exposures without consideration of standard mitigation procedures summed across all at-sea explosion events during the two proposed exercises per year. The implementation of the mitigation procedures presented in Section 5.1.7 will reduce the potential for marine mammal exposure and harassment through area clearance procedures (NMFS 2008). The set up procedures and checks required for safety of event participants make it unlikely Dall's porpoise, Pacific white-sided dolphin, or Northern fur seal would remain in an area undetected during the set-up of the event or before explosive detonation occurred during the period the target area or SINKEX is under observation. In addition, the distances from an at-sea explosion at which these injuries would occur are relatively short and well within the buffer zones established as standard mitigation (see Section 5.1.7.2). Therefore, the four MMPA Level A harassments and the one severe injury/mortality are predicted by the modeling without consideration of standard mitigation should not occur.

Active Sonar and Other Non-Sonar Acoustic Sources for ASW Training

There was no sonar use in conjunction with ASW training under the No Action Alternative. Under Alternative 2, use of sonar and other non-sonar acoustic sources would double above that proposed in Alternative 1. This sonar and other non-sonar acoustic source use for ASW training is associated with the potential addition of another carrier strike group participating in the training during a second summer time-frame exercise. However, it is unlikely that effects to marine mammals from sonar and other non-sonar acoustic source use would be significant because of the mitigation measures employed by the Navy to exclude marine mammal presence in the vicinity of the sources.

Alternative 2 would include mid and high frequency sonar use, including 578 hours of SQS-53 and 52 hours of SQS-56 surface ship sonar (315 additional hours of usage over Alternative 1), the BQQ-10 (48 hours) and BQS-15 (24 Hours) submarine sonars (twice that of Alternative 1), 266 active SSQ-62 sonobuoys (increase of 133 sonobuoys compared to Alternative 1), and 192 dips (an increase of 96 compared to Alternative 1) of helicopter dipping sonar (see Table 3.8-15 and 3.8-16).

Table 3.8-15: Annual Sonar Hours and Sources for Alternative 2

	SQS 53 Sonar [a]	SQS-56 Sonar [a]	BQQ-10 Sonar [a]	BQS-15 Sonar [a]	SSQ-62 DICASS Sonobuoy[b]	AQS 22 Dipping Sonar[c]
Alternative 2	578	52	48	24	266	192

Notes: a = Number reflects hours of operations not total transmission time, representative for all variants of system. b = Number is counted by buoy, c = Number is counted as individual use "dips" of the system

Non-Sonar Acoustic Sources Used During Training

In addition to the use of mid- and high frequency sonar, additional non-sonar acoustic sources used during training under the Alternative 2 would include components of the Portable Undersea Tracking Range including MK-84 Range Tracking Pingers (80 ea) and Transponders (80 ea), plus MK-39 EMATT targets (12 ea) and SUS MK-84 signaling devices (24 ea) as shown in Table 3.8-16. Use of these sources did not occur under the No Action Alternative and are double the numbers proposed for Alternative 1.

Table 3.8-16: Annual Non-Sonar Acoustic Sources for Alternative 2

	MK-84 Range Tracking Pinger[a]	PUTR Transponder[a]	MK-39 EMATT targets[b]	SUS MK-84 signaling devices[b]
Alternative 2	80	80	12	24

Notes: a = This number reflects hours of operation for the PUTR system under average conditions and is not total transmission time of the components. b = Number is counted by device.

Quantification from behavioral effects modeling, accounting for rare species for which modeling was not possible, and for which modeling provided an estimate of zero exposures, indicates sonar use under Alternative 2 may affect ESA listed blue, fin, humpback, North Pacific right, sei, and sperm whales, and Steller sea lions

Quantification from behavioral effects modeling and accounting for rare species indicates 424,620 MMPA Level B harassments from non-TTS for Alternative 2 (Table 3.8-17). The modeling also indicates 931 MMPA Level B harassments from TTS. There is one predicted MMPA Level A harassment from PTS for Alternative 2. This one MMPA Level A harassment should not, however, occur given it is predicted for Dall's porpoise, which should be readily detectable given their general large group size and characteristic porpoising behavior. Without consideration of the reduction expected from implementation of mitigation measures, modeling and accounting for rare species estimates a total of 425,551 MMPA Level B harassments for active sonar and non-sonar acoustic sources for Alternative 2. The implementation of the mitigation and monitoring procedures presented in Section 5.1.7 will reduce the potential occurrence for some of these modeled marine mammal exposures and harassments (NMFS 2008).

Under Alternative 2, sonar use may result in Level B harassment as defined by the MMPA. Sonar and non-sonar acoustic source use under Alternative 2 would not result in Level A harassment as defined by the MMPA. MMPA Level B harassments associated with Alternative 2 may affect the ESA listed blue whales, fin whales, humpback whales, North Pacific right whales, sei whales, sperm whales, and Steller sea lions.

It is not likely that use of sonar and other acoustic sources associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, use of sonar and other acoustic sources would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Table 3.8-17: Alternative 2 Annual Sonar and Non-Sonar Acoustic Exposures Summary

Species	MMPA Level B Harassment		MMPA Level A Harassment
	Non-TTS	TTS	PTS
ESA Species			
Blue whale	1*	0	0
Fin whale	10,998	21	0
Humpback whale	1,388	6	0
North Pacific Right whale	1*	0	0
Sei whale	4*	0	0
Sperm whale	327	1	0
Steller sea lion	11,104	1	0
Non-ESA Listed Species			
Baird's beaked whale	485	1	0
Cuvier's beaked whale	2,302	6	0
Dall's porpoise	205,485	768	1
Gray whale	384	1	0
Harbor Porpoise	5,438	0	0
Killer whale	10,602	41	0
Minke whale	677	2	0
Pacific white-sided dolphin	16,912	61	0
Stejneger's beaked whale	2,302	6	0
California sea lion	1*	0	0
Harbor seal	1*	0	0
Northern elephant seal	2,064	0	0
Northern fur seal	154,144	16	0
Total	**424,620**	**931**	**1**

TTS and PTS Thresholds: Cetaceans TTS = 195 dB re 1 μPa^2-s; PTS = 215 dB, re 1 μPa^2-s; Northern elephant seal TTS = 204 re 1 μPa^2-s, PTS = 224 re 1 μPa^2-s; Otariids TTS = 206 re 1 μPa^2-s, PTS = 226 re 1 μPa^2-s; * = Accounting for rare animals.

Notes: ESA = Endangered Species Act, MMPA = Marine Mammal Protection Act, PTS = Permanent Threshold Shift, TTS = Temporary Threshold Shift

Special Considerations for Beaked Whales

Neither NMFS nor the Navy anticipates that marine mammal strandings or mortality will result from the operation of mid-frequency sonar during Navy exercises within the TMAA. The history of Navy activities in the Gulf of Alaska and analysis in this document indicate that military readiness activities are not expected to realistically result in any sonar-induced Level A injury or mortalities to marine mammals.

However, evidence from five beaked whale strandings occurring at various locations around the world over approximately a decade, suggests that the exposure of beaked whales to mid-frequency sonar in the presence of certain conditions (e.g., multiple units using tactical sonar, steep bathymetry, constricted channels, strong surface ducts, etc.) may result in strandings, potentially leading to mortality. Although these physical factors believed to contribute to the likelihood of beaked whale strandings are not present, in their aggregate, in the TMAA, scientific uncertainty exists regarding what other factors, or combination of factors, may contribute to beaked whale strandings. Recent data from the Southern California Range

Complex (Falcone et al. 2009), where Navy ASW activities have been occurring year-round for decades, indicates Cuvier's beaked whales are resident at that ASW training location with no apparent effect from exposure to mid-frequency sonar.

To allow for scientific uncertainty regarding the strandings of beaked whales and the exact mechanisms of the physical effects, the Navy will request authorization for take, by mortality, of the beaked whale species present in the TMAA despite the decades long history of these same training operations with the same basic equipment having had no know effect on beaked whales at any Navy training ranges where mid-frequency sonar training routinely has occurred.

Accordingly and to account for this potential under the preferred alternative, the MMPA Letter of Authorization request will include an annual mortality take request for a total of three (3) beaked whales of the Ziphidae family, to include any combination of Baird's beaked whale, Cuvier's beaked whale, Stejneger's beaked whale, and Mesoplodon sp.

Expended Materials

The amount of expended materials would increase to 41,298 items or approximately 160 percent in the TMAA under Alternative 2 as compared to the No Action Alternative.

Portable Undersea Tracking Range (PUTR) Materials

Upon deployment of the PUTR, clump weights are used to anchor transponders in place. As a result of these anchor weights, there would be direct localized impact to bottom habitat; however, this should have no impact on marine mammals. Sediments stirred up by the clump weight anchors should only result in a temporary and localized turbidity. Upon completion of the exercise, the transponders are recovered, which eliminates any potential impacts associated with hazardous materials such as batteries and electronic components associated with the PUTR system. The clump weights are not recovered, and since they are composed of inert material, they are not a potential source of contaminants. The expending of PUTR anchor weights under Alternative 2 is not likely to have an impact on marine mammals.

Ordnance-Related Materials

The amount of ordnance-related materials would increase to 39,060 items or approximately 149 percent in the TMAA under Alternative 2 as compared to the No Action Alternative. Ingestion of ordnance under Alternative 2 may affect sperm whales. Ordnance-related materials under Alternative 2 should have no effect on the remaining ESA-listed species (blue, fin, humpback, North Pacific right, sei and sperm whales, and Steller sea lions) or other marine mammals in the TMAA based on the feeding habits of these species and the likely deep water areas where training using ordnance will occur. It is not likely that use of ordnance related material associated with training activities would result in effects to the life functions of marine mammals in the TMAA. Ordnance-related materials would not be expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with EO 12114, ordnance related materials would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Target-Related Materials

Under Alternative 2, the number of targets used in the TMAA would increase to 250 by 290 percent over the No Action Alternative. As discussed above for the No Action Alternative, species that feed on or near the bottom (which are the sperm whales and beaked whales) could possibly encounter an expended target while feeding; however, the size of the target or pieces would generally prohibit any listed species from ingesting it. However, if target materials are fragmented into smaller pieces, there is a possibility to ingest fragments while feeding on the sea floor although the required co-occurrence of these unlikely events is considered discountable. Therefore, Alternative 2 may affect sperm whales under the ESA. Ingestion of target-related materials under Alternative 2 should not affect the other ESA listed marine mammals (blue, fin, humpback, North Pacific right, sei, and sperm whales, and Steller sea lions) given their feeding habits. Target materials would not be expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that use of targets associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO12114, targets would not cause significant harm to marine mammals in nonterritorial seas (seaward of 12 nm [22 km]).

Chaff

Under Alternative 2, the quantity of chaff used (1080 lbs/490 kg) would increase by 100 percent from the No Action. This increase is not considered significant given the size of the area involved. As detailed in Section 3.2.1.1, chaff consists of aluminum-coated fibers used as an electronic countermeasure designed to reflect radar waves and obscure aircraft, ships, and other equipment from radar tracking sources. Upon deployment, the chaff fibers are widely dispersed in the air and eventually land in the water and sink to the ocean floor.

As first presented in DoN (2009), the dispersion characteristics of chaff make it likely that marine mammals would occasionally come in direct contact with chaff fibers while at the water's surface and while submerged, but such contact would be inconsequential. Chaff is similar in form to fine human hair with the fibers being flexible and soft. Evaluation of the potential for chaff to be inhaled by humans, livestock, and animals found that the fibers are too large to be inhaled into the lung (Arfsten et al.2002, Hullar et al. 1999, USAF 1997). Although these reviews did not specifically consider the respiratory system of large whales, any effects of chaff inhalation on marine mammals are considered insignificant given the dispersal of chaff fibers resulting in very low concentration in the air.

While no studies have been conducted to evaluate the effects of chaff ingestion on marine mammals, the effects are expected to be insignificant and discountable based the low concentrations when dispersed, the small size of chaff fibers, available data on the toxicity of chaff components (silicon dioxide and aluminum), and evidence indicating the lack of significant accumulation of aluminum in sediments after prolonged training (DoN 2009). Silicon and aluminum are two of the most abundant elements in the earth's crust. Marine mammals, such as gray whales that forage on the bottom, routinely ingest sediment containing these elements. The aluminum concentrations in brain tissue of gray whales are within the range for terrestrial mammals that may receive high concentrations of aluminum in their diets, suggesting a broad range in tolerance to aluminum in mammals (Varanasi et al. 1993, Tilbury 2002, DoN 2009). Chaff cartridge plastic end-caps and pistons would also be expended into the marine environment, where they would sink and could potentially be ingested by marine mammals. Based on the low concentration of these components in the TMAA, it is very unlikely a marine mammal would encounter a plastic end-cap or piston from the chaff cartridge. Even in the very unlikely event one of these components was encountered and then consumed by a marine mammal, the small size of chaff end-caps and pistons (1.3 inch [33 mm] diameter and 0.13 inch [3.3 mm] thick) would suggest it would likely pass through the digestive tract and be voided without causing harm.

Under ESA, chaff use under the Alternative 2 may affect blue, fin, humpback, North Pacific right, sei, and sperm whales but these effects are insignificant and discountable. Use of chaff is not expected to result in Level A or Level B harassment as defined by the MMPA and would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

SINKEX

As described previously in Section 2.6.1.1, a SINKEX event involves use of a decommissioned and environmentally remediated vessel as a target for training involving the use of bombs, missiles, gunfire, and torpedoes. Analysis of effects on marine mammals from at-sea explosions during a SINKEX was presented in the preceding sub-section. Analysis of the SINKEX vessel as expended material was presented in Section 3.2.2.6. In summary, however, each target vessel is made environmentally safe for sinking according to standards set by the U.S. Environmental Protection Agency (EPA). Requirements are that the SINKEX must occur greater than 50 nm (93 km) out to sea and in water depths greater than 6,000 ft (1,830 m) (40 C.F.R. § 229.2), which is beyond the known dive depth of marine mammals. The presence of a vessel hull on the bottom in excess of 6,000 ft (1,830 m) depth should have no effect on marine mammals.

Marine Markers

The number of marine markers used in the TMAA would increase 500 percent from the No Action under Alternative 2 to 120 per year. The probability of a marine mammal ingesting an expended marine marker would be extremely low based on the low concentration in the TMAA (0.014/nm^2). Marine marker ingestion under Alternative 2 may affect ESA-listed marine mammals. The use of marine markers is not expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that use of marine markers associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of marine markers during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

TALDS

The number of TALDS used in the TMAA would increase 200 percent from the No Action under Alternative 2 to 24 per year. The probability of a marine mammal ingesting a piece of an expended TALD would be extremely low based on the size of the TMAA. TALD ingestion under Alternative 2 may affect ESA-listed marine mammals. The use of TALDS is not expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that use of TALDS associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from the use of TALDS during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

BQM-74Es

The number of BQM-74Es used in the TMAA would increase 100 percent from the No Action under Alternative 2 to 4 per year. The probability of a marine mammal ingesting a piece of an expended BQM-74E would be extremely low based on the size of the TMAA. BQM-74E ingestion under Alternative 2 may affect ESA-listed marine mammals. The use of BQM-74Es is not expected to result in Level A or Level B harassment as defined by the MMPA. It is not likely that use of BQM-74Es associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from the use of BQM-74Es during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

EMATT

Use of EMATTs was not part of the No Action Alternative. The use of up to 12 EMATTs could occur under Alternative 2 in support of ASW Training. This is an increase of 100 percent over Alternative 1.

DICASS, SUS MK-84, and Passive Sonobuoys

The number of SSQ-36 BT sonobuoys could increase up to 120 under Alternative 2 (from 24 under the No Action; a 400 percent increase). There were no active sonobuoys used in conjunction with ASW training under the No Action Alternative. The number of passive and active sonobuoys would increase annually under Alternative 2 by approximately 200 percent more than Alternative 1. Approximately 1,507 sonobuoys would be deployed in the TMAA. Approximately 66 percent of the sonobuoys would be passive SSQ-53 DIFAR and an additional 8 percent would be passive SSQ-101 VLAD. About 17 percent of all sonobuoys would be active sonar emitters (SSQ-62 DICASS Active). Approximately 267 active (SSQ-62 DICASS) acoustic sonobuoys would be deployed in the TMAA annually and approximately 1,000 passive SSQ-53 Directional Frequency and Ranging (DIFAR) sonobuoys would be used in conjunction with the DICASS sonobuoys. Approximately 120 SSQ-77 Very Long Range Acoustic Detection (VLAD) passive sonobuoys would also be used under Alternative 2. Approximately 24 SUS MK-84 signaling devices would also be used under Alternative 2. Also under Alternative 2 would be the use of the EER system using approximately 80 SSQ-110 active and 80 passive SSQ-101 ADAR.

With regard to potential entanglement encounters between marine mammals and unrecovered sonobuoy and flare parachute assemblies expended during military activities, the entanglement effects would be potentially greater than those described for the No Action Alternative and Alternative 1 because of the greater number of sonobuoy and flare deployments (1,507 more sonobuoys than the No Action Alternative and 732 more sonobuoys than Alternative 1). With Alternative 2 unrecovered materials would sink; the amount remaining on or near the sea surface would be low, and the density of such debris would be double that resulting from Alternative 1 activities. Entanglement impacts to marine mammals from this and other expended debris are unlikely.

Expended sonobuoys are a potential ingestion hazard for marine mammals while they are floating, while they are descending to the seafloor, or after they sink to the bottom. However, the probability of ingestion is extremely low based on the number of sonobuoys expended (1,507) and the size of the TMAA. Sonobuoy ingestion under Alternative 2 may affect ESA-listed marine mammals. The use of passive sonobuoys is not expected to result in Level A or Level B harassment as defined by the MMPA. Acoustic effects of active sonobuoys and SUS MK-84 are addressed as part of the acoustic effects analysis. It is not likely that use of passive sonobuoys associated with training activities would result in effects to the life functions of marine mammals in the TMAA. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of passive sonobuoys during training exercises in nonterritorial seas (seaward of 12 nm [22 km]).

Critical Habitats

There is no designated critical habitat or PCEs within the TMAA. Therefore, in accordance with ESA consultation provisions to assess potential effects of proposed actions to critical habitat, it is concluded that Navy activities of Alternative 2 will have no effect on any critical habitat.

3.8.8 Mitigation

The Navy has implemented a comprehensive suite of mitigation measures that will serve to reduce impacts to marine mammals that might result from Navy training in the TMAA. The mitigation measures applicable to this Proposed Action are described in Section 5.1.7. In order to make the findings necessary to issue a LOA under the MMPA, it may be necessary for NMFS to require additional mitigation or monitoring measures beyond those addressed in this Draft EIS/OEIS. These measures could include measures considered, but eliminated in this Draft EIS/OEIS, or as yet undeveloped measures. The public will have an opportunity, through the MMPA process, both to provide information to NMFS in the comment period following NMFS' Notice of Receipt of the application for an LOA, and to review any additional mitigation or monitoring measures that NMFS might propose in the comment period at the proposed rule stage. The final suite of measures developed as a result of the MMPA process would be identified and analyzed in the Final EIS/OEIS.

Effective training in the TMAA dictates that ship, submarine, and aircraft participants utilize their sensors and exercise weapons to their optimum capabilities as required by the mission. Section 5.1.7 presents a comprehensive list of mitigation measures that would be utilized for training activities analyzed in this

Draft EIS/OEIS in order to minimize potential for impacts on marine mammals and sea turtles in the TMAA.

Section 5.1.7 includes mitigation measures that are followed for all types of exercises; those that are associated with a particular type of training event; and those that apply generally to all Navy training at sea. For major exercises, the applicable mitigation measures are incorporated into a naval message which is disseminated to all of the units participating in the exercise or training event and applicable responsible commands. Appropriate measures are also provided to non-Navy participants (other DoD and allied forces) as information in order to ensure their use by these participants.

The extensive set of protective measures avoids, minimizes, and reduces potential adverse effects of surface, air, and subsurface training and testing activities on marine mammals. In general the protective measures include:

- Training personnel (watchstanders) to detect and report the presence of marine mammals so that activities can be stopped or altered to prevent conflicts or injuries.
- Maneuvering to keep at least 1,500 ft (500 yds) away from any observed whale in the vessel's path and avoid approaching whales head-on. These requirements do not apply if a vessel's safety is threatened, such as when change of course will create an imminent and serious threat to a person, vessel, or aircraft, and to the extent vessels are restricted in their ability to maneuver.
- Taking all practicable steps to alert other vessels in the vicinity of an observed whale.
- Conducting pre-training site surveys for events involving ordnance in the water to detect and clear training areas of marine mammals that might be affected by activities before training activities are initiated.
- Reducing sonar emission when marine mammals are detected in the vicinity of naval activities.
- Adjusting, delaying or moving activities when marine mammals are detected in the area.
- Maintaining protective buffer zones around ships and other vessels when marine mammals are detected within established safety zone distances of ships and sonar exercises.
- Maintaining marine mammal exclusion zones around areas that involve at-sea explosions.
- Coordinating with NMFS before, during, and after major training exercises and reporting incidents that may have involved marine mammals.

The effectiveness of these protective measures was considered in determining the impacts of the proposed alternatives to marine mammals.

Navy shipboard lookouts (also referred to as “watchstanders”) are highly qualified and experienced observers of the marine environment. Their duties require that they report all objects sighted in the water to the Officer of the Deck (e.g., trash, a periscope, marine mammals, sea turtles) and all disturbances (e.g., surface disturbance, discoloration) that may be indicative of a threat to the vessel and its crew. There are personnel serving as lookouts on station at all times (day and night) when a ship or surfaced submarine is moving through the water. Navy lookouts undergo extensive training in order to qualify as a lookout. This training includes on-the-job instruction under the supervision of an experienced lookout, followed by completion of the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects).

The Navy also includes marine species awareness as part of its training for its bridge lookout personnel on ships and submarines. Lookouts are trained how to look for marine species, and report sightings to the

Officer of the Deck so that action may be taken to avoid the marine species or adjust the exercise to minimize effects to the species. Marine Species Awareness Training (MSAT) was updated in 2006, and the additional training materials are now included as required training for Navy ship and submarine lookouts. This training addresses the lookout's role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments, and general observation information to aid in avoiding interactions with marine species. Additionally, all Commanding Officers and Executive Officers (CO/XOs) of units involved in training exercises are also required to review the marine species awareness training material.

3.8.1.2 Alternative Mitigation Measures Considered but Eliminated

As described in Section 3.8.6, the vast majority of estimated sound exposures of marine mammals during proposed active sonar activities would not cause injury. Potential acoustic effects on marine mammals would be further reduced by the mitigation measures described in Section 5.1.7. Therefore, the Navy concludes the Proposed Action and mitigation measures would achieve the least practical adverse impact on species or stocks of marine mammals.

A determination of "least practicable adverse impacts" includes consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity in consultation with the DoD. Therefore, the following additional mitigation measures were analyzed and eliminated from further consideration:

- Reduction of training. The requirements for training have been developed through many years of iteration to ensure sailors achieve levels of readiness to ensure they are prepared to properly respond to the many contingencies that may occur during an actual mission. These training requirements are designed provide the experience needed to ensure sailors are properly prepared for operational success. There is no extra training built in to the plan, as this would not be an efficient use of the resources needed to support the training (e.g. fuel, time). Therefore, any reduction of training would not allow sailors to achieve satisfactory levels of readiness needed to accomplish their mission.
- Use of ramp-up to attempt to clear the range prior to the conduct of exercises. Ramp-up procedures, (slowly increasing the sound in the water to necessary levels), are not a viable alternative for training exercises because the ramp-up would alert opponents to the participants' presence. This affects the realism of training in that the target submarine would be able to detect the searching unit prior to themselves being detected, enabling them to take evasive measures. This would insert a significant anomaly to the training, affecting its realism and effectiveness. Though ramp-up procedures have been used in testing, the procedure is not effective in training sailors to react to tactical situations, as it provides an unrealistic advantage by alerting the target. Using these procedures would not allow the Navy to conduct realistic training, thus adversely impacting the effectiveness of the military readiness activity.
- Visual monitoring using third-party observers from air or surface platforms, in addition to the existing Navy-trained lookouts.
  - The use of third-party observers would compromise security due to the requirement to provide advance notification of specific times/locations of Navy platforms.
  - Reliance on the availability of third-party personnel would also impact training flexibility, thus adversely affecting training effectiveness.
  - The presence of other aircraft in the vicinity of naval exercises would raise safety concerns for both the commercial observers and naval aircraft.

- Use of Navy observers is the most effective means to ensure quick and effective implementation of mitigation measures if marine species are spotted. A critical skill set of effective Navy training is communication. Navy lookouts are trained to act swiftly and decisively to ensure that appropriate actions are taken.
- Use of third-party observers is not necessary because Navy personnel are extensively trained in spotting items on or near the water surface. Navy spotters receive more hours of training, and use their spotting skills more frequently, than many third-party trained personnel.
- Crew members participating in training activities involving aerial assets have been specifically trained to detect objects in the water. The crew's ability to sight from both surface and aerial platforms provides excellent survey capabilities using the Navy's existing exercise assets.
- Security clearance issues would have to be overcome to allow non-Navy observers onboard exercise participants.
- Some training events will span one or more 24-hour periods, with operations underway continuously in that timeframe. It is not feasible to maintain non-Navy surveillance of these activities, given the number of non-Navy observers that would be required onboard.
- Surface ships having active mid-frequency sonar have limited berthing capacity. As exercise planning includes careful consideration of this limited capacity in the placement of exercise controllers, data collection personnel, and Afloat Training Group personnel on ships involved in the exercise. Inclusion of non-Navy observers onboard these ships would require that in some cases there would be no additional berthing space for essential Navy personnel required to fully evaluate and efficiently use the training opportunity to accomplish the exercise objectives.
- Contiguous ASW events may cover many hundreds of square miles. The number of civilian ships and/or aircraft required to monitor the area of these events would be considerable. It is, thus, not feasible to survey or monitor the large exercise areas in the time required ensuring these areas are devoid of marine mammals. In addition, marine mammals may move into or out of an area, if surveyed before an event, or an animal could move into an area after an exercise took place. Given that there are no adequate controls to account for these or other possibilities and there are no identified research objectives, there is no utility to performing either a before or an after the event survey of an exercise area.
- Survey during an event raises safety issues with multiple, slow civilian aircraft operating in the same airspace as military aircraft engaged in combat training activities. In addition, most of the training events take place far from land, limiting both the time available for civilian aircraft to be in the exercise area and presenting a concern should aircraft mechanical problems arise.
- Scheduling civilian vessels or aircraft to coincide with training events would impact training effectiveness, since exercise event timetables cannot be precisely fixed and are instead based on the free-flow development of tactical situations. Waiting for civilian aircraft or vessels to complete surveys, refuel, or be on station would slow the unceasing progress of the exercise and impact the effectiveness of the military readiness activity.
- Multiple simultaneous training events continue for extended periods. There are not enough qualified third-party personnel to accomplish the monitoring task.

- Reducing or securing power during the following conditions.

  - Low-visibility / night training: ASW can require a significant amount of time to develop the "tactical picture," or an understanding of the battle space such as area searched or unsearched, identifying false contacts, understanding the water conditions, etc. Reducing or securing power in low-visibility conditions would affect a commander's ability to develop this tactical picture and would not provide realistic training.
  - Strong surface duct: The complexity of ASW requires the most realistic training possible for the effectiveness and safety of the sailors. Reducing power in strong surface duct conditions would not provide this training realism because the unit would be operating differently than it would in a combat scenario, reducing training effectiveness and the crew's ability. Additionally, water conditions may change rapidly, resulting in continually changing mitigation requirements, resulting in a focus on mitigation versus training.
- Vessel speed: Establish and implement a set vessel speed.
  - Navy personnel are required to use caution and operate at a slow, safe speed consistent with mission and safety. Ships and submarines need to be able to react to changing tactical situations in training as they would in actual combat. Placing arbitrary speed restrictions would not allow them to properly react to these situations, resulting in decreased training effectiveness and reduction the crew proficiency.
- Increasing power down and shut down zones:
  - The current power down zones of 457 and 914 m (500 and 1,000 yd), as well as the 183 m (200 yd) shut down zone were developed to minimize exposing marine mammals to sound levels that could cause TTS or PTS, levels that are supported by the scientific community. Implementation of the safety zones discussed above will prevent exposure to sound levels greater than 195 dB re 1µPa for animals sighted. The safety range the Navy has developed is also within a range sailors can realistically maintain situational awareness and achieve visually during most conditions at sea.
  - Although the three action alternatives were developed using marine mammal density data and areas believed to provide habitat features conducive to marine mammals, not all such areas could be avoided. ASW requires large areas of ocean space to provide realistic and meaningful training to the sailors. These areas were considered to the maximum extent practicable while ensuring Navy's ability to properly train its forces in accordance with federal law. Avoiding any area that has the potential for marine mammal populations is impractical and would impact the effectiveness of the military readiness activity.
- Using active sonar with output levels as low as possible consistent with mission requirements and use of active sonar only when necessary.
  - Operators of sonar equipment are always cognizant of the environmental variables affecting sound propagation. In this regard, the sonar equipment power levels are always set consistent with mission requirements.
  - Active sonar is only used when required by the mission since it has the potential to alert opposing forces to the sonar platform's presence. Passive sonar and all other sensors are used in concert with active sonar to the maximum extent practicable when available and when required by the mission.

3.8.9 Summary of Effects

3.8.9.1 Endangered Species Act

The Navy is consulting with NMFS under Section 7 of the ESA regarding its determination of effect for federally-listed marine mammals and critical habitat. Table 3.8-18 provides a summary of the Navy's determination of acoustic effects for federally listed marine mammals that potentially occur in the TMAA. The analysis presented above indicates that all seven ESA-listed species of marine mammals may be affected by one or more stressors resulting from Alternative 2 (Preferred Alternative) training activities. All species may be affected by exposures to sonar emissions and at-sea explosions.

This assessment focused on four aspects of the proposed Navy training events—ship traffic, use of active sonar, other non-sonar acoustic sources, aircraft overflights, and at-sea explosions. Potential risks associated with sonars and other non-sonar acoustic sources that are likely to be employed during anti-submarine warfare exercises were assessed by treating the acoustic energy produced by those sources as a pollutant introduced into the ocean environment. The acoustic analyses evaluated the likelihood of listed species being exposed to sound pressure levels associated with active sonar and other non-sonar acoustic sources, which includes estimating the intensity, duration, and frequency of exposure. The analysis assumed that active sonar and other non-sonar acoustic sources posed no risk to listed species if they were not exposed to sound pressure levels exceeding established regulatory thresholds. The analyses also assumed that the potential consequences of exposure to sonar and other non-sonar acoustic sources on individual animals would be a function of the intensity (measured in both SPL in decibels and frequency), duration, and frequency of the animal's exposure to the mid- and high frequency sonar transmissions and to other acoustic sources.

Potential risks associated with at-sea explosions that are likely to be employed during BOMBEX, GUNEX, SINKEX, and use of SSQ-110 sonobuoys were assessed by treating the impulse energy produced by at-sea explosions as an energy force introduced into the ocean environment. The at-sea explosion analysis evaluated the likelihood of ESA listed species being exposed to sound pressure levels associated with at-sea explosions, which includes estimating the intensity, duration, and frequency of exposure. The analysis assumed that the energy from at-sea explosions posed no risk to marine mammal species if they were not exposed to sound or pressure levels from the detonations.

There are no critical habitats in the TMAA and Navy training activities will not destroy or adversely modify critical habitat. There are no primary constituent elements of critical habitat present in the TMAA. Therefore, in accordance with ESA consultation provisions to assess potential effects of Proposed Action to critical habitat, it is concluded that Navy activities will have no effect on any critical habitats.

3.8.9.2 Marine Mammal Protection Act

The analysis presented above indicates that several species of marine mammals could be exposed to impacts associated with at-sea explosions and explosive ordnance use under Alternative 2 that could result in Level A or Level B harassment as defined by MMPA provisions that are applicable to the Navy. Exposure estimates are provided in Tables 3.8-8, 3.8-9, 3.8-12. 3.8-13, and 3.8-16. Other stressors associated with Alternative 2 are not expected to result in MMPA Level A or Level B harassment. It is not likely that any of the proposed training activities would result in effects to the life functions of marine mammals in the TMAA. Accordingly, the Navy is working with NMFS through the MMPA permitting process to ensure compliance with the MMPA.

3.8.9.3 National Environmental Policy Act and Executive Order 12114

Table 3.8-19 summarizes the effects of the No Action Alternative, Alternative 1, and Alternative 2 on marine mammals under both NEPA and EO 12114.

Table 3.8-18: Summary of the Navy's Determination of Effect for Federally Listed Marine Mammals That May Occur in the TMAA – Alternative 2 (Preferred Alternative)

Stressor	Blue Whale	Fin Whale	Humpback Whale	North Pacific Right Whale	Sei Whale	Sperm Whale	Steller Sea Lion
Vessel Movements							
Vessel Disturbance	MA	MA	MA	MA	MA	MA	MA
Vessel Collisions	MA	MA	MA	MA	MA	MA	MA
Aircraft Overflights							
Aircraft Disturbance	MA	MA	MA	MA	MA	MA	MA
Non-explosive Practice Ordnance							
Weapons Firing Disturbance	MA	MA	MA	MA	MA	MA	MA
Non-explosive Ordnance Strikes	MA	MA	MA	MA	MA	MA	MA
High Explosive Ordnance							
At-Sea Explosion	MA	MA	MA	MA	MA	MA	MA
Explosive Ordnance	MA	MA	MA	MA	MA	MA	MA
Active Sources							
Mid- and High-Frequency Sonar	MA	MA	MA	MA	MA	MA	MA
Non-Sonar Acoustic Sources	MA	MA	MA	MA	MA	MA	MA
Expended Materials							
Ordnance Related Materials	MA	MA	MA	MA	MA	MA	MA
Chaff	MA	MA	MA	MA	MA	MA	MA
MK-58 Marine Markers	MA	MA	MA	MA	MA	MA	MA
Target Related Materials	MA	MA	MA	MA	MA	MA	MA
Sonobuoys	MA	MA	MA	MA	MA	MA	MA

MA = May Affect; TMAA = Temporary Maritime Activities Area

Table 3.8-19: Summary of Effects of the Alternatives

Alternative and Stressor	NEPA (U.S. Territorial Seas, 0 to 12 nm)	Executive Order 12114 (Non-Territorial Seas, >12 nm)
No Action	• Aircraft overflights of U.S. Territorial Seas would occur at altitudes at or above 15,000 ft (915 m) and have no effect on marine mammals.	**Vessel Movements** • Short-term behavioral responses from general vessel disturbance possible. Potential for injury or mortality from vessel collisions but occurrence is very unlikely. **Aircraft Overflights** • Potential for short-term behavioral responses to low level overflights. No long-term population-level effects. **Non-explosive Practice Ordnance** • Extremely low probability of direct strikes. **At-Sea Explosions** • Behavioral effects modeling and accounting for rare species provided an estimate of zero exposures indicates 102 MMPA Level B harassments from sub-TTS and/or TTS, one MMPA Level A harassment resulting from slight injury, and no exposures resulting in potential severe injury. Mitigation would reduce the number of these harassments. With implementation of mitigation measures, the MMPA Level A harassment should not occur. **Active Sonar** • Not applicable **Expended Materials** • Low potential for ingestion of expended materials. **ESA-Listed Species** All seven ESA-listed species of marine mammals may be affected by one or more stressors resulting from No Action Alternative training activities. All species may be affected by at-sea explosions.

Table 3.8-18: Summary of Effects of the Alternatives (continued)

Alternative and Stressor	NEPA (U.S. Territorial Seas, 0 to 12 nm)	Executive Order 12114 (Non-Territorial Seas, >12 nm)
Alternative 1	• Aircraft overflights of U.S. Territorial Seas would occur at altitudes at or above 15,000 ft (915 m) and have no effect on marine mammals.	**Vessel Movements** • Short-term behavioral responses from general vessel disturbance possible. Potential for injury or mortality from vessel collisions but occurrence is very unlikely. **Aircraft Overflights** • Potential for short-term behavioral responses to low level overflights. No long-term population-level effects. **Non-explosive Practice Ordnance** • Extremely **low probability of** direct strikes. **At-Sea Explosions** • Behavioral effects modeling and accounting for rare species provided an estimate of zero exposures indicates 137 MMPA Level B harassments from sub-TTS and/or TTS, one MMPA Level A harassments from slight injury, and no exposures resulting in potential severe injury. Mitigation would reduce the number of these harassments. With implementation of mitigation measures, the one MMPA Level A harassments should not occur. **Active Sonar and Other Non-Sonar Acoustic Sources** • Behavioral effects modeling and accounting for rare species provided an estimate of zero exposures indicates 215,053 MMPA Level B harassments from non-TTS and 466 MMPA Level B harassments from TTS for a total of 215,519 MMPA Level B harassments from acoustic sources. There is one predicted MMPA Level A harassment from PTS, but with implementation of mitigation measures, this MMPA Level A harassment should not occur. **Expended Materials** • Low potential for ingestion of expended materials. **ESA-Listed Species** All seven ESA-listed species of marine mammals may be affected by one or more stressors resulting from Alternative 1 training activities. All species may be affected by exposures to sonar emissions and at-sea explosions.

Table 3.8-18: Summary of Effects of the Alternatives (continued)

Alternative and Stressor	NEPA (U.S. Territorial Seas, 0 to 12 nm)	Executive Order 12114 (Non-U.S. Territorial Seas, >12 nm)
Alternative 2 (Preferred Alternative)	• Aircraft overflights of U.S. Territorial Seas would occur at altitudes at or above 15,000 ft (915 m) and have no effect on marine mammals.	**Vessel Movements** • Short-term behavioral responses from general vessel disturbance possible. Potential for injury or mortality from vessel collisions but occurrence is very unlikely. **Aircraft Overflights** • Potential for short-term behavioral responses to low level overflights. No long-term population-level effects. **Non-explosive Practice Ordnance** • Extremely low probability of direct strikes. **At-Sea Explosions** • Behavioral effects modeling and accounting for rare species provided an estimate of zero exposures indicates 240 MMPA Level B harassments from sub-TTS and/or TTS, four MMPA Level A harassments, and one exposure resulting in potential severe injury. Mitigation would reduce the number of these harassments. With implementation of mitigation measures, the four MMPA Level A harassments and one severe injury should not occur. • Increase in at-sea explosions from SINKEX are offset by area clearance procedures. **Active Sonar and Other Non-Sonar Acoustic Sources** • Behavioral effects modeling and accounting for rare species provided an estimate of zero exposures indicates 424,620 MMPA Level B harassments from non-TTS and 931 MMPA Level B harassments from TTS for a total of 425,551 MMPA Level B harassments from acoustic sources. There is one predicted MMPA Level A harassment from PTS, but with implementation of mitigation measures, this MMPA Level A harassment should not occur. **Expended Materials** • Low potential for ingestion of expended materials. **ESA-Listed Species** • All seven ESA-listed species of marine mammals may be affected by one or more stressors resulting from Alternative 2 training activities. All species may be affected by exposures to sonar emissions and at-sea explosions

Notes: MAA = Temporary Maritime Activities Area, MMPA = Marine Mammal Protection Act, NEPA = National Environmental Protection Act, nm = nautical mile, PTS = Permanent Threshold Shift, SPL = Sound Pressure Level, TTS = Temporary Threshold Shift

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3.9 BIRDS

3.9.1 Affected Environment

For purposes of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the Region of Influence (ROI) for birds is the Temporary Maritime Activities Area (TMAA) within the Gulf of Alaska (GOA). The nearest shoreline (Kenai Peninsula) is located approximately 24 nautical miles (nm) (44 kilometers [km]) north of the TMAA's northern boundary. The approximate middle of the TMAA is located 140 nm (259 km) offshore. Given that the TMAA is more than 12 nm (22 km) from the closest point of land, it is therefore outside of United States (U.S.) Territorial Seas. Areas inland from the coastline, including United States (U.S.) Air Force (Air Force) air ranges and U.S. Army (Army) training lands, are addressed in the *Alaska Military Operations Areas EIS* (USAF 1995), *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999) and the *Transformation of U.S. Army Alaska FEIS* (Army 2004). Thus, this section provides an overview of the species, distribution, and occurrence of birds that are either resident or migratory through the TMAA.

3.9.1.1 Existing Conditions

The habitat found within the TMAA supports a wide diversity of resident and migratory seabirds and sea ducks. Since the TMAA occurs mostly over the outer shelf slope and deeper ocean waters, this area is dominated by species that use the region seasonally and are not land-based outside the nesting season. Birds that are year-round residents or that migrate from northern waters frozen over in the winter use the protected embayment's of Kodiak Island and the mainland shoreline to avoid harsh winter storms (Navy 2006).

Migratory birds are any species or family of birds that live, reproduce, or migrate within or across international borders at some point during their annual life cycle. Seabirds, which are included in migratory birds protected by the Migratory Bird Treaty Act (MBTA, Section 3.9.2.2) (U.S. Fish and Wildlife Service [USFWS] 1985), are birds whose normal habitat and food source is the sea, whether they utilize coastal waters (the nearshore), offshore waters (the continental shelf), or pelagic waters (the open sea) (Harrison 1983).

The TMAA consists of open water surface and subsurface operating areas and overlying airspace to the south of Prince William Sound and east of Kodiak Island. The GOA is one of the world's most productive ocean regions and the habitats associated with these cold and turbulent waters contain identifiable collections of macrohabitats that sustain resident and migratory species of seabirds. The waters of the GOA provide both protected shallow water habitat for seabirds and sea ducks, which forage on the sea bottom, and nutrient rich offshore areas for seabirds that rely on upwelling zones and shelf currents to transport prey to the surface. In general, seabird and sea duck distribution in the GOA is seasonally influenced by prey availability and probably weather patterns (Hunt and Schneider 1987). Since carbon flux for the benthic community is highest in the nearshore areas (Iverson et al. 1979), these waters provide good winter food sources for bottom-feeding ducks.

The GOA is a Large Marine Ecosystem (LME) that lies off the southern coast of Alaska and the western coast of Canada. It is separated from the East Bering Sea LME by the Alaska Peninsula. Its climate is sub-Arctic. The cold Subarctic Current, as it bifurcates towards the south, serves as the boundary between the GOA and the California Current LME. Decadal climate change has shown an effect on plankton production and plankton species composition. The GOA LME is a Class I, highly productive (>300 grams [g] of carbon per square meter [m^2] per year) ecosystem based on global primary productivity estimates (Sea-viewing Wide Field-of-view Sensor [SeaWiFS] 2008). It presents a significant upwelling phenomenon linked to the presence of the counterclockwise gyre of the Alaska Current (National Oceanic and Atmospheric Administration [NOAA] 2002). A well-documented climatic regime shift occurring in the late 1970s caused the Alaska gyre to be centered more to the east (Lagerloef 1995). The LME's cold, nutrient-rich waters support a diverse ecosystem. Large-scale atmospheric and oceanographic conditions affect the productivity of this LME. Changes in zooplankton biomass have been observed in both the GOA LME and the California Current LME directly to the south. These biomass changes appear to be inversely related to each other (Brodeur et al. 1999).

Many of the larger seabirds, especially the albatrosses and the shearwaters, move into the Gulf from more southern climates during the summer and fall months and feed along the Alaskan current as it traces the continental shelf break. Carbon flux in the pelagic food chain is greatest in the outer shelf (where bottom depth is 328 to 558 feet (ft) (100 to 170 meters [m]); Iverson et al. 1979), as upwelling brings deepwater nutrients to the surface, which stimulates planktonic growth. Hunt and Schneider (1987) found that the pelagic distribution of seabirds mirrored the distribution of plankton, regardless of the trophic level on which a particular species fed. Since the TMAA occurs mostly over outer shelf, slope, and deeper ocean waters, this area is dominated by those species that use the region seasonally and are not land-based outside the nesting season.

The USFWS, which oversees the National Wildlife Refuges (NWR) System, protects a significant amount of marine habitat within U.S. waters. Three NWRs (Alaska Maritime, Becharof, and Kenai) that contain a marine component are located throughout the GOA. These NWRs provide over 3 million hectares of refuge for seabirds, shorebirds, migratory waterfowl, and a diverse array of marine mammals and flora. Together with federal agencies and legislation, the operation and management of Alaska NWRs is also influenced by policy documents such as the Alaska National Interest Lands Conservation Act of 1980 (USFWS 2004a).

Table 3.9-1 identifies bird species known to occur in or breed in the coastal zones within the GOA. Two of these are protected under the authority of the Endangered Species Act (ESA): one is federally listed as endangered (Short-tailed Albatross [*Phoebastria albatrus*]) and one is federally listed as threatened (Steller's Eider [*Polysticta stelleri*]). Five species are not listed as threatened or endangered under the ESA but have been named Birds of Conservation Concern (BCC) by the USFWS. These are the Black-footed Albatross (*Phoebastria nigripes*), Laysan Albatross (*Phoebastria immutabilis*), Aleutian Tern (*Onychoprion aleutica*), Arctic Tern (*Sterna paradisaea*), and the Caspian Tern (*Hydroprogne caspia*).

Other species are not listed but have been identified by agencies for different reasons. The Black Oystercatcher (*Haematopus bachmani*) is considered by the U.S. Shorebird Conservation Plan and its regional counterpart, the Alaska Shorebird Conservation Plan, as a species of high concern. Classification is due to the species' limited breeding distribution and small global populations (Brown et al. 2001). The Kittlitz's Murrelet (*Brachyramphus brevirostris*) has been listed as a candidate species throughout its range as several core populations have been reduced by 80 to 90 percent in the past two decades.

Table 3.9-1: Representative Birds Known to Occur or Breed in the Coastal Zones within the GOA

Common Name	Genus and Species	Common Name	Genus and Species
Aleutian Tern[BCC, B]	*Onychoprion aleutica*	Long-billed Dowitcher	*Limnodromus scolopaceus*
American Avocet	*Recurvirostra americana*	Long-tailed Duck	*Clangula hyemalis*
American Golden-Plover	*Pluvialis dominica*	Long-tailed Jaeger[B]	*Stercorarius longicaudus*
American Wigeon	*Anas americana*	Long-toed Stint	*Calidris subminuta*
Ancient Murrelet[B]	*Synthliboramphus antiquus*	Mallard	*Anas platyrhynchos*
Arctic Loon	*Gavia arctica*	Manx Shearwater	*Puffinus puffinus*
Arctic Tern[BCC,B]	*Sterna paradisaea*	Marbled Godwit	*Limosa fedoa*
Baird's Sandpiper	*Calidris bairdii*	Marbled Murrelet[B]	*Brachyramphus marmoratus*
Barrow's Goldeneye	*Bucephala islandica*	Marsh Sandpiper	*Tringa stagnatilis*
Bar-tailed Godwit	*Limosa lapponica*	Mew Gull[B]	*Larus canus*
Black Guillemot[B]	*Cepphus grylle*	Mongolian Plover	*Charadrius mongolus*
Black Oystercatcher	*Haematopus bachmani*	Mottled Petrel	*Pterodroma inexpectata*
Black Scoter	*Melanitta nigra*	Mottled Petrel	*Pterodroma inexpectata*
Black Turnstone	*Arenaria melanocephala*	Northern Fulmar[B]	*Fulmarus glacialis*
Black-bellied Plover	*Pluvialis squatarola*	Northern Pintail	*Anas acuta*
Black-footed albatross[BCC, B]	*Phoebastria nigripes*	Northern Shoveler	*Anas clypeata*
Black-legged Kittiwake[B]	*Rissa tridactyla*	Oriental Pratincole	*Glareola maldivarum*
Black-tailed Godwit	*Limosa limosa*	Pacific Golden-Plover	*Pluvialis fulva*
Black-winged Stilt	*Himantopus himantopus*	Pacific Loon	*Gavia pacifica*
Blue-winged Teal	*Anas discors*	Parakeet Auklet[B]	*Aethia psittacula*
Bonaparte's Gull	*Larus philadelphia*	Parasitic Jaeger[B]	*Stercorarius parasiticus*
Brandt's Cormorant[B]	*Phalacrocorax penicillatus*	Pectoral Sandpiper	*Calidris melanotos*
Brant[B]	*Branta bernicla*	Pelagic Cormorant[B]	*Phalacrocorax pelagicus*
Bristle-thighed Curlew	*Numenius tahitiensis*	Peregrine Falcon	*Falco peregrinus*
Broad-billed Sandpiper	*Limicola falcinellus*	Pied-billed Grebe	*Podilymbus podiceps*
Buff-breasted Sandpiper	*Tryngites subruficollis*	Pigeon Guillemot[B]	*Cepphus columba*
Bufflehead	*Bucephala albeola*	Pink-footed Shearwater	*Puffinus creatopus*
Buller's Shearwater	*Puffinus bulleri*	Pin-tailed Snipe	*Gallinago stenura*
Cackling Goose	*Branta huchinsii*	Pomarine Jaeger[B]	*Stercorarius pomarinus*
Canada Goose	*Branta canadensis*	Purple Sandpiper	*Calidris maritima*
Canvasback	*Aythya valisineria*	Red Knot	*Calidris canutus*
Caspian Tern[BCC,B]	*Hydroprogne caspia*	Red Phalarope	*Phalaropus fulicarius*
Cassin's Auklet[B]	*Ptychoramphus aleuticus*	Red-breasted Merganser	*Mergus serrator*
Clark's Grebe	*Aechmophorus clarkii*	Red-faced Cormorant[B]	*Phalacrocor axurile*
Common Eider	*Somateria mollissima*	Redhead	*Aythya americana*

Table 3.9-1: Representative Birds Known to Occur or Breed in the Coastal Zones within the GOA (continued)

Common Name	Genus and Species	Common Name	Genus and Species
Common Goldeneye	*Bucephala clangula*	Red-legged Kittiwake[B]	*Rissa brevirostris*
Common Greenshank	*Tringa nebularia*	Red-necked Grebe	*Podiceps grisegena*
Common Loon	*Gavia immer*	Red-necked Phalarope	*Phalaropus lobatus*
Common Merganser	*Mergus merganser*	Red-throated Loon	*Gavia stellata*
Common Murre[B]	*Uria aalge*	Rhinoceros Auklet[B]	*Cerorhinca monocerata*
Common Ringed Plover	*Charadrius hiaticula*	Ring-necked Duck	*Aythya collaris*
Common Sandpiper	*Actitis hypoleucos*	Rock Sandpiper	*Calidris ptilocnemis*
Cook's Petrel	*Pterodroma cookii*	Ruddy Turnstone	*Arenaria interpres*
Crested Auklet[B]	*Aethia cristatella*	Ruff	*Philomachus pugnax*
Curlew Sandpiper	*Calidris ferruginea*	Rufous-necked Stint	*Calidris ruficollis*
Double-crested Cormorant[B]	*Phalacrocorax auritus*	Sabine's Gull[B]	*Xema sabini*
Dovkie[B]	*Alle alle*	Sanderling	*Calidris alba*
Dunlin	*Calidris alpina*	Semipalmated Plover	*Charadrius semipalmatus*
Emperor Goose	*Chen canagica*	Semipalmated Sandpiper	*Calidris pusilla*
Eskimo Curlew	*Numenius borealis*	Sharp-tailed Sandpiper	*Calidris acuminata*
Eurasian Dotterel	*Charadrius morinellus*	Short-billed Dowitcher	*Limnodromus griseus*
Eurasian Wigeon	*Anas penelope*	Short-tailed Albatross[E, B]	*Phoebastria albatrus*
Far Eastern Curlew	*Numenius madagascariensis*	Short-tailed Shearwater[B]	*Puffinus tenuirostris*
Flesh-footed Shearwater	*Puffinus carneipes*	Slaty-backed Gull[B]	*Larus schistasagus*
Fork-tailed Storm-Petrel[B]	*Oceanodroma furcata*	Snow Goose	*Chen caerulescens*
Gadwall	*Anas strepera*	Snowy Plover	*Charadrius alexandrinus*
Glaucous Gull[B]	*Larus hyperboreus*	Solitary Sandpiper	*Tringa solitaria*
Glaucous-winged Gull[B]	*Larus glaucescens*	Sooty Shearwater [B]	*Puffinus griseus*
Gray-tailed Tattler	*Tringa brevipes*	Spectacled Eider	*Somateria fischeri*
Great Knot	*Calidris tenuirostris*	Spoonbill Sandpiper	*Eurynorhynchus pygmeus*
Greater Scaup	*Aythya marila*	Spotted Redshank	*Tringa erythropus*
Greater White-fronted Goose	*Anser albifrons*	Spotted Sandpiper	*Actitis macularius*
Greater Yellowlegs	*Tringa melanoleuca*	Steller's Eider[T]	*Polysticta stelleri*
Green Sandpiper	*Tringa ochropus*	Stilt Sandpiper	*Calidris himantopus*
Green-winged Teal	*Anas crecca*	Surf Scoter	*Melanitta perspicillata*
Harlequin Duck	*Histrionicus histrionicus*	Surfbird	*Aphriza virgata*
Herring Gull[B]	*Larus argentatus*	Temminck's Stint	*Calidris temminckii*
Hooded Merganser	*Lophodytes cucullatus*	Terek Sandpiper	*Xenus cinereus*
Horned Grebe	*Podiceps auritus*	Thick-billed Murre [B]	*Uria lomvia*

Table 3.9-1: Representative Birds Known to Occur or Breed in the Coastal Zones within the GOA (continued)

Common Name	Genus and Species	Common Name	Genus and Species
Horned Puffin[B]	*Fratercula corniculata*	Trumpeter Swan	*Cygnus buccinator*
Hudsonian Godwit	*Limosa haemastica*	Tufted Puffin[B]	*Fratercula cirrhata*
Jack Snipe	*Lymnocryptes minimus*	Tundra Swan	*Cygnus columbianus*
Killdeer	*Charadrius vociferus*	Upland Sandpiper	*Bartramia longicauda*
King Eider	*Somateria spectabilis*	Wandering Tattler	*Tringa incana*
Kittlitz's Murrelet[B]	*Brachyramphus brevirostris*	Western Grebe	*Aechmophorus occidentalis*
Laysan Albatross[BCC, B]	*Phoebastria immutabilis*	Western Sandpiper	*Calidris mauri*
Leach's Storm-Petrel[B]	*Oceanodroma leucorhoa*	Whimbrel	*Numenius phaeopus*
Least Auklet[B]	*Aethia pusilla*	Whiskered Auklet[B]	*Aethia pygmaea*
Least Sandpiper	*Calidris minutilla*	White-rumped Sandpiper	*Calidris fuscicollis*
Lesser Scaup	*Aythya affinis*	White-winged Scoter	*Melanitta fusca*
Lesser Yellowlegs	*Tringa flavipes*	Wilson's Phalarope	*Phalaropus tricolor*
Little Curlew	*Numenius minutus*	Wilson's Snipe	*Gallinago delicata*
Little Ringed Plover	*Charadrius dubius*	Wood Sandpiper	*Tringa glareola*
Little Stint	*Calidris minuta*	Yellow-billed Loon	*Gavia adamsii*

Notes: [E] Endangered, [T] Threatened, [BCC] Bird of Conservation Concern, [B] Breeding

Based loosely on their geographic distribution and feeding habits, birds observed in the TMAA are divided into two groups, (Department of Commerce [DOC] 1993), seabirds and waterfowl.

- Seabirds, such as alcids, shearwaters, and gulls. These feed in open waters ranging from the shoreline and estuaries to the open ocean. Some seabirds are strictly pelagic, while others prefer the nearshore environment.
- Waterfowl, such as ducks and geese. These familiar species are found near shore on the open coast and in estuaries, but some also use inland freshwater habitats.

In general, seabird activity is most concentrated along the GOA coastline, while waterfowl are found primarily in the bays and shallow waters of the southern coast (DOC 1993). Waterfowl (e.g., ducks and geese) can be hunted, but seasons and bag limits are established in federal and/or state regulations.

Seabirds and Their Habitats

The seabird colonies off the coast of Alaska are among the largest in population in the continental United States. About 50 million seabirds nest on Alaska's coast each summer; this is 87 percent of all the seabirds in the United States (USFWS 2008). Alaska's seabirds nest in more than 1,600 seabird colonies around the coast of Alaska due to the fact that the State's coast is very long (approximately 30,000 miles [mi]), the coast has many cliffs and islands that provide habitat for nesting seabirds, and the nearby seas (Bering Sea, Gulf of Alaska, and north Pacific Ocean) provides an abundant food source for the species (USFWS 2008).

Seabirds known to occur within the GOA include those that are pelagic (generally foraging far offshore over the continental shelf and in oceanic waters) and those that feed in nearshore zones. Pelagic seabirds go ashore primarily to breed (Piatt and Springer 2003). Pelagic species include albatross, petrels, shearwaters, cormorants, jaegers, skuas, gulls, terns, and alcids. Nearshore seabirds feed within sight of land and include Pacific (*Gavia pacifica*) and Red-throated Loons (*Gavia stellata*), Western Grebes (*Aechmorphorus occidentalis*), Brown Pelicans, several species of gulls and cormorants, Common Murres (*Uria aalge*), and Red-necked Phalaropes (*Phalaropus lobatus*). Coastal rocks, headlands, and islands along the outer coast are critical nesting and roosting sites for many seabird species (DOC 1993). Colony sites are important habitat for seabirds because reproductive success and continuation of species depend on these sites.

Alcids are a distinctive family of seabirds present in the GOA and along the coast that includes the Tufted Puffin (*Fratercula cirrhata*), Rhinoceros Auklet (*Cerorhinca monocerata*), Cassin's Auklet (*Ptychoramphus aleuticus*), Common Murre, Ancient Murrelet (*Synthliboramphus antiquus*), Marbled Murrelets (*Brachyramphus marmoratus*), and Pigeon Guillemot (*Cepphus columba*) (DoC 1993). They are long-lived colonial nesters that reproduce slowly and are found in shallower nearshore waters, especially in summer when birds are closely tied to nesting sites (DOC 1993). Large colonies of Tufted Puffins, Rhinoceros Auklets, Cassin's Auklets, and Common Murres are present on the Aleutian islands. Common Murres are circumpolar and number in the millions worldwide. They are the dominant member of the breeding seabird community on the west coast. They nest on open rock or dirt ledges along the Alaskan outer coast and sometimes shift colony sites. These birds are strong fliers and forage long distances from their colonies. They dive to considerable depths to capture fish, crustaceans, and cephalopods. In late summer and fall, adult females of the Washington coastal population fly into Puget Sound to molt and winter (DOC 1993).

Waterfowl

Waterfowl are flat-billed birds that spend most of their lifecycle on the water (DOC 1993). Waterfowl typically breed in freshwater habitats, but many species move to shoreline or nearshore habitats when breeding is complete. Many species of waterfowl stage and winter in Alaskan waters and winter in the western Arctic plain. Species such as the Harlequin Duck (*Histronicus histronicus*), scoters (*Melanitta* sp.), Bufflehead (*Bucephala albeola*), mergansers, goldeneyes, Long-tailed Duck (*Clangula hyemalis*), and scaup winter in the nearshore waters of the open coast (DOC 1993). Scoters and eiders are by far the most numerous species of sea ducks in nearshore waters, with all four species of eider, King (*Somateria spectabilis*), Common (*S. mollissima*), Steller's and Spectacled (*S. fischeri*) breeding in Alaska.

Federally Endangered or Threatened Species

Two seabird species within the GOA are protected under the authority of the ESA. One is federally listed as endangered (short-tailed albatross) and one is federally listed as threatened (Steller's Eider).

The Alaska breeding population of Steller's eiders was listed as threatened under ESA on June 11, 1997 (62 FR 31748). Steller's eiders are not expected to occur in the TMAA, and there is no critical habitat or foraging areas in or within the vicinity of the TMAA. During the months of April to October, when the training activities are planned to occur, Steller's eiders can be found in nearshore areas, and in particular protected lagoons with tidal flats located hundreds of miles to the northwest and west of the TMAA (Alaska Department of Environmental Conservation 2009). During the winter, the distribution of Steller's eiders includes the nearshore areas around Kodiak Island, Cook Inlet, the southern side of the Alaska Peninsula, and the eastern Aleutian Islands. Though these areas are north and west of the TMAA, there will be no Navy activities in the TMAA during the winter. Therefore, Steller's eiders are not likely to be present in the TMAA or be affected by any of the proposed activities and will not be considered further in this analysis.

A description of the Short-tailed Albatross, its habitat and brief life history is presented below.

Short-tailed Albatross

The Short-tailed Albatross is the largest of the three north Pacific albatrosses (Harrison 1984). Adult Short-tailed albatrosses are distinguishable from other Pacific albatrosses by their entirely white back and large bubble-gum pink bill that is strongly hooked at the end (Roberson 2000).

The Short-tailed Albatross was listed as endangered throughout its range under the ESA in 2000 (USFWS 2000). There is no designated critical habitat under ESA for the Short-tailed Albatross. During the late 1800s, the world population of short-tailed albatrosses was severely reduced by aggressive hunting for their plumage, resulting in the death of an estimated five million birds. Short-tailed albatrosses nest on isolated, windswept, offshore islands owned and administered by Japan that have restricted human access. The population has been rebounding in recent years because several Pacific rookeries have been protected from human use. The world population of short-tailed albatross is currently estimated at approximately 1,200 birds and is increasing (USFWS 2001b).

Current human-induced threats include hooking and drowning on commercial long-line gear, entanglement in derelict fishing gear, ingestion of plastic debris, contamination from oil spills, and potential predation by introduced mammals on breeding islands (USFWS 2001b). Plastic bags and plastic sheeting are most commonly swallowed by birds but balloons, Styrofoam beads, monofilament fishing line, and tar are also known to be ingested (Lutz 1990, Bjorndal et al 1994, Tomas 2002). Invasive species at colonies, including cats, rats, and plants, also can be a significant source of mortality (USFWS 2005).

Short-tailed albatrosses have a lifespan of more than 40 years. Sexual maturity is reached at age 7 or 8 (Harrison 1990; USFWS 2001b). The nesting seasons lasts from August to December on two rugged islands in Japan in October, with the hatching of a single egg occurring in late December and January. Both adults incubate the egg during this period. Fledging occurs in late April to early June, and the colony is totally deserted by mid-July (Roberson 2000). This species disperses throughout the north Pacific when it is not breeding.

Short-tailed albatrosses are pelagic wanderers, traveling thousands of miles at sea during the nonbreeding season (DoN 2006). Foraging occurs over open, offshore, ocean waters (DoN 2006). Most of their travel is concentrated along the continental shelf edge upwelling zones where they forage, utilizing shallow dives between 15 and 40 ft (4.5 and 12 m) in depth, on squid, fish, shrimp and other crustaceans, and flying-fish eggs (USFWS 2005). Their at-sea distribution includes the entire Pacific north of about 20°N, but they tend to concentrate along the Aleutians in the Bering Sea (Piatt et al. 2006).

Historic records indicate frequent use of nearshore and coastal waters in the eastern north Pacific from California through Alaska (Committee on the Status of Endangered Wildlife in Canada [COSEWIC] 2002; USFWS 2001b). Current sightings in the eastern north Pacific and in the TMAA are concentrated offshore of Alaska and British Columbia. Sightings off the continental states are gradually increasing as the population rebounds (Unitt 2004). Sightings of short-tailed albatross have the potential to increase in frequency as the species continues recovering.

Hearing in Birds

While little is known about the general hearing or underwater hearing capabilities of birds, research suggests an in-air maximum auditory sensitivity between 1 and 5 kilohertz (kHz) for most bird species (National Marine Fisheries Service [NMFS] 2003). It is possible that birds are likely to hear some mid-frequency sound in air. However, there is little published literature on the effects of underwater sound on diving birds. A review of available literature shows that most research focused on effects of pile-driving and seismic surveys. During such studies, airguns did not cause harm to birds. Similarly explosives used during ship shock trials did not cause harm unless birds were within 200 meters of the detonation site (Turnpenny and Nedwell 1994).

NMFS issued an environmental assessment with regards to the harassment of marine mammals in 2003 in accordance with the Marine Mammal Protection Act of 1972 (MMPA). As part of the environmental documentation, birds were analyzed for potential effects associated with exposure to active sonar. The operating frequency of the system was greater than 20 kHz, with a maximum source level at or less than 220 decibels (dB) at a reference pressure of 1 microPascal at 1 meter (re 1 µPa-m) in individual pulses less than 1 second for a duty cycle (time on over total time) of less than 10 percent. For example, in an 8-hour day, maximum sonar use would be less than 48 minutes (NMFS 2003). The potential hearing capability of birds was outside the proposed high frequency of the operating system and there is no evidence that birds utilize sound underwater to forage or locate prey. Thus, it was concluded that effects were unlikely. In addition, birds would not be an effective receptor because they are submerged only for short periods and birds at the surface can rapidly fly away from disturbance and annoying sounds.

3.9.1.2 Current Requirements and Practices

Standard operating procedures and best management practices implemented by the Navy for resource protection would reduce potential effects to birds. Avoidance of birds and their nesting and roosting habitats provides the greatest degree of protection from potential impacts within the TMAA or coastal areas of the GOA. For example, pursuant to Navy instruction (OPNAVINST) 3750.6R, measures to evaluate and reduce or eliminate bird/aircraft strike hazards to aircraft, aircrews, and birds are implemented during operations in the TMAA. See Chapter 5 for details.

3.9.2 Environmental Consequences

As noted in Section 3.9.1, the ROI for birds includes the TMAA. Navy training activities that occur within the Air Force inland Special Use Airspace (SUA) and the Army inland training lands were evaluated under previous National Environmental Policy Act (NEPA) documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents are incorporated by reference. Environmental effects in the open ocean beyond the U.S. territorial seas (outside of 12 nautical nm [22 km]) are analyzed in this EIS/OEIS pursuant to Executive Order (EO) 12114.

3.9.2.1 Previous Analyses

Impacts related to birds were previously evaluated in Sections 3.5 and 4.5 of the *Alaska MOA EIS* (USAF 1995), Sections 3.3 and 4.0 of the *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), Sections 3.12 and 4.12 of the *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999); and Sections 3.9, 3.10, 4.9, and 4.10 of the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

3.9.2.2 Regulatory Framework

Migratory Bird Treaty Act

The MBTA of 1918 (16 U.S.C. 703 et seq.) and the Migratory Bird Conservation Act (16 U.S.C. 715–715d, 715e, 715f–715r) of 18 Feb 29, (45 Stat. 1222) are the primary legislation in the United States established to conserve migratory birds. These statutes implement the United States' commitment to four bilateral treaties, or conventions, for the protection of a shared migratory bird resource. Current treaties are with the countries of Great Britain, Mexico, Canada, Japan, and the Soviet Union. The MBTA prohibits the taking, killing, or possessing of migratory birds or the parts, nests, or eggs of such birds, unless permitted by regulation. The species of birds protected by the MBTA appears in Title 50, Section 10.13 of the Code of Federal Regulations (50 C.F.R. 10.13) and represents almost all avian families found in North America. In general, there are only three species that are not protected by the MBTA and they include the Rock Pigeon (*Columba livia*), European Starling (*Sturnus vulgaris*), and House Sparrow (*Passer domesticus*).

On December 2, 2003, the President signed the 2003 National Defense Authorization Act. The Act provides that the Secretary of the Interior shall exercise his/her authority under the MBTA to prescribe regulations to exempt the Armed Forces from the incidental taking of migratory birds during military readiness activities authorized by the Secretary of Defense. Take under the MBTA is defined to be unlawful at any time, by any means or in any manner, to pursue, hunt, take, capture, kill, attempt to take, capture, or kill, possess, offer for sale, sell, offer to barter, barter, offer to purchase, purchase, deliver for shipment, ship, export, import, cause to be shipped, exported, or imported, deliver for transportation, transport or cause to be transported, carry or cause to be carried, or receive for shipment, transportation, carriage, or export, any migratory bird, any part, nest, or eggs of any such bird, or any product, whether or not manufactured, which consists, or is composed in whole or part, of any such bird or any part, nest, or egg thereof, included in the terms of the conventions between the United States and Great Britain for the protection of migratory birds concluded August 16, 1916 (39 Stat. 1702), the United States and Mexico for the protection of migratory birds and game mammals concluded February 7, 1936, the United States and the Government of Japan for the protection of migratory birds and birds in danger of extinction, and their environment concluded March 4, 1972 and the convention between the United States and the Union of Soviet Socialist Republics for the conservation of migratory birds and their environments concluded November 19, 1976.

The final rule authorizing the Department of Defense (DoD) to take migratory birds during military readiness activities was published in the Federal Register on February 28, 2007. The regulation can be found at 50 C.F.R. Part 21. The regulation provides that the Armed Forces must confer and cooperate with the USFWS on the development and implementation of conservation measures to minimize or mitigate adverse effects of a military readiness activity if it determines that such activity may have a "significant adverse effect" on a population of a migratory bird species. An activity has a significant adverse effect if, over a reasonable period of time, it diminishes the capacity of a population of a migratory bird species to maintain genetic diversity, to reproduce, and to function effectively in its native ecosystem. A population is defined as "a group of distinct, coexisting, same species, whose breeding site fidelity, migration routes, and wintering areas are temporally and spatially stable, sufficient distinct geographically (at some point of the year), and adequately described so that the population can be effectively monitored to discern changes in its status. Virtually all bird species found within the TMAA and coastal areas of the GOA are covered by the MBTA (exceptions are noted above). Two of the species covered under the MBTA are also federally listed as threatened or endangered and have additional protection under the ESA.

Migratory bird conservation relative to non-military readiness activities is addressed separately in a Memorandum of Understanding (MOU) developed in accordance with EO 13186, signed January 10, 2001, "Responsibilities of Federal Agencies to Protect Migratory Birds." This document encourages conservation measure integration into regional or state management plans, management of military lands to support conservation measures, avoidance or minimization of impacts to migratory birds, and the periodic evaluation of conservation measurements. The MOU between the DoD and the USFWS was signed on July 31 2006.

Endangered Species Act of 1973

As the TMAA is more than 12 nm (22 km) from the closest point of land and thus outside of U.S. territorial seas, this EIS/OEIS analyzes potential effects to birds in the context of the ESA, NEPA, and EO 12114. For purposes of ESA compliance, effects of the action were analyzed to make the Navy's determination of effect for listed species (i.e., no effect or may affect). The definitions used in making the determination of effect under Section 7 of the ESA are based on the USFWS and NMFS *Endangered Species Consultation Handbook* (USFWS and NMFS 1998).

"No effect" is the appropriate conclusion when a listed species will not be affected, either because the species will not be present or because the project does not have any elements with the potential to affect the species. "No effect" does not include a small effect or an effect that is unlikely to occur.

If effects are insignificant (in size) or discountable (extremely unlikely), a "may affect but not likely to adversely affect" determination is appropriate. Insignificant effects relate to the magnitude or extent of the impact (that is, they must be small and would not rise to the level of a take of a species). Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur. These factors were also considered in determining the significance of effects EO 12114.

Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c), enacted in 1940 and amended several times since, prohibits anyone without a permit issued by the Secretary of the Interior from "taking" bald eagles, including their parts, nests, or eggs. The Eagle Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." However, bald eagles are not expected in the TMAA due to lack of proximity (> 12 nm [22 km]) to the Alaskan shoreline. As such, there is little indication that military activities in the TMAA will result in negative effects on bald eagles.

3.9.2.3 Approach to Analysis

Data Sources

A systematic review of relevant literature and data has been conducted to complete this analysis for seabirds. Of the available scientific literature (both published and unpublished), the following types of documents were utilized in the assessment: journals, books, periodicals, bulletins, DoD operations reports, theses, dissertations, endangered species recovery plans, species management plans, and other technical reports published by government agencies, private businesses, or consulting firms. The scientific literature was also consulted during the search for geographic location data (geographic coordinates) on the occurrence of marine resources within the TMAA and the coastal environments of the GOA.

Assessment Methods

The analysis considered effects on seabirds as a group from:

- Vessel movements;
- Aircraft overflights, including aircraft disturbance (such as noise) and aircraft strikes on birds;
- Ordnance use;
- Explosions and impacts; and
- Expended materials, including ordnance-related materials, target-related materials, and entanglement.

Each of the species that was identified as a federally listed threatened and/or endangered, or candidate species was then individually evaluated for each of these stressors. An assessment was not conducted on the effects of sonar on seabirds. As described in Section 3.9.1.1 (Hearing in Birds), a study documented by NMFS (2003) concluded that effects to seabirds from sonar were unlikely. Although some species may be able to hear sonar, several factors combine to make effects improbable, most notably the fact that seabirds spend a very small fraction of time submerged and most return to the surface within seconds of diving. Because seabirds spend relatively little time beneath the water surface, there would be a low likelihood of seabird exposure. Given that there is no evidence of sonar causing harm to seabirds, this issue is not addressed further in the analysis of effects on this resource.

As discussed in Section 3.1 (Air Quality) and Section 3.3 (Water Resources), some air and water pollutants would be released into the environment as a result of the Proposed Action. The analyses presented in Sections 3.1 and 3.3 indicate that any increases in air or water pollutant concentrations resulting from Navy training activities in the TMAA would be negligible and localized, and impacts to air and water quality would be minor. Based on these analyses, air and water quality changes would have no effect or negligible effects on birds. Accordingly, the effects of air and water quality changes on birds are not addressed further in this section.

As previously discussed in Section 3.9.2.2, military readiness activities are exempt from the take prohibitions of the MBTA provided they do not result in a significant adverse effect on a population of a migratory bird species. The migratory bird species that are protected under ESA are discussed in the analyses that follow.

3.9.2.4 No Action Alternative

Vessel Movements

Many of the ongoing and proposed activities within the TMAA involve maneuvers by various types of surface ships and submarines (collectively referred to as vessels). Currently, the number of Navy vessels participating in training under the No Action Alternative is 23, consisting of 4 military vessels and up to 19 contracted vessels and boats, but can vary based on training schedules and scenarios. Activities involving vessel movements occur intermittently and are short in duration, generally a few hours in duration. These activities are widely dispersed throughout the TMAA, which is a vast area encompassing 42,146 square nautical miles (nm^2) (144,557 square kilometers [km^2]) of surface/subsurface ocean. Ship movements on the ocean surface have the potential to affect birds by disturbing or striking individual animals. The probability of ship and seabird interactions occurring in the TMAA depends on several factors, including the presence and density of birds; numbers, types, and speeds of vessels; duration and spatial extent of activities; and protective measures implemented by the Navy.

Birds respond to moving vessels in various ways. Some species, such as gulls and albatross, commonly follow vessels (Hamilton 1958, Hyrenbach 2001, Hyrenbach 2006), while other species, such as plovers and curlews, seem to avoid vessels (Borberg et al. 2005, Hyrenbach 2006). Vessel movements could elicit brief behavioral or physiological responses, such as alert response, startle response, or fleeing the immediate area, such responses typically conclude as rapidly as they occur. However, the general health of individual birds is not compromised (see additional discussion of these responses below for aircraft overflights).

Direct collisions with vessels or a vessel’s rigging, such as wires, poles, or masts, could result in bird injury or mortality. Bird/vessel collisions are probably rare events during daylight hours, but the possibility of collisions could increase at night, especially during inclement weather. Birds can become disoriented at night in the presence of artificial light (Black 2005), and lighting on vessels may attract some birds (Hunter et al. 2006), increasing the potential for harmful encounters.

Based on the low density of Navy vessels and the high mobility of birds, the probability of bird/vessel collisions is low. Navy mitigation measures (see Chapter 5), which include avoidance of seabird colonies and habitats where birds may concentrate, would further reduce the probability of bird/vessel collisions.

In accordance with EO 12114, harm to birds from vessel movements in nonterritorial seas would be unlikely.

Short-tailed albatross exposure to vessels could occur while foraging or migrating in open water environments within the TMAA. Periods of exposure of individual birds would be extremely short given the low density and constant movement of naval vessels at sea. If birds were to respond to vessel movements, the responses would be limited to short-term behavioral or physiological reactions. Direct collisions with vessels or a vessel's rigging could result in bird injury or mortality, but is unlikely based on the low density of Navy vessels and the high mobility of birds. In accordance with the ESA, vessel movements under the No Action Alternative may affect, but are not likely to adversely affect, ESA-listed seabirds.

Aircraft Overflights

Aircraft Disturbance

Various types of fixed-wing aircraft and helicopters are used in training activities throughout the TMAA. For this reason, birds in the TMAA could be exposed to airborne noise associated with these aircraft. Numerous studies have documented that birds respond to anthropogenic noise, including aircraft overflights, weapons firing, and explosions (National Park Service [NPS] 1994, Larkin 1996, Plumpton 2006). The manner in which birds respond to noise depends on several factors, including life-history characteristics of the species, characteristics of the noise source, loudness, onset rate, distance from the noise source, presence or absence of associated visual stimuli, and previous exposure.

Researchers have documented a variety of behavioral responses of birds to noise, such as alert behavior, startle response, flying or swimming away, diving into the water, and increased vocalizations. While they are difficult to measure in the field, some of these behavioral responses are likely accompanied by physiological responses, such as increased heart rate, or stress (NPS 1994). Chronic stress can compromise the general health of birds, but stress does not necessarily result in negative consequences to individual birds or to populations (NPS 1994; Larkin 1996). For example, the reported behavioral and physiological responses of birds to noise exposure are within the range of normal adaptive responses to external stimuli, such as predation, that birds face on a regular basis. Unless they are repeatedly exposed to loud noises or simultaneously exposed to a combination of stressors, individuals may return to normal behavior and physiology almost immediately after exposure. Studies also have shown that birds can become habituated to noise following frequent exposure and cease to respond behaviorally to the noise (NPS 1994; Larkin 1996; Plumpton 2006); however, such frequent exposure is not anticipated to occur in the TMAA.

Under the No Action Alternative, most overflights would occur over marine environments, at elevations in excess of 15,000 ft (4,752 m) above mean sea level (MSL), and beyond 20 nm (37 km) from shore. Bird exposure to aircraft noise would be brief as aircraft quickly passed overhead. Exposures would be infrequent to seabirds and practically nonexistent to waterfowl based on the distance of the TMAA from coastal environments, large operational area of the TMAA, dispersed nature of the overflights, and the low probability of repeated exposure of individual birds over a short period of time (hours or days).

Most documented responses of birds have been to low-level aircraft overflights occurring below 3,000 ft (914 m) (NPS 1994). Unlike the situation at a busy commercial airport or military landing field, repeated exposure of individual birds or groups of birds is unlikely within the TMAA based on the dispersed nature of the overflights. If birds were to respond to an overflight, the responses would be limited to brief behavioral or physiological reactions and the general health of individual birds would not be compromised. Aircraft transiting between the TMAA and inland special use areas do so within a designated corridor that is above 15,000 ft (4,752 m), well above altitudes that would cause an exposure to birds near the surface from aircraft noise.

Unlike fixed-wing aircraft, helicopter training activities often occur at low altitudes (75 to 100 ft [22.8 to 30 m]), which increases the likelihood that birds would respond to helicopter overflights. In addition, some studies have suggested that birds respond more to noise from helicopters than that from fixed-wing aircraft (Larkin 1996; Plumpton 2006). Noise from low-altitude helicopter overflights would be expected to elicit brief behavioral or physiological responses in exposed birds. Repeated exposure of individual birds or groups of birds would be unlikely, based on the distance of the TMAA from coastal environments, large operational area of the TMAA, and the dispersed nature of the overflights. The general health of individual birds would not be compromised.

Aircraft noise under the No Action Alternative would not adversely affect populations of migratory birds and their habitat. In accordance with NEPA, aircraft noise over territorial seas would have minimal impacts on birds. In accordance with EO 12114, aircraft noise over nonterritorial seas would not cause considerable harm to birds.

Short-tailed albatross exposure to aircraft noise could occur while foraging or migrating in open water environments within the TMAA. Periods of elevated noise levels would be brief and repeated exposure of individual birds would be extremely short given the constant movement of naval vessels at sea. If birds were to respond to an overflight, the responses would be limited to short-term behavioral or physiological reactions. In accordance with the ESA, aircraft noise under the No Action Alternative may affect but is not likely to adversely affect ESA-listed seabirds.

Aircraft Collisions

Aircraft strikes on birds are a major concern for the Navy because they can cause harm to aircrews, damage equipment, and produce bird mortality. During maritime operations, OPNAVINST 3750.6R identifies measures to evaluate and reduce or eliminate bird/aircraft strike hazards to aircraft, aircrews, and birds and requires the reporting of all strikes when damage or injuries occur as a result of a bird – aircraft strike. However, the numbers of bird deaths that occur annually from all Navy activities are insignificant from a bird population standpoint. From 2002 through 2004, an annual average of 596 known wildlife/aircraft strike events occurred Navy-wide. While most of these involved birds (Navy Safety Center [NSC] 2004), only five known bird strikes occurred involving vessel-based aircraft.

While bird strikes can occur anywhere aircraft are operated, Navy data indicate that they occur most often over land or close to shore. The potential for bird strikes to occur in offshore areas is relatively low because activities are widely dispersed and at relatively high altitudes (above 15,000 ft [4,752 m] for fixed-wing aircraft) where bird densities are low. Approximately 95 percent of bird flight during migrations occurs below 10,000 ft (3,048 m) with the majority below 3,000 feet (914 m) (USGS 2006). Aircraft transiting between the TMAA and inland special use areas do so within a designated corridor that is above 15,000 ft (4,752 m), in regions where bird density is extremely low.

Aircraft strikes under the No Action Alternative would not adversely affect migratory bird populations and their habitat. In accordance with NEPA, aircraft strikes over territorial seas are not anticipated and would have minimal impacts on birds. In accordance with EO 12114, harm to birds from aircraft strikes over nonterritorial seas would not be expected.

Short-tailed albatross could be exposed to airborne noise associated overflights and to potential aircraft strike. Fixed wing aircraft overflights generally occur at altitudes above that where albatross are present. Additionally, Navy helicopter pilots are vigilant with regard to strike hazards and avoid interactions with birds. Aircraft strikes under the No Action Alternative may affect, but are not likely to adversely affect, ESA-listed seabirds.

Expended Materials

The Navy expends a variety of materials during training exercises in the TMAA. The types and quantities of expended materials used, and information regarding fate and transport of these materials within the marine environment, are discussed in Section 3.2 (Expended Materials) and Section 3.3 (Water Resources).

The effect of materials expended during training in the TMAA is assessed by the number of expended items per unit area. Under the No Action Alternative, an estimated 15,982 items would be expended in this area (Table 3.9-2). Based on a TMAA size of 42,146 nm^2 (144,557 km^2) and assuming distribution of activities within 20 percent of the TMAA (8,429 nm^2 [28,911 km^2]), 1.9 items per nm^2 per year (0.5 kg per km^2) would be deposited in the ocean. More than 97 percent of these items would be from gunshells and small caliber rounds.

Table 3.9-2: Expended Training Materials in the TMAA – All Alternatives

Training Material	No Action Alternative	Alternative 1		Alternative 2	
	Number	Number	% Increase from No Action	Number	% Increase from No Action
Bombs	120	180	50	360	200
Missiles	22	33	50	66	200
Naval Gunshells	10,564	13,188	25	26,376	150
Small Caliber Rounds	5,000	5,700	14	11,400	128
Sonobuoys	24	793	3,200	1,587	6,500
Targets & Pyrotechnics	252	322	28	644	160
PUTR	0	7	N/A	7	N/A
SINKEX	0	0	N/A	858	N/A
Total	**15,982**	**20,223**	**26**	**41,298**	**160**

Additional materials expended during training include illuminating flares, chaff, and marine markers. These materials are dismissed from further analysis because, for both canisters and markers, the majority of the constituents are consumed by heat and smoke, both of which dissipate in the air. MK-58 marine markers produce chemical flames and surface smoke and are used in training exercises to mark an ocean surface position to simulate divers, ships, and points of contact. The smoke dissipates in the air and has little or no effect on birds. The marker burns similarly to a flare, producing a flame until all combustible components have been consumed. Any remaining materials from marine markers would sink into bottom sediments or become encrusted by chemical processes or by marine animals. Phosphorus contained in the markers reacts with seawater to produce phosphoric acid, a variable, but normal, component of seawater.

Chaff is a thin polymer with an aluminum coating that is cut in various lengths to affect and block various radar frequencies. All of the components of the aluminum coating are present in seawater in trace amounts, except magnesium, which is present at 0.1 percent. The stearic acid coating is biodegradable and nontoxic. The fibers are too short and fine to pose an entanglement risk. Although they potentially could be ingested by marine life, the fibers are non-toxic. Chemicals leached from the chaff would be diluted by the surrounding seawater to levels below those that can affect sediment quality and benthic habitats.

Ordnance and Ordnance-Related Materials

Current Navy training activities in the TMAA include firing a variety of weapons. As listed in Table 3.9-2, these weapons employ a variety of nonexplosive and explosive training rounds, including bombs, missiles, naval gun shells, cannon shells, and small caliber ammunition. These materials are used in the open ocean beyond 12 nm (22 km) from shore. These activities account for the majority of naval shells and rounds used in the TMAA.

Direct ordnance strikes from firing weapons are a potential, but unlikely, stressor to seabirds. Seabirds both in flight and resting on the water's surface would be vulnerable to an ordnance strike. Seabirds exposed to an ordnance strike would suffer sublethal injury or mortality. However, the vast area over which training activities occur and implementation of Navy resource protection measures, combined with the small size and ability of birds to flee disturbance, would make direct strikes unlikely. Individual birds may be affected, but ordnance strikes have no effect on species or community populations. Ordnance strikes under the No Action Alternative will not have a significant adverse effect on migratory bird populations. Furthermore, in accordance with EO 12114, harm to seabirds from ordnance strikes in nonterritorial seas is improbable. Ordnance strikes under the No Action Alternative may affect, but are not likely to adversely affect, ESA-listed seabirds.

Expended materials resulting from ordnance use include remnants and shrapnel from explosive rounds and nonexplosive training rounds. These solid materials, many of which have a high metal content, quickly drop through the water column to the sea floor. Ingestion of expended ordnance does not occur in the water column because ordnance-related materials quickly sink.

The probability of birds ingesting expended ordnance depends on factors such as the location of the spent material, size of the material, likelihood the material would be mistaken for prey, and extent of benthic foraging that occurs in the impact area. Some materials, such as nonexplosive training bombs, would be too large to be ingested by a bird, but other materials, such as small-caliber ammunition and shrapnel, are small enough to be swallowed. Marine debris can pass through the digestive tract and be voided naturally without causing harm, or it can cause sublethal or lethal effects. Sublethal effects include nutrient dilution, which occurs when nonnutritive debris displaces nutritious food in the gut, leading to slow growth or reduced reproductive success (McCauley and Bjorndal 1999). While ingestion of marine debris has been linked to bird mortalities, sublethal effects are more common (Bjorndal et al 1994, Tomas 2002, McCauley and Bjorndal 1999). It is possible that persistent expended ordnance could be colonized by benthic organisms (such as clams and oysters) and then mistaken by birds for prey, or that expended ordnance could be accidentally ingested by birds while they were foraging for natural prey items. As foraging depths of diving birds is restricted to shallow depths, it is highly unlikely that benthic foraging by birds would occur in areas of ordnance use, or that ingestion of expended ordnance would affect birds. Most benthic foraging by birds occurs in nearshore areas (Lutcavage et al. 1997). All ordnance use in the TMAA would occur in areas beyond 12 nm (22 km) from shore where water depths in excess of 3,000 ft would exclude benthic foraging.

Ordnance-related materials under the No Action Alternative would not adversely affect migratory bird populations and their habitat. In accordance with EO 12114, harm to birds from ordnance-related materials would be unlikely in nonterritorial waters.

Direct ordnance strikes from firing weapons are potential, but very unlikely, threats to short-tailed albatross. Based on a TMAA size of 42,146 nm^2 (144,557 km^2) and assuming distribution of activities within 20 percent of the TMAA (8,429 nm^2 [28,911 km^2]), 1.86 items per nm^2 per year (0.5 kg per km^2) would be used in within the TMAA. However, the potential for a direct bird strike by ordnance would remain quite low. Effects could include disturbance and relocation, sub-lethal injury, and mortality. However, the vast area of 42,146 nm^2 (145,482 km^2) over which training activities could occur and combined with the small size of the birds and the ability of the birds to flee, would make direct strikes unlikely. Additionally, Navy guidance indicates that activities involving explosions must have a cleared buffer area of 600 yards around the detonation area before the activity can be conducted (See Mitigation, Section 3.9.3) further reduces the possibility of a direct ordnance strike. In accordance with the ESA, ordnance and ordnance-related materials under the No Action Alternative may affect, but are not likely to adversely affect, ESA-listed seabirds.

Target-Related Materials

A variety of at-sea targets are used in the TMAA, ranging from high-technology, remotely operated airborne and surface targets (such as airborne drones) to low-technology, floating, at-sea targets (such as inflatable targets) and airborne, towed banners. Many of the targets are designed to be recovered for reuse and are not destroyed during training. The expendable targets used in the TMAA include the BQM-74E Tactical Air Launched Decoy (TALD), floating targets, and MK-58 marine marker. These units are 2 and 3 ft (0.6 and 0.9 m) in length, respectively, sink to the bottom intact, and present no ingestion hazard to birds.

The TALD is an air launched, preprogrammed, unpowered vehicle used to deceive and saturate enemy integrated air defenses during strike aircraft operations. It is approximately 7.5 ft (2.3 m) long, with a wing span of 5 ft (1.5 m). It operates as an expendable vehicle with no recovery capabilities. Under the No Action Alternative, eight TALDs would be used annually. Based on the large size of the TMAA, low number of TALDs used, and abilities of birds to readily disperse from disturbance, it is very unlikely that birds would be measurably affected by use of TALDS.

Floating targets, such as naval gunnery target balloons (known as Killer Tomatoes) are required and utilized by Navy units to maintain a state of readiness in target acquisition and gunnery skills. Surface targets are made from urethane fabric, are relatively lightweight, easily stored, inflated, and deployed by just a few personnel. Most target balloons are radar enhanced with reflective metal foil material intended to simulate a small-craft on electronic systems. This allows radar system operators to lock onto their target to ascertain range and azimuth information for use by commanders to initiate simulated combat, interdiction, or rescue missions. Though the naval gunnery target balloons are attempted to be recovered after training activities, a destroyed floating target could fill with water and sink to the bottom of the water column. Combined with the low number of floating targets that could sink in this manner, the large area of the TMAA, and the depth of the expended target after completing the exercise, it is very unlikely that birds would be measurably affected by use of floating targets.

Target use under the No Action Alternative would not adversely affect migratory bird populations and their habitat. In accordance with EO 12114, harm to birds from targets and marine markers would be unlikely in nonterritorial seas.

Target use under the No Action Alternative is an unlikely threat to short-tailed albatross. The expendable targets used in the TMAA quickly sink to the bottom, and present little to no ingestion hazard to short-tailed albatross. Impacts would be possible, but have a low potential for occurrence due to the large area of the TMAA and low numbers of targets used. Target use in nonterritorial seas under the No Action Alternative may affect, but is unlikely to adversely affect, ESA-listed seabirds.

Entanglement

Expended material such as parachutes from sonobouys, associated parachute lines, or shrouds may be encountered by birds in the waters of the TMAA. Entanglement in persistent marine debris causes mortality in birds in the eastern Pacific Ocean. Birds that become entangled could drown, starve to death, lose a limb, or attract predators with their struggling (Melvin and Parrish 2001). There is a potential for birds to become entangled in expended materials that are on or near the surface. Materials that are expended in training activities, including sonobuoys and markers, usually sink shortly after they are deployed. As a result, the potential for entanglement in these materials is low.

Under the No Action Alternative, approximately 24 parachutes associated with sonobuoys are deployed and not recovered. These parachutes deliver sonobuoys during training activities in the TMAA. Given the infrequent occurrence of birds in the study area and the low concentration of entanglement hazards, the potential for bird entanglement in Navy debris would be low. Entanglement hazards under the No Action Alternative would not adversely affect migratory bird populations. In accordance with EO 12114, harm to birds from marine debris would be unlikely in nonterritorial seas.

Similar to target use, parachute lines or shrouds sink shortly after being deployed. Given the low density of short-tailed albatross in the TMAA and the low concentration of entanglement hazards, the potential for short-tailed albatross entanglement in Navy expended material is low. In accordance with the ESA, expended material under the No Action Alternative may affect, but is not likely to adversely affect, ESA-listed seabirds.

At-Sea Explosions

Under the No Action Alternative, activities involving explosions and impacts occur at or just below the surface in the TMAA. These explosions missiles and bombs used during Bombing Exercises (BOMBEX); and high-explosive shells fired during Gunnery Exercises (GUNEX) and BOMBEX. Missiles used in air-to-air training events at sea (MISSLEX), although part of live fire events, are designed to detonate in the air (typically above 15,000 feet where expected bird density is low) and do not constitute an at-sea explosion occurring in water as analyzed in this document. Birds in the immediate vicinity and exposed to explosions and impacts could suffer temporary effects, and these effects would be in proportion to the proximity to the explosion and size of the detonation. Birds that may be present in proximity to these activities could be disturbed and relocate, or they could be injured or killed (NMFS 2002). Based on a TMAA size of 42,146 nm^2 (144,557 km^2) and assuming distribution of activities within 20 percent of the TMAA (8,429 nm^2 [28,911 km^2]), 0.01 explosions per nm^2 per year (0.003 per km^2) could occur in within the TMAA. This usage would produce a very low density of offshore detonations per year within the TMAA. This, coupled with Navy resource protection measures implemented prior to these activities (Section 3.9.3) would provide a high level of protection for the birds during these exercises, making the potential for effects quite low.

At-sea explosions under the No Action Alternative would not adversely affect migratory bird populations and their habitat. In accordance with EO 12114, minimal harm to birds from at-sea explosions in nonterritorial seas would occur.

Direct impacts from at-sea explosions are possible, but are unlikely threats to short-tailed albatross. Explosions have the potential to affect the short-tailed albatross only if the bird is in the immediate vicinity above the explosion. Impacts would be possible, but have a low potential for occurrence given the large area of the TMAA, limited use of live ordnance, and implementation of Navy protective measures. In accordance with the ESA, at-sea explosions under the No Action Alternative may affect, but are not likely to adversely affect, ESA-listed seabirds.

Threatened and Endangered Species

Within the TMAA, the single endangered species is the Short-tailed Albatross. As part of the EIS/OEIS process the Navy has entered into consultation with the appropriate federal and state agencies. Utilizing criteria and analysis methodology as presented for non-listed species, vessel movements, aircraft overflight, ordnance use, explosions, and military expended materials (entanglement) may affect, but are not likely to adversely affect individual or populations of Short-tailed albatross under the No Action Alternative in the TMAA.

Migratory Bird Treaty Act

All activities that would take place under the No Action Alternative fall within the MBTA definition of military readiness activities. The take of an individual bird from these activities is allowed under the MBTA provided it does not result in a significant adverse effect on a population of a migratory bird species. The activities associated with the No Action Alternative would not diminish the capacity of a population of a migratory bird species to maintain genetic diversity, to reproduce, and to function effectively in its native ecosystem, nor would it adversely affect migratory bird populations. As a result and in accordance with 50 C.F.R. Part 21, the Navy is not required to confer with the USFWS on the development and implementation of conservation measures to minimize or mitigate adverse effects to migratory birds that are not listed under the ESA.

3.9.2.5 Alternative 1

Vessel Movements

As discussed for the No Action Alternative, the number of Navy vessels operating during training activities varies, but generally includes up to 27 surface ships and one submarine (collectively referred to as vessels). Vessel movements would be widely dispersed throughout the area. Under Alternative 1, steaming hours would increase from current conditions. The small increase in steaming hours would not measurably increase potential effects to birds from disturbance or vessel collision. Impacts would be the same as those described for the No Action Alternative.

Vessel movements under Alternative 1 would not adversely affect migratory bird populations. In accordance with EO 12114, harm to birds from vessel movements in nonterritorial seas would be unlikely. In accordance with the ESA, vessel movements in nonterritorial seas under Alternative 1 may affect but are unlikely to adversely affect ESA-listed seabirds.

Aircraft Overflights

As discussed for the No Action Alternative, most flights under Alternative 1 would occur over marine environments, at elevations in excess of 3,000 ft (914 m), and beyond 12 nm (22 km). Most sound exposure levels would be lower than 97 A-weighted decibels (dBA) because a majority of the overflights would occur above 15,000 ft (4,752 m). Overflights occurring between the TMAA and inland operating areas occur at altitudes above 15,000 ft, well above those flight levels that would cause exposure to sound. Impacts to birds from aircraft disturbance would be the same as those described for the No Action Alternative. Under Alternative 1, aircraft overflight noise would elicit brief behavioral responses in exposed birds, but the general health of individual birds would not be compromised.

As discussed for the No Action Alternative, relatively few vessel-based Navy aircraft strike birds each year. The potential for bird strikes to occur offshore is low because activities are widely dispersed and at altitudes above 15,000 ft (914 m) where densities bird are low. Overflights occurring between the TMAA and inland operating areas occur at altitudes above 15,000 ft (4,752 m), where bird densities are much lower than those at lower altitudes. The proposed increase in aircraft overflights would not measurably change impacts from those described for the No Action Alternative. Few, if any, birds would be struck by vessel-based Navy aircraft under Alternative 1.

Aircraft overflights under Alternative 1 would not adversely affect migratory bird populations. In accordance with EO 12114, harm to birds from aircraft overflights in nonterritorial seas is possible, but would be unlikely. Aircraft overflights in nonterritorial seas under Alternative 1 may affect, but are not likely to adversely affect, ESA-listed seabirds.

Expended Materials

Under Alternative 1, an estimated 20,223 items would be expended in the TMAA, a 26 percent increase over the No Action Alternative (see Table 3.9-2). Based on an open ocean area of 42,146 nm^2 (144,557 km^2) and assuming a distribution of activities over 20 percent of this area, 2.4 items per nm^2 per year (0.7 kg per km^2) would be deposited in the ocean. More than 93 percent of these expended items would be gunshells and small caliber rounds that sink through the water column quickly. It is highly unlikely that benthic foraging by birds occurs in the area where ordnance would be found. All ordnance use in the TMAA would occur in areas more than 3 nm offshore where water depths are in excess of 3,000 ft (914 m). Under Alternative 1, ingestion of expended materials may affect, but is not likely to adversely affect, ESA-listed seabirds.

As described for the No Action Alternative, the potential for birds to be struck by ordnance is low, given the patchy distribution of birds, ability of birds to flee from disturbance, and low concentration of dispersed rounds. Individual birds may be affected, but ordnance strikes would have no effect on species or community populations. Avoidance measures are implemented prior to and during these activities to minimize impacts to birds (see Section 3.9.3 and Chapter 5, Mitigation).

As indicated in Table 3.9-2, use of targets and pyrotechnics would increase by 28 percent under Alternative 1 from 252 to a total of 322 targets. As discussed for the No Action Alternative, the expendable targets used in the TMAA are the Expendable Mobile Anti-Submarine Warfare (ASW) Training Target (EMATT), floating targets, and TALD. An EMATT is a small device (approximately 2 ft in length and 3 inches in diameter) shaped like a torpedo that can be launched by hand from a surface vessel or deployed from a submarine or aircraft. EMATTs are programmed to move through the water and provide acoustic and other sensor that mimic a submarine. At the end of its use, an EMATT will sink to the floor of the ocean. Expended EMATTs are unlikely to result in any physical impacts to the sea floor. Expended EMATTs would sink into a soft bottom or would lie on a hard bottom, where they may provide a substrate for benthic colonization and may be covered eventually by shifting sediments. All EMATTs used in the TMAA would occur in areas beyond 12 nm (22 km) from shore where water depths in excess of 3,000 ft (914 m) would exclude benthic foraging on materials resting on the bottom following exercises. The modest change in use of these materials and the inclusion of EMATTs would not measurably change the impacts to birds over existing conditions. Thus, effects would be the same as those described for the No Action Alternative.

Under Alternative 1, approximately 793 parachutes associated with sonobuoys would be deployed and not recovered. Assuming a distribution of hazards covering only 20 percent of the TMAA, the concentration of entanglement hazards would be 0.09 per nm^2. As described for the No Action Alternative, given the infrequent occurrence of birds in the TMAA and the low concentration of entanglement hazards, the potential for bird entanglement in Navy debris would be low.

Expended materials under the Alternative 1 would not adversely affect migratory bird populations. In accordance with EO 12114, harm to birds from expended materials in nonterritorial seas would be unlikely. In accordance with the ESA, expended materials in nonterritorial seas under Alternative 1 may affect, but are not likely to adversely affect, ESA-listed seabirds.

At-Sea Explosions

Under Alternative 1, explosions from missiles and bombs used during BOMBEX and MISSILEX; and shells fired during GUNEX and BOMBEX would increase. As mentioned previously, missiles used in air to air training events at sea (MISSLEX), although part of a live fire event, are designed to detonate in the air (typically above 15,000 ft (4,752 m) where expected bird density is low) and do not constitute an at-sea explosion occurring in water as analyzed in this document. In addition, there would also be subsurface explosions that involve the use of explosive sonobuoys used during a Tracking Exercise (TRACKEX). Birds in relatively close proximity to these activities could be disturbed and relocate, or be injured or killed. Based on a TMAA size of 42,146 nm^2 (144,557 km^2) and assuming distribution of GUNEX and BOMBEX activities within 20 percent of the TMAA (8,429 nm^2 [28,911 km^2]), 0.015 explosions per nm^2 per year (0.004 per km^2) would occur in within the TMAA. Although the potential for birds to be injured by explosions exists, the chance of this occurrence is low. Navy avoidance measures (see Section 3.9.3) implemented prior to explosive activities would provide a high level of protection for birds during at-sea explosions.

Under Alternative 1, explosions and impacts would not adversely affect migratory bird populations. In accordance with EO 12114, harm to birds from at-sea explosions in nonterritorial seas would be unlikely. In accordance with the ESA, explosions in nonterritorial seas under Alternative 1 may affect, but is unlikely to adversely affect, ESA-listed seabirds.

Threatened and Endangered Species

Within the TMAA, the single endangered species is the Short-tailed Albatross. As part of the EIS/OEIS process the Navy has entered into consultation with the appropriate federal and state agencies. Utilizing criteria and analysis methodology as presented for nonlisted species, vessel movements, aircraft overflight, ordnance use, explosions, and military expended materials (entanglement) may affect, but are unlikely to adversely affect, individual Short-tailed albatross under Alternative 1 in the TMAA.

Migratory Bird Treaty Act

All activities that would take place under Alternative 1 fall within the MBTA definition of military readiness activities. The take of an individual bird from these activities is allowed under the MBTA provided it does not result in a significant adverse effect on a population of a migratory bird species. The activities associated with Alternative 1 would not diminish the capacity of a population of a migratory bird species to maintain genetic diversity, to reproduce, and to function effectively in its native ecosystem, nor would it adversely affect migratory bird populations. As a result and in accordance with 50 C.F.R. Part 21, the Navy is not required to confer with the USFWS on the development and implementation of conservation measures to minimize or mitigate adverse effects to migratory birds that are not listed under the ESA.

3.9.2.6 Alternative 2

Vessel Movements

Under Alternative 2, there may be up to 30 surface vessels and 1 submarine participating in training activities during two distinct training periods. Under Alternative 2, steaming hours would increase from current conditions, although the increase in steaming hours would not measurably increase potential effects to birds. Disturbance impacts to birds from vessel movements under Alternative 2 would be the same as those described for the No Action Alternative.

Vessel movements under Alternative 2 would not adversely affect migratory bird populations. In accordance with EO 12114, harm to birds from vessel movements in nonterritorial seas would be unlikely. In accordance with the ESA, vessel movements in nonterritorial seas under Alternative 2 may affect, but are not likely to adversely affect, ESA-listed seabirds.

Aircraft Overflights

As discussed in the analyses for the No Action Alternative and Alternative 1, bird responses to noise from aircraft overflights would be limited to brief behavioral or physiological reactions and the general health of individual birds would not be compromised. The increase in potential exposure to visual and sound disturbance would not measurably increase effects to birds. Aircraft noise effects of Alternative 2 would be the same as the described for the other alternatives.

As described for the No Action Alternative and Alternative 1, the potential for bird strikes to occur in offshore areas is relatively low because activities are widely dispersed and at relatively high altitudes where bird densities are low. Few, if any, aircraft strikes are expected to occur in the TMAA. The potential for bird strikes to occur between the TMAA and inshore areas is much lower than those for offshore areas, as the bird densities at the altitudes of these overflights (above 15,000 ft) is extremely low.

Aircraft overflights under Alternative 2 would not adversely affect migratory bird populations. In accordance with NEPA, aircraft overflights in territorial waters would have minimal impacts on birds. In accordance with EO 12114, harm to birds from aircraft overflights in nonterritorial seas would be unlikely. In accordance with the ESA, aircraft overflights in nonterritorial seas under Alternative 2 may affect, but are not likely to adversely affect, ESA-listed seabirds.

Expended Materials

Under Alternative 2, an estimated 41,298 items would be expended in the TMAA, a 160 percent increase over the No Action Alternative (Table 3.9-2). Based on an open ocean area of 42,146 nm^2 (144,557 km^2) and assuming distribution of activities over 20 percent of the TMAA, 4.9 items per nm^2 per year (1.4 kg per km^2) would be deposited in the ocean. As described for the other alternatives, all ordnance use would occur in areas beyond 12 nm (22 km) from shore where water depths in excess of 3,000 ft (914 m), excluding seabird benthic foraging. Although a small potential for expended materials to be ingested by birds may exist, the low concentration of expended rounds and the great depth to benthic habitats in the TMAA would make this occurrence highly unlikely.

As described for the other alternatives, birds could be vulnerable to a direct ordnance strike. However, the potential for birds to experience strike would remain quite low. Avoidance measures are implemented prior to and during these activities to minimize impacts to birds (see Section 3.9.3). The large area over which ordnance is used, small size of the birds, and ability of birds to readily flee would make direct strikes unlikely. Individual birds may be affected, but ordnance strikes would have no effect on species or community populations.

Ordnance strikes under Alternative 2 would not adversely affect migratory bird populations. In accordance with EO 12114, harm to birds from ordnance use in nonterritorial seas would not be likely.

Under Alternative 2, 644 target related materials would potentially be expended in the TMAA. As described for the other alternatives, many of the targets are designed to be recovered for reuse, but the EMATT, and TALD would be expended. Based on the large size of the TMAA, low number of targets used, and abilities of birds to readily disperse from disturbance, it is not likely that birds would be measurably affected by use of at-sea targets.

Under Alternative 2, approximately 1,587 parachutes associated with sonobuoys would be deployed with at-sea targets and marine markers in offshore areas and not recovered. Assuming a distribution of activities over 20 percent of the TMAA, the concentration of these expended parachutes which represent an entanglement hazard would be 0.18 per nm^2. Given this low concentration, the potential for bird entanglement in Navy debris would be low. Under Alternative 2, birds may be affected by entanglement in Navy debris, but the effects would be small because of the infrequent occurrence of birds and low concentration of debris.

Expended materials would not adversely affect migratory bird populations. In accordance with EO 12114, harm to birds from expended materials in nonterritorial seas would be possible, but unlikely. In accordance with the ESA, expended materials in nonterritorial seas under Alternative 2 may affect, but are not likely to adversely affect, ESA-listed seabirds.

At-Sea Explosions

Under Alternative 2, explosions and impacts would occur either at the water's surface, or underwater at depth. Birds in relatively close proximity to these activities could be disturbed and relocate, or be injured or killed. However, the rate of occurrence of these effects would be quite low. Based on a TMAA size of 42,146 nm^2 (144,557 km^2) and assuming distribution of GUNEX and BOMBEX activities within 20 percent of the TMAA (8,429 nm^2 [28,911 km^2]), 0.02 explosion per nm^2 per year (0.006 per km^2) would occur in the TMAA. Navy avoidance measures (see Section 3.9.3 and Chapter 5, Mitigation) implemented prior to explosive activities would provide a high level of protection for birds during at-sea explosions, and the likelihood of birds being affected is expected to be quite low.

Birds exposed to explosions could suffer temporary effects, sublethal injury or mortality (Yelverton et al. 1973, Yelverton 1981). Although the potential for birds to be injured by explosions exists, the chance of this occurrence is low. At-sea explosions under Alternative 2 would not adversely affect migratory bird populations. In accordance with EO 12114, harm to birds from at-sea explosions in nonterritorial seas would be unlikely. In accordance with the ESA, at-sea explosions in nonterritorial seas under Alternative 2 may affect, but are not likely to adversely affect ESA-listed seabirds.

Sinkex

Under Alternative 2, additional explosions would occur in the Study Area associated with two sinking exercises (SINKEX) that use explosive ordnance. In a SINKEX, weapons are typically fired in order of decreasing range from the source with weapons fired until the target is sunk. For each SINKEX, up to 14 missiles, 14 bombs, 400 gunnery rounds, and 1 torpedo are utilized during SINKEX activities.

More than 93 percent of these items would be gunnery (5-inch) rounds. As described for other activities involving ordnance, individual birds may be affected, but ordnance strikes would have no effect on species or community populations. Birds exposed to underwater explosions would suffer temporary effects, sub-lethal or lethal injuries, or direct mortality, in proportion to the proximity to the explosion and size of the detonation. Avoidance measures are implemented prior to and during these activities to minimize impacts to birds (see Section 3.9.3 and Chapter 5). Typical areas where large numbers of birds congregate are located in nearshore and intertidal areas. Offshore explosives use in the TMAA is a considerable distance from areas where most birds would be expected, therefore impacts to birds from offshore explosions are possible, but have a low potential for occurrence.

Under Alternative 2, ordnance use and explosions associated with SINKEX would not adversely affect migratory bird populations. In accordance with EO 12114, harm to birds from at-sea ordnance use and explosions in nonterritorial seas would be unlikely.

Direct impacts from explosions associated with SINKEX activities are possible, but are unlikely threats to short-tailed albatross. Explosions have the potential to affect the short-tailed albatross only if the bird is in the immediate vicinity above the explosion. Effects would depend on the distance from the detonation and size of the explosion and would include disturbance and relocation, temporary effects, sub-lethal injuries, or direct mortality. Impacts would be possible, but have a low potential for occurrence given the use of live ordnance is limited. In accordance with the ESA, ordnance use and explosions in nonterritorial seas associated with SINKEX under Alternative 2 may affect, but are not likely to adversely affect, ESA-listed seabirds.

Threatened and Endangered Species

Within the TMAA, the single endangered species is the Short-tailed Albatross. As part of the EIS/OEIS process, the Navy has entered into consultation with the appropriate federal and state agencies. Utilizing criteria and analysis methodology as presented for nonlisted species, vessel movements, aircraft overflight, ordnance use, explosions, and military expended materials (entanglement) may affect individual Short-tailed albatross under Alternative 2 in the TMAA.

Migratory Bird Treaty Act

All activities that would take place under Alternative 2 fall within the MBTA definition of military readiness activities. The take of an individual bird from these activities is allowed under the MBTA provided it does not result in a significant adverse effect on a population of a migratory bird species. The activities associated with Alternative 2 would not diminish the capacity of a population of a migratory bird species to maintain genetic diversity, to reproduce, and to function effectively in its native ecosystem, nor would it adversely affect migratory bird populations. As a result and in accordance with 50 C.F.R. Part 21, the Navy is not required to confer with the USFWS on the development and implementation of conservation measures to minimize or mitigate adverse effects to migratory birds that are not listed under the ESA.

3.9.3 Mitigation

As summarized in Section 3.9.4, the actions proposed in this EIS/OEIS could affect some individual birds within the TMAA, but community- or population-level effects would not be expected under any of the alternatives. Current mitigation measures include:

- Guidance involving explosions contains instructions to personnel to observe the surrounding area within 600 yards for 30 minutes prior to detonation. If diving birds (or marine mammals or sea turtles) are seen, the activity must be relocated to an unoccupied area or postponed until animals leave the area.

Current protective measures would continue to be implemented by the Navy, and no additional mitigation measures would be needed to protect birds or their habitats.

3.9.4 Summary of Effects

The Alaska Training Area (ATA) encompasses important foraging habitats for birds. Migratory birds utilize the productive offshore waters associated with the Pacific coast upwelling to forage during wintering and migratory movements. Coastal developments, loss of habitat, commercial fishing, and introduced species have caused populations of many seabird species to decline in recent decades. Navy activities in the TMAA however, would not be expected to increase effects to bird populations. Based on the analysis of the proposed alternatives, it is thought that impacts to individual protected and migratory birds could occur, but the number of individual birds affected would be low and poses minimal impact potential to seabird populations. Table 3.9-3 summarizes the effects of the No Action Alternative, Alternative 1, and Alternative 2 on birds under both NEPA and EO 12114.

Under the No Action Alternative, Alternative 1, or Alternative 2 (Preferred Alternative) at the TMAA, vessel movements, aircraft overflight, ordnance use, at-sea explosions, and military expended materials (entanglement) may affect, but not likely to adversely affect, individual Short-tailed albatross.

Table 3.9-3: Summary of Effects by Alternative

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
No Action Alternative	• Due to flight altitude, behavioral responses to overflights in territorial seas are not expected. • Potential for harm to birds from aircraft strikes is extremely low and is not anticipated. • The remainder of training activities are located outside the U.S territorial sea boundary.	• Harm due to vessel movements is unlikely. • Brief behavioral response to overflights above nonterritorial seas. Low potential for harm to birds from aircraft strikes. • Low potential for harm to birds from ordnance use in nonterritorial seas. • Low potential for harm to birds from explosives use in nonterritorial seas. • Low potential for harm from military expended materials in nonterritorial seas. • Within the TMAA, the single endangered species is the Short-tailed Albatross. Vessel movements, aircraft overflight, ordnance use, at-sea explosions, and military expended materials (entanglement) may affect, but are not likely to adversely affect individual ESA-listed seabirds.
Alternative 1	• Due to flight altitude, behavioral responses to overflights in territorial seas are not expected. • Potential for harm to birds from aircraft strikes is extremely low and is not anticipated. • The remainder of training activities are located outside the U.S territorial sea boundary.	• Harm due to vessel movements is unlikely. • Brief behavioral response to overflights above nonterritorial seas. Low potential for harm to birds from aircraft strikes. • Low potential for harm to birds from ordnance use in nonterritorial seas. • Low potential for harm to birds from explosives use in nonterritorial seas. • Low potential for harm from military expended materials in nonterritorial seas. • No considerable harm to birds, migratory birds, bald eagles, or their habitat in nonterritorial seas. • Within the TMAA, the single endangered species is the Short-tailed Albatross. Vessel movements, aircraft overflight, ordnance use, at-sea explosions, and military expended materials may affect, but not likely to adversely affect individual ESA-listed seabirds.

Table 3.9-3: Summary of Effects by Alternative (continued)

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
Alternative 2 (Preferred Alternative)	• Due to flight altitude, behavioral responses to overflights in territorial seas are not expected. • Potential for harm to birds from aircraft strikes is extremely low and is not anticipated. • The remainder of training activities are located outside the U.S territorial sea boundary.	• Harm due to vessel movements is unlikely. • Brief behavioral response to overflights above nonterritorial seas. Low potential for harm to birds from aircraft strikes. • Low potential for harm to birds from ordnance use in nonterritorial seas. • Low potential for harm to birds from explosions and impacts in nonterritorial seas. • Low potential for harm from military expended materials in nonterritorial seas. • No considerable harm to birds, migratory birds, bald eagles, or their habitat in nonterritorial seas. • Within the TMAA, the single endangered species is the Short-tailed Albatross. Vessel movements, aircraft overflight, ordnance use, at-sea explosions, and military expended materials may affect, but not likely to adversely affect individual ESA-listed seabirds.

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3.10 CULTURAL RESOURCES

The term "cultural resources" includes prehistoric and historic sites, structures, objects, landscapes, ethnographic resources, and other physical evidence of human activity considered important to a culture, subculture, or community for scientific, traditional, religious, or other reasons. Cultural resources are divided into four groups: archaeological resources (both historic and prehistoric terrestrial and nearshore sites), architectural resources, traditional cultural resources, and underwater (submerged) resources. The focus on this analysis is on submerged resources which are sites that may, or may not, have cultural affiliation. Submerged resources in the Alaska Region may include prehistoric and/or historic coastal migration and settlement sites, shipwrecks, airplanes, or pieces of ship components, such as cannons or guns.

3.10.1 Affected Environment

For purposes of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the Region of Influence (ROI) for cultural resources includes the Temporary Maritime Activities Area (TMAA). Aircraft overflights above 15,000 ft will take place between the shore and the TMAA; however, this activity will have no impact on cultural resources given the altitude of these flights. This area from shore to the TMAA is not considered further in this analysis of potential impact on cultural resources. Areas inland from the coastline, including United States (U.S.) Air Force (Air Force) air ranges and U.S. Army (Army) training lands, are addressed in the *Alaska Military Operations Areas EIS* (USAF 1995), *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999), and the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

3.10.1.1 Cultural Resources in the Alaska Region

The Alaska Region is an enormous (one fifth the size of the continental United States) and diverse ecological, physiological, and cultural area. A complete discussion of what is known of the prehistory and history of the Alaska Region would be inappropriate for this document; however, a general description of cultural resources within the area is provided below.

More than 10,000 years ago, the Alaska mainland was, physically and ecologically, a part of Asia, from which it was severed by the rising seawater that formed the Bering Sea to the south and the Chukchi Sea to the north. The Bering Strait is the connection between the two seas. Alaska's importance to American prehistory is the result of its unique geographic position; not just for the early settlement of the continent but also as the area through which later waves of immigration passed (U.S. Department of the Interior [USDOI], National Park Service [NPS] 2004).

At the height of the Pleistocene Epoch (approximately 11,500 years ago), the Alaskan interior formed a relatively ice-free bowl, covered by "steppe tundra" vegetation (also called mammoth tundra), out of which a narrow, ice-free corridor led eastward and southward into the continental interior. There may have also been an ice-free zone along coastal zones into the Pacific Northwest; however, most of those areas are now submerged due to rising sea levels and there is no definitive evidence confirming this migration route. At the time of European contact (18^{th} century), inhabitants of the Alaska coast existed by open-water hunting and fishing; the Alaskan interior was home to broadly adapted hunters and fishers of the boreal forest (USDOI, NPS 2004).

Archaeological evidence from Alaska reveals a wide range of archaeological site types. Among the most important are those that date from the late Pleistocene and early Holocene (approximately 15,000 to 8,000 years before the present). These sites (known as Paleoarctic or Paleoindian sites) provide a record of the first entries of humans into the Americas and are consequently associated with a significant migratory event- the peopling of the New World. Descendants of the "First Alaskans" eventually migrated across both North and South America (USDOI, NPS 2004).

3.10.1.2 Underwater Cultural Resources

Powerful currents, gales, treacherous seas, and mechanical reasons have been responsible for the numerous shipwrecks off the Alaska coast. There are thousands of shipwrecks within the GOA, the earliest of which date to the 18th century. The location (on the bottom) for all but a few of these shipwrecks is unknown or only roughly approximate. The highest density of shipwrecks occurs within 50 nautical miles (nm) (92.6 kilometers [km]) of the Alaska coastline and most rest at depths of between 656 feet (ft) (200 meters [m]) and 3,280 ft (1,000 m). Among the many types of wrecks represented are schooners, brigs, trawlers and other fishing vessels, cargo ships, barges, icebreakers, ferries, tug boats, cruise ships, freighters, and pleasure boats (USDOI Minerals Management Service, Alaska OCS Region 2008).

A comprehensive shipwreck database is maintained by the Department of the Interior, Minerals Management Service, Alaska OCS Region and this database serves as the definitive record for shipwrecks in the region. Based on this database, nine shipwrecks are believed to potentially be within the TMAA (Figure 3.10-1). Given the age of some of the wrecks and the types of historical records used to identify their locations, precise longitudes/latitudes are not always possible; however, the information provided in the database is the most accurate locational data available based on the wreck descriptions (Burwell 2008a). The oldest of the shipwrecks potentially within the TMAA dates to 1786 (the *Sea Otter*, a British sloop) (Table 3.10-1). Three of the shipwrecks are modern (sank between 1990 and 1992) and none of the nine shipwrecks has been determined eligible for inclusion in the National Register of Historic Places (NRHP). The closest known NRHP-eligible shipwreck is the *S.S. Aleutian* in Uyak Bay, which is situated on the north side of Kodiak Island, approximately 75 miles (mi) (120 km) from the TMAA (Burwell 2008b).

3.10.1.3 Current Requirements and Practices

The Navy has established protective measures to reduce potential effects on cultural and natural resources from training exercises in coastal waters and for land and sea ranges. Some are generally applicable, while others apply to particular geographic areas or during specific times of year. Protective measures in other locations include avoidance of known shipwreck sites or the use of inert ordnance. Precise and accurate locations for shipwrecks in the TMAA are not known. Inadvertent discovery of a shipwreck would cause training potentially impacting the resource to halt until federal authorities (e.g., Navy Federal Preservation Officer; Alaska State Historic Preservation Officer [SHPO]) are notified to determine the appropriate actions.

3.10.2 Environmental Consequences

As noted in Section 3.10.1, the ROI for cultural resources includes the TMAA. Navy training activities that occur within the Air Force inland Special Use Airspace and the Army inland training lands were evaluated under previous National Environmental Policy Act (NEPA) documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents are incorporated by reference. Environmental effects in the open ocean beyond the U.S. territorial seas (outside of 12 nm [22 km]) are analyzed in this EIS/OEIS pursuant to Executive Order (EO) 12114.

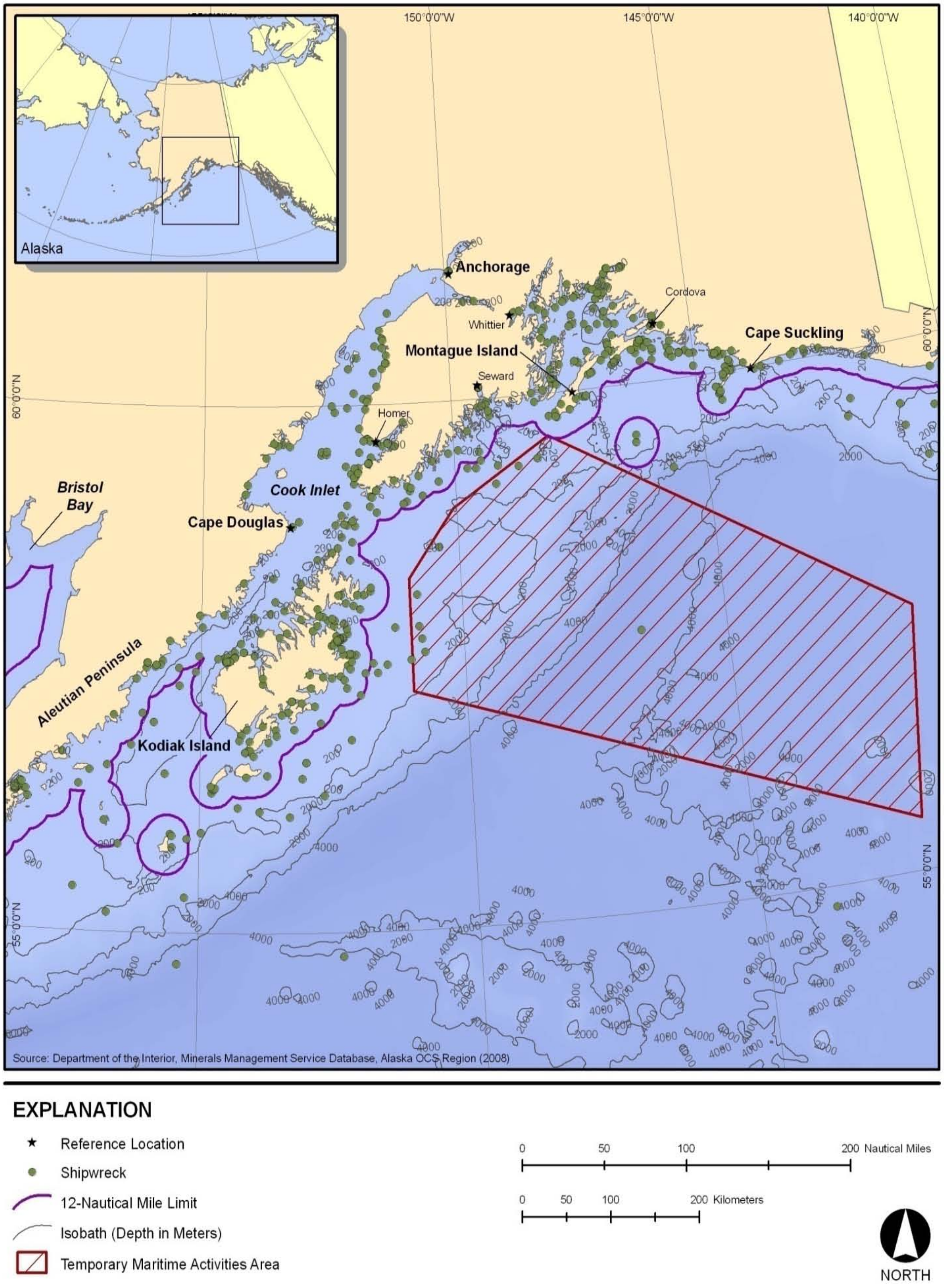

Figure 3.10-1: Shipwrecks in and around the Gulf of Alaska

Table 3.10-1: Shipwrecks that May be Located within the TMAA

Vessel ID #	Vessel Name	Vessel Type	Date Lost	Cause of Loss
609	*Mary Wood*	Schooner	Jan 18, 1894	Stranded
851	*Sea Otter*	British Sloop	Sep 1, 1786	Carrying a cargo of furs, this vessel was met at Prince William Sound by the vessels *Captain Cook* and *Experiment*. It was believed to have floundered and been lost at sea but it "may have been cut off by Natives."
877	*Seventy Six*	Trading Schooner	Dec 11, 1895	Lost at sea while on a trading cruise. Seven lives lost.
1026	*Name Unknown*	Russian Baidara	Feb 10, 1830	Disregarding the warnings of local Aleuts, the vessel set out in bad weather and wrecked with 20 lives lost. Parts of the vessel, clothes, and other pieces of wreck washed ashore at Crane Bay.
1038	*Urania*	Schooner	Dec 29, 1876	Disappeared with all hands and passengers and a cargo of furs.
2147	*Yukon*	Passenger Steamship	Feb 4, 1946	The well-known Alaska Steamship Co. liner *Yukon* grounded on sharp rocks in a severe gale. Fifty-foot breakers hammered the ship and she broke in two, carrying away 11 people. The remaining passengers and crew, some of whom had made it to a narrow beach, were rescued by a flotilla of seven ships, including the Coast Guard cutter *Onandaga* and lighthouse tender *Cedar*. Salvage attempted in 1946 and 1955 without success.
518571	*Cajun Mama*	Unknown	May 26, 1992	Rolled in high seas and sank.
592909	*Sundancer*	Longline Fishing Vessel	Sep 8, 1991	Vessel took a rogue wave, had a 35-degree list, rolled over, and sank.
640429	*Little Ann*	Longline Fishing Vessel	May 1, 1990	Vessel went down by the bow and sank. All eight persons on board were picked up.

Source: USDOI, Minerals Management Service, Alaska OCS Region 2008

3.10.1.4 Previous Analyses

Impacts related to cultural resources from training activities were previously evaluated in Section 1.6.2.1 and Appendix L of the *Alaska Military Operations Areas EIS* (USAF 1995), Section 3.0 of the *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), Sections 3.18 and 4.18 of the *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999), and Sections 3.12, 4.12, and 9.3 of the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

Consultation with the Alaska SHPO was conducted during the preparation of the *Alaska MOA EIS* and the *Transformation of U.S. Army Alaska FEIS*. A copy of SHPO correspondence regarding the *Alaska MOA EIS* is provided in Appendix C of this EIS/OEIS. Based on the previous consultations, no further analysis of prehistoric and historic archaeological resources on land is required.

3.10.1.5 Regulatory Framework

Laws and Regulations

Numerous laws and regulations mandate that possible effects on important cultural resources be considered during the planning and execution of federal undertakings. These laws define the compliance process and federal agency responsibilities, and prescribe the relationship among other involved agencies such as the Advisory Council on Historic Preservation (ACHP) and SHPO.

Federal mandates include provisions of NEPA and Sections 106 and 110 of the National Historic Preservation Act (NHPA) and their implementing regulations at 40 Code of Federal Regulations (C.F.R.) 1500 and 36 C.F.R. 800, respectively.

- Under NEPA, for all federal actions that could significantly affect the quality of the human environment, agencies must consider the effect an action would have on cultural resources, including prehistoric and historic resources, architectural resources, and traditional cultural properties that are eligible for listing in the NRHP (i.e., historic properties).
- Section 106 includes the mandate to assess the significance and integrity of those cultural resources to determine eligibility for listing in the NRHP. The NRHP eligibility criteria are defined by the Secretary of the Interior's Standards for Evaluation in 36 C.F.R. 60. Regulations at 36 C.F.R. 800.8 provide for coordination of public participation, consultation, and evaluation to meet the purpose and requirements of both NEPA and NHPA in a timely and efficient manner.
- Section 110 of the NHPA requires inventory of cultural resources present in the Area of Potential Effect (APE).

As required in these regulations, the Navy has complied with the requirements for using the NEPA process to achieve Section 106 compliance. Groups that have been formally notified about the project include Alaska Native tribes, the Alaska SHPO, and the ACHP. The Navy also has undertaken public involvement activities throughout development of this EIS/OEIS and the draft EIS/OEIS will be forwarded to these groups for their review and comment.

Other laws that may be relevant include:

- Antiquities Act of 1906 (16 United States Code [U.S.C.] 431);
- Historic Sites Act of 1935;
- Submerged Lands Act of 1953; and
- Archaeological Resource Protection Act of 1979 (16 U.S.C. 470aa-470mm), which prohibits the removal of items of archaeological interest from federal lands without a permit.

The Abandoned Shipwreck Act of 1987 extends the jurisdiction of abandoned shipwrecks in State waters (up to 3 nm [5.5 km] from shore), considering them U.S. property, and then transfers management authority to the states; None of the TMAA is located within State waters. The NPS's Abandoned Shipwreck Act Guidelines are published in 55 Federal Register (FR) 50116, 55 FR 51528, and 56 FR 7875. Lost U.S. Navy vessels and downed aircraft remain the property of the U.S. regardless of where they were lost or the passage of time. These properties are administered by the U.S. Naval Historical Center, a facility that has begun an underwater archaeological program to inventory shipwrecks under Navy jurisdiction, including those owned or managed by the Navy.

In 2004, the Sunken Military Craft Act (passed as Title XIV of the fiscal year 2005 National Defense Authorization Act) preserved the "sovereign status of sunken U.S. military vessels and aircraft by codifying both their protected sovereign status and permanent U.S. ownership regardless of the passage of time.” This act recognizes the probable historic status of the craft and the fact that these craft often contain the remains of U.S. military personnel. The Sunken Military Craft Act explicitly states that the protection of the law “shall not be extinguished by the passage of time, regardless of when the sunken military craft sank regardless of age.”

Military regulations that mandate protection of cultural resources as part of the Navy’s mission include:

- Chief of Naval Operations Instruction 5090.1C: Environmental Readiness Program Manual (2007);
- Secretary of the Navy Instruction 11010.14A: Department of the Navy Policy for Consultation with Federally Recognized Indian Tribes (2005);
- Department of Defense Directive (DoDD) 4710.1: Archeological and Historic Resources Management (1984);
- Department of Defense (DoD) Instruction (DoDINST) 4715.3: Environmental Conservation Program (1996).
- DoD American Indian and Alaska Native Policy (1998);
- DoDD 3200.15 10: Sustainment of Ranges and Operating Areas (2003);
- DoDINST 4710.02: DoD Interactions with Federally Recognized Tribes (2006);
- Alaska Implementation Guidance of the DoD American Indian and Alaska Native Policy (2007);

Under the NHPA, the APE typically includes areas within which land-based or nearshore activities could potentially affect NRHP-listed or -eligible historic properties, including archaeological and traditional cultural resources. Also included in an APE are any at-sea locales where bombing, operations, or equipment might affect submerged ruins, sites, features, or shipwrecks. Depending on location, vessel affiliation, and whether the wreck meets the criteria of abandonment, shipwrecks in coastal waters may fall under the jurisdiction of the individual state, or one or more federal agencies, or may belong to other nations. Depending on the proposed activities, the APE can also include land, nearshore, and at-sea areas where proposed Navy training activities could potentially affect ethnographic resources, traditional cultural properties, or traditional uses such as the tribal fishery grounds.

Government-to-Government Consultation

Government-to-government consultation with federally recognized Native American tribes and nations was outlined in an April 29, 1994, presidential memorandum titled, “Government-to-Government Relations with Native American Tribal Governments.” Native American sacred sites were included in EO 13007, May 24, 1996. EO 13175, *Consultation and Coordination with Tribal Governments,* was issued in 2000 to establish collaboration with American Indian tribal governments.

Alaska Native Tribes

Alaska Natives tribes are in themselves diverse, representing twenty language groups comprised of Inupiaq, Yupik (Central and Siberian), Aleut, Alutiiq, Eyak, Haida, Tsimshian, Tlingit, and eleven interior Alaska Athabaskan peoples such as Gwich’in and Tanaina. Many individuals still only speak their indigenous languages. There are 229 federally recognized tribes in Alaska constituting 40% of the nation’s total. The 2000 census indicated 19% of the Alaska population is Alaska Native or American Indian versus less than 0.5 % for the contiguous United States. Living off the land or “subsistence” as it is called in Alaska is a lifestyle adhered to more with Alaska Natives than American Indians today. Coastal Alaska tribes subsist principally off marine mammals and fish. The tribes nearest the TMAA include the Alutiiq, Eyak and Tlingit groups; however, there is no subsistence use of the TMAA.

Of the 229 federal tribes in Alaska, this EIS/OEIS takes into consideration comments resulting from government-to-government consultation, which has been offered to the Alaska Native tribes listed in Table 3.10-2 given their general proximity to the TMAA. Letters were sent to each tribe by Alaskan Command (ALCOM), Elemendorf Air Force Base (AFB), in March 2008 (see example letter in Appendix C). The result was that all 12 tribes replied to ALCOM via telephone or letters indicating that they have no concerns over the proposed activities described within this EIS/OEIS. The Navy will, however, keep the tribes informed of the timeframes of future joint training exercises.

Table 3.10-2: Tribes Offered Consultation

Name of Tribe	Location
Kaguyak Village	Akhiok
Lesnoi Village	Green Island
Native Village of Afognak	Kodiak
Native Village of Chenega	Chenega Bay
Native Village of Eyak	Cordova
Native Village of Old Harbor	Old Harbor
Native Village of Ouzinkie	Ouzinke
Native Village of Port Graham	Port Graham
Native Village of Port Lions	Port Lions
Native Village of Tatitlek	Tatitlek
Shoonaq Tribe of Kodiak	Kodiak
Yakutat Tlingit Tribe	Yakutat

Alaska State Historic Preservation Officer/Advisory Council on Historic Preservation

In accordance with Section 106 of the NHPA, consultation has been initiated with the Alaska SHPO. Correspondence is included in Appendix C.

3.10.1.6 Approach to Analysis

Federal laws and regulations have established the requirements for identifying, evaluating, and mitigating impacts on cultural resources. Pertinent provisions of NHPA, Archaeological Resources Protection Act, and Native American Graves Protection and Repatriation Act address management and treatment of cultural resources. Under NHPA, resource significance is determined on the basis of NRHP criteria (36 C.F.R. § 60.4) in consultation with SHPO. A project affects a resource's significance when it alters the characteristics of the property that qualify it as significant under NRHP criteria. Effects may include:

- Physical destruction or damage to all or part of the resource;
- Alteration of a property in a way that is inconsistent with the Secretary's Standards for the Treatment of Historic Properties (36 C.F.R. Part 68);

- Introduction of visual, atmospheric, or audible elements that alter the setting and diminish the integrity of the property's significant features;
- Neglect of a resource, resulting in its deterioration or destruction; and
- Any change that could adversely affect the qualities that make the property significant.

Under NHPA, assessing impacts involves identifying activities that could directly or indirectly affect significant resources, identifying known or expected significant resources in the area of potential effects, and determining the level of impacts on the resources. Possible findings include no effect, no adverse effect, or an adverse effect on significant resources (36 C.F.R. § 800.4-9).

Data Sources for Submerged Resources

Information on the locations of resources was obtained from the *Shipwreck Database* (USDOI, Minerals Management Service, Alaska OCS Region 2008), which includes the following:

- Alaska Shipwreck Customs Report of Casualty 1741-1939 (1982)
- Marine Disasters of the Alaska Route (1916)
- The History of Alaska, 1730-1885 (1886)
- Marine Resources Assessment for the Gulf of Alaska Operating Area (2006)
- A List of Trading Vessels in the Maritime Fur Trade, 1785-1825 (1973)
- Alaskan Shipping, 1867-1978: Arrivals and Departures at the Port of Sitka (1972)
- Sourcebook of Alaskan Shipwrecks 1786-1932 (1984)
- Database of Fishing Vessel Incidents, 1989-2004 (1989-2004)
- Alaska OCS Region Shipwreck Database (2008)
- Archaeological Overview of Alaska (2004)
- Lewis and Dryden's Marine History of the Pacific Northwest (1967)
- Other environmental and reference documents from the area, as cited.

3.10.1.7 No Action Alternative

Training activities in the TMAA take place in the air, on the ocean surface, and subsurface. No historic resources, traditional cultural properties, or areas containing resources exploited for subsistence use are known to exist within the TMAA. There are nine shipwrecks that are believed to be within the TMAA but given some are relatively recent, not all would be considered historic resources. Submerged cultural resources (shipwrecks) will not be affected by the proposed training activities given these activities do not come in contact with or otherwise impact the historic integrity of any submerged cultural resources.

Under the No Action Alternative, the Navy would continue to conduct training activities within the TMAA. Effects of offshore training activities on cultural resources are limited to training expendable materials (e.g., targets, sonobuoys, and bombs, missiles, and other ordnance) falling into the ocean and potentially settling on submerged cultural resources. These effects from training on historic resources are negligible because there is only one shipwreck believed to be located the middle of the TMAA (as opposed to the edge) where training activities are likely. The probability of expendable material landing on a submerged cultural resource is so extremely low it can be discounted. In addition, the settling of material on submerged cultural resources will have no more adverse effect than the gradual accumulation of natural sediments on such resources. In addition, the only shipwreck that has been determined eligible for inclusion in the National Register is outside the TMAA situated north of Kodiak Island, approximately 65 mi (120 km) from the TMAA.

3.10.1.8 Alternative 1

Under Alternative 1, the number of Navy training events in the TMAA would increase (refer to Table 2-7). The nature of the training activities, however, would not change substantially. Aerial, surface, and subsurface training activities would not affect submerged cultural resources resting on or buried in bottom sediments.

Under Alternative 1, a Portable Undersea Tracking Range (PUTR) would be used to support Anti-Submarine Warfare (ASW) training in the TMAA where the ocean depth is between 300 ft and 12,000 ft. The PUTR is a self-contained, portable, undersea tracking capability that employs modern technologies to support safe and coordinated undersea warfare training for Forward Deployed Naval Forces (FDNF). The system will be capable of tracking submarines, surface ships, weapons, targets, and Unmanned Underwater Vehicles (UUVs) and distribute the data to a data processing and display system, either aboard ship, or at a shore site. When training is complete, the PUTR equipment would be recovered.

No area supporting a PUTR system has been identified; however, potential impacts to cultural resources can be assessed based on several assumptions. The Navy would avoid known resource sites in the placement of the PUTR equipment. Upon completion of the exercise, the transponders are recovered. This eliminates any potential long term impacts associated with hazardous materials such as batteries and electronic components. Effects of PUTR training activities on cultural resources are limited to transponders settling on submerged resources. These effects on historic resources are negligible because there are few underwater cultural resources, and they are widely dispersed. The probability of a transponder landing on a resource is very low and, in any case, the temporary settling of transponder on submerged resources will have no more adverse effect than the gradual accumulation of natural sediments on such resources. Deployment and use of the PUTR under Alternative 1 would not affect submerged cultural resources.

3.10.1.9 Alternative 2

Implementation of Alternative 2 would include all elements of Alternative 1 (accommodating training activities currently conducted, increasing specific training activities to include the use of active sonar, and accommodating force structure changes). In addition, under Alternative 2 the following activities would occur:

- Conduct one additional separate summertime Carrier Strike Group exercise lasting up to 21 days within the ATA.
- Conduct a Sinking Exercise (SINKEX) in each summertime exercise (a maximum of 2) in the TMAA.

SINKEX

A SINKEX is typically conducted by aircraft, surface ships, and submarines in order to take advantage of a full size ship target and an opportunity to fire live weapons. Ship, aircraft, and submarine crews typically are scheduled to attack the target with coordinated tactics and deliver live ordnance to sink the target. As such, aspects of the exercise that have potential effects on submerged cultural resources include the presence of expended materials (fragments of missiles and bombs) as well as the sunken target vessel itself. The effects from expended materials on historic resources has been addressed previously and are negligible because there are few underwater cultural resources, and they are widely dispersed. The probability of anything landing on a resource is very low and, in any case, the settling of small amounts of expended materials on submerged resources will have no more effect than the gradual accumulation of natural sediments on such resources.

Alternative 2 would expend two surface vessels per year during SINKEX. By rule, SINKEX would be conducted at least 50 nm (93 km) offshore and in water at least 6,000 feet deep (1,830 m) (40 CFR 229.2). As shown in Figure 3.10-1, there is only one known shipwreck that is further than 50 nm (93 km) offshore and within the TMAA. The probability of a sunken vessel settling on a submerged cultural resource is extremely unlikely and can be discounted. Therefore, conducting a SINKEX would not impact submerged cultural resources.

Under Alternative 2, the number of Navy training events in the MAA would increase (refer to Table 2-7). These increases, which would also include SINKEX, would not change from those described under the other alternatives. Aerial, surface, and subsurface training activities would not affect submerged cultural resources resting on or buried in bottom sediments.

3.10.3 Mitigation

No substantial impacts on cultural resources from the proposed activities were identified. Therefore, no additional mitigation measures are necessary or appropriate.

3.10.4 Summary of Effects

Table 3.10-3 summarizes the effects of the No Action Alternative, Alternative 1, and Alternative 2 on cultural resources under both NEPA and EO 12114.

Table 3.10-3: Summary of Effects by Alternative

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
No Action Alternative	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to cultural resources onshore would occur. • Aircraft overflights above 15,000 ft (915 m) altitude between the shore and the TMAA would have no impact on cultural resources.	• Submerged cultural resources would not be impacted because of the type of training activities and the low density of submerged cultural resources within the area of effect.
Alternative 1	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to cultural resources onshore would occur. • Aircraft overflights above 15,000 ft (915 m) altitude between the shore and the TMAA would have no impact on cultural resources.	• Submerged cultural resources would not be impacted because of the type of training activities and the low density of submerged cultural resources within the area of effect.

Table 3.10-3: Summary of Effects by Alternative (continued)

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
Alternative 2 (Preferred Alternative)	• Under Alternative 2, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to cultural resources onshore would occur. • Aircraft overflights above 15,000 ft (915 m) altitude between the shore and the TMAA would have no impact on cultural resources.	• Submerged cultural resources would not be impacted because of the type of training activities and the low density of submerged cultural resources within the area of effect.

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3.11 TRANSPORTATION AND CIRCULATION

3.11.1 Affected Environment

For purposes of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the Region of Influence (ROI) for transportation and circulation includes the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA). Areas inland from the coastline, including United States (U.S.) Air Force (Air Force) air ranges and U.S. Army (Army) training lands, are addressed in the *Alaska Military Operations Areas EIS* (USAF 1995), *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999), and the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

3.11.1.1 Air Traffic

The offshore Special Use Airspace (SUA) of the TMAA overlies the surface and subsurface operating area. This overwater airspace supports aircraft training activities generally conducted by the Navy and Air Force aircraft. This SUA extends from the ocean surface to 60,000 feet (ft) (18,288 meters [m]) mean sea level, and encompasses 42,146 square nautical miles (nm^2) (145,482 square kilometers [km^2]) of airspace.

Additionally, a portion of Warning Area (W-612) lies within the northwestern quadrant of the TMAA over Blying Sound (Figure 3.11-1). The airspace provides 2,256 nm^2 (8,766 km^2) of SUA and extends from the ocean surface up to Flight Level (FL) 290. Military pilots travel under Instrument Flight Rules (IFR) flight plans from local air bases until they reach W-612 and proceed under Visual Flight Rules (VFR) while operating within it or the TMAA. When W-612 is active, aircraft on IFR clearances are precluded from entering the warning area by the FAA. However, since W-612 is located entirely over international waters, nonparticipating aircraft operating under VFR are not prohibited from entering the area. Examples of aircraft flights of this nature include light aircraft, fish spotters, and whale watchers.

When not included as part of the TMAA, W-612 is used by USAF aircraft to conduct training in Anti-Air Warfare (AAW) and by the United States Coast Guard (USCG) to fulfill some of its training requirements. Activation of the warning areas by the Federal Aviation Administration (FAA) is performed by notifying the controlling air traffic agency of the change in status. This allows the agency to issue an advanced warning via a Notice to Airmen (NOTAM) or provide real-time notices and deconfliction to pilots to alter their courses to avoid military activities.

Military Aviation

Military aircraft operating in the TMAA can originate from aircraft carriers offshore in the TMAA or from military airfields in Alaska. Aircraft taking off from aircraft carriers operating in the TMAA will launch under Visual Meteorological Conditions or Instrument Meteorological Conditions and proceed to their designated working area within the TMAA or W-612. When operating within the confines of the TMAA or W-612, military aircraft will operate using a “see-and-avoid” rule to remain clear of other air traffic. Aircraft taking off from military airfields will normally file for and receive an IFR clearance from FAA Air Traffic Control Center. This clearance will provide them with the routing to the inland SUA, either via the normal jet route structure, via special instructions as assigned by the FAA, or some combination of both. Once within the TMAA or W-612, flights proceed via VFR, using a “see-and-avoid” rule to remain clear of other air traffic. Subsequent to leaving the TMAA, these aircraft will have contacted and activated their return IFR clearance with the FAA.

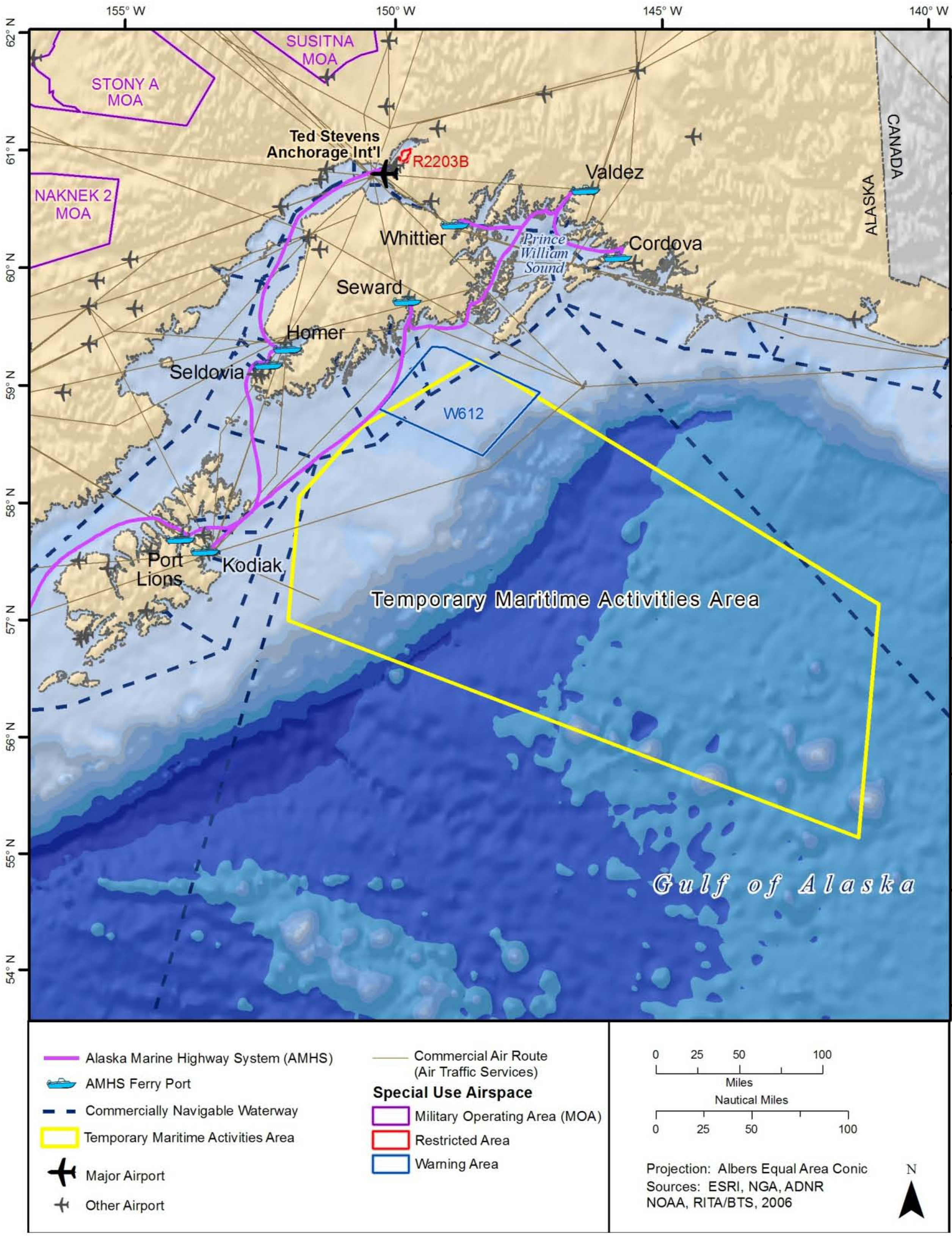

Figure 3.11-1: Air and Marine Traffic in Vicinity of the TMAA

Commercial and General Aviation

Aviation is an important and basic mode of transportation in Alaska because approximately 90 percent of Alaska is not served by roads. Alaska has six times as many pilots per capita and 16 times as many aircraft per capita compared to the rest of the United States. Aircraft operating under VFR can fly along the Alaska coast, largely unconstrained, except by safety requirements and mandated traffic flow requirements. Aircraft operating under IFR clearances, authorized by the FAA, normally fly on the airway route structures (see Figure 3.11-1). These routes include both high- and low-altitude routes. When W-612 is active, aircraft on IFR clearances are precluded from entering the warning area.

3.11.1.2 Marine Traffic

A significant amount of ocean traffic, consisting of both military, Coast Guard, commercial, and recreational vessels transit through the GOA. For commercial vessels, the major transoceanic routes enter the TMAA briefly to transit (see Figure 3.11-1). The approach and departure routes into the inland waters can be adjusted depending on Navy activities notification through Notices to Mariners (NOTMARs) found at http://www.navcen.uscg.gov/lnm/d17/.

Military

Military traffic consists of the transit of large military vessels at sea, including submarines. The TMAA surface/subsurface operating area is depicted in Figure 3.11-1. Total surface area of the TMAA is 42,146 nm^2 (145,482 km^2). The TMAA undersea training area lies beneath the surface and extends to the seafloor. Commander, Submarine Force, U.S. Pacific Fleet[1] manages this underwater space as transit lanes and operational areas for U.S. submarines.

Civilian

Marine vessels, large and small, transit the GOA to several commercial ports occurring near the TMAA. Vessel traffic approaching these ports is managed by the Vessel Traffic Service, which is operated jointly by the United States Coast Guard (USCG) and the Marine Exchange of Alaska (a nonprofit organization established to serve the Alaska Maritime Community by providing information, communications, and services to ensure safe, secure, efficient, and environmentally responsible maritime operations). The Vessel Traffic Center is located in Valdez at the north end of Prince William Sound (USCG Navigation Center n.d.). The ocean traffic flow in congested waters, especially near coastlines, is controlled by the use of directional shipping lanes for large vessels, including cargo, container ships, and tankers. Traffic flow controls are also implemented to ensure that harbors and ports-of-entry remain as uncongested as possible.

Two major ports close to the TMAA, Anchorage and Valdez, were ranked in the top 150 U.S. ports by tonnage in 2000 (U.S. Department of Transportation Research and Innovative Technology Administration/Bureau of Transportation Statistics 2001). Commercially navigable waterways traverse the TMAA, but are controlled by the use of directional shipping lanes for large vessels (cargo, container ships, and tankers) (see Figure 3.11-1). Ships traveling from major ports to the Lower 48 and Hawaii as well as marine traffic between coastal ports enter the TMAA briefly, but Navy activities are communicated to all vessels and operators by use of NOTMARs found at http://www.navcen.uscg.gov/lnm/d17/.

[1] The Commander Submarine Force, U.S. Pacific Fleet is the principal advisor to the Commander in Chief, U.S. Pacific Fleet for submarine matters. The force provides anti-submarine warfare, anti-surface ship warfare, precision land strike, mine warfare, intelligence, surveillance, and early warning and special warfare capabilities to the U.S. Pacific Fleet and strategic deterrence capabilities to the U.S. Strategic Command.

In addition to large commercial vessels traversing the GOA, the Alaska Marine Highway System (AMHS) provides ferry service for passengers and vehicles between coastal communities (AMHS 2007). The Southwest Alaska route services Prince William Sound, Kodiak Island, the Alaska Peninsula, and the Aleutian Islands. The ferry route closest to the TMAA provides service to Chenega Bay in the Prince William Sound and the town of Kodiak on Kodiak Island (see Figure 3.11-1). The route is one of the least busy routes with only 12 sailings in 2007 (AMHS 2007).

3.11.1.3 Current Requirements and Practices

Safety and security factors dictate that use of airspace and control of air traffic be closely regulated. The Navy strives to ensure that it retains access to ocean training areas and SUA as necessary to accomplish its mission, while facilitating joint military-civilian use of such areas to the extent practicable and consistent with safety. The regulatory scheme for airspace and air traffic control varies from highly controlled to uncontrolled. Less controlled situations include flight under VFR or flight outside of U.S. controlled airspace, such as flight over international waters off the coast of Alaska. Examples of highly controlled air traffic situations are flights in the vicinity of airports, where aircraft are in a critical phase of flight, either takeoff or landing, and flight under IFR, particularly flight on high- or low-altitude airways.

Accordingly, regulations applicable to all aircraft are promulgated by the FAA to define permissible uses of designated airspace, and to control that use. These goals of military access, joint use, and safety are promoted through various coordination and outreach measures, including:

- NOTAMs advising of the status and nature of activities being conducted in W-612, and other components of SUA in the TMAA. NOTAMs are available via the internet at https://pilotweb.nas.faa.gov/.
- Return of SUA to civilian FAA control when not in use for military activities. According to FAA and Department of Defense policy, SUA, including warning areas, should be made available for use by nonparticipating aircraft when all or part of the airspace is not needed by the using agency. To accommodate the joint use of SUA, a Letter of Authorization (LOA) or a Letter of Procedure is drafted between the controlling agency and the using agency. The LOA establishes the activation/deactivation procedures for the SUA and may outline periods when the FAA, with the Navy's concurrence, may route IFR traffic through the active SUA. The LOA defines the conditions and procedures to ensure safe and efficient joint use of warning areas. The FAA does not prohibit aircraft operating under VFR from entering warning areas that overlie international waters.

The Navy provides publication of NOTMARs and other outreach information about potentially hazardous activities planned for the TMAA, for publication by the USCG in NOTMARs. To ensure the broadest dissemination of information about hazards to commercial and recreational vessels, the Navy provides schedule conflicts along with other Coast Guard concerns at: http://www.navcen.uscg.gov/lnm/d17/.

3.11.2 Environmental Consequences

As noted in Section 3.11.1, the ROI for transportation and circulation includes the TMAA and ocean areas in the vicinity used for Navy air and marine transportation. Navy training activities that occur within the Air Force inland SUA and the Army inland ranges were evaluated under previous National Environmental Policy Act (NEPA) documentation (USAF 1995, USAF 1997, Army 1999, Army 2004) These documents are incorporated by reference. Environmental effects in the open ocean beyond the U.S. territorial seas (outside of 12 nm [22 km]) are analyzed in this EIS/OEIS pursuant to EO 12114.

3.11.2.1 Previous Analyses

Impacts related to transportation and circulation were previously evaluated in Sections 3.2 and 4.2 of the *Alaska Military Operations Areas EIS* (USAF 1995), Sections 3.2.3 and 4.0 of the *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), Sections 3.16 and 4.16 of the *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999); and Sections 3.19 and 4.19 of the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

3.11.2.2 Approach to Analysis

The principal issue is the potential for existing or proposed military air or vessel traffic to affect existing transportation and circulation conditions. Impacts on traffic were assessed with respect to the potential for disruption of transportation pattern and systems, and changes in existing levels of transportation safety.

Factors used to assess the significance of impacts on air traffic include consideration of an alternative's potential to result in an increase in the number of flights such that they could not be accommodated within established operational procedures and flight patterns; a requirement for an airspace modification; or an increase in air traffic that might increase collision potential between military and nonparticipating civilian operations.

Factors used to assess the significance of impacts on ocean vessel traffic include the extent or degree to which an alternative would disrupt the flow of commercial surface shipping or recreational fishing or boating. A serious disruption occurs when a vessel is unable to proceed to its intended destination due to exclusion from areas in the TMAA.

3.11.2.3 No Action Alternative

Both military and non-military entities have been sharing the use of the airspace and ocean surface comprising the TMAA for decades. Military, commercial, and general aviation users have established an operational coexistence consistent with federal, state, and local plans and policies and compatible with each interest's varying objectives. Activities under the No Action Alternative include activities that are and have been routinely conducted in the area for decades.

Air Traffic

Navy aviation activities travelling from the TMAA to inland training areas have the potential to affect commercial and recreational air traffic. Section 2.1.2.1 of the Northern Edge Exercise Final EA-OEA (2008) describes the proposed Western Altitude Reservation (ALTRV). An ALTRV is a flight clearance corridor provided by the FAA, for a "block of airspace" used to conduct activities and/or allow aircraft to transit from one area to another. Such would be the case when military aircraft leave the TMAA enroute to the inland SUA of the Air Force. During training activities, aircraft operating within the ALTRV will be under positive control of the FAA and will comply with all FAA flight rules. Figure 3.11-2 is an example of an ALTRV that could be used to accommodate aircraft overflights between the TMAA and the inland training ranges. In coordination with the FAA, the ALTRV will be reassessed each exercise year for suitability and functionality and may change to accommodate the needs of the military and the FAA. Due to the coordination between the FAA and the military, no impacts are expected to occur from overflights to commercial and general aviation.

Warning areas such as W-612 have been established to coordinate offshore civilian and military uses. When military aircraft are conducting activities that are not compatible with civilian activity, military aircraft is confined to the designated SUA, which is specifically designed to coordinate incompatible activities. Limitations are communicated to commercial airlines and general aviation by NOTAMs, published by the FAA. Because of these precautions, there will be no adverse effects on commercial or general aviation activities as a result of the No Action Alternative.

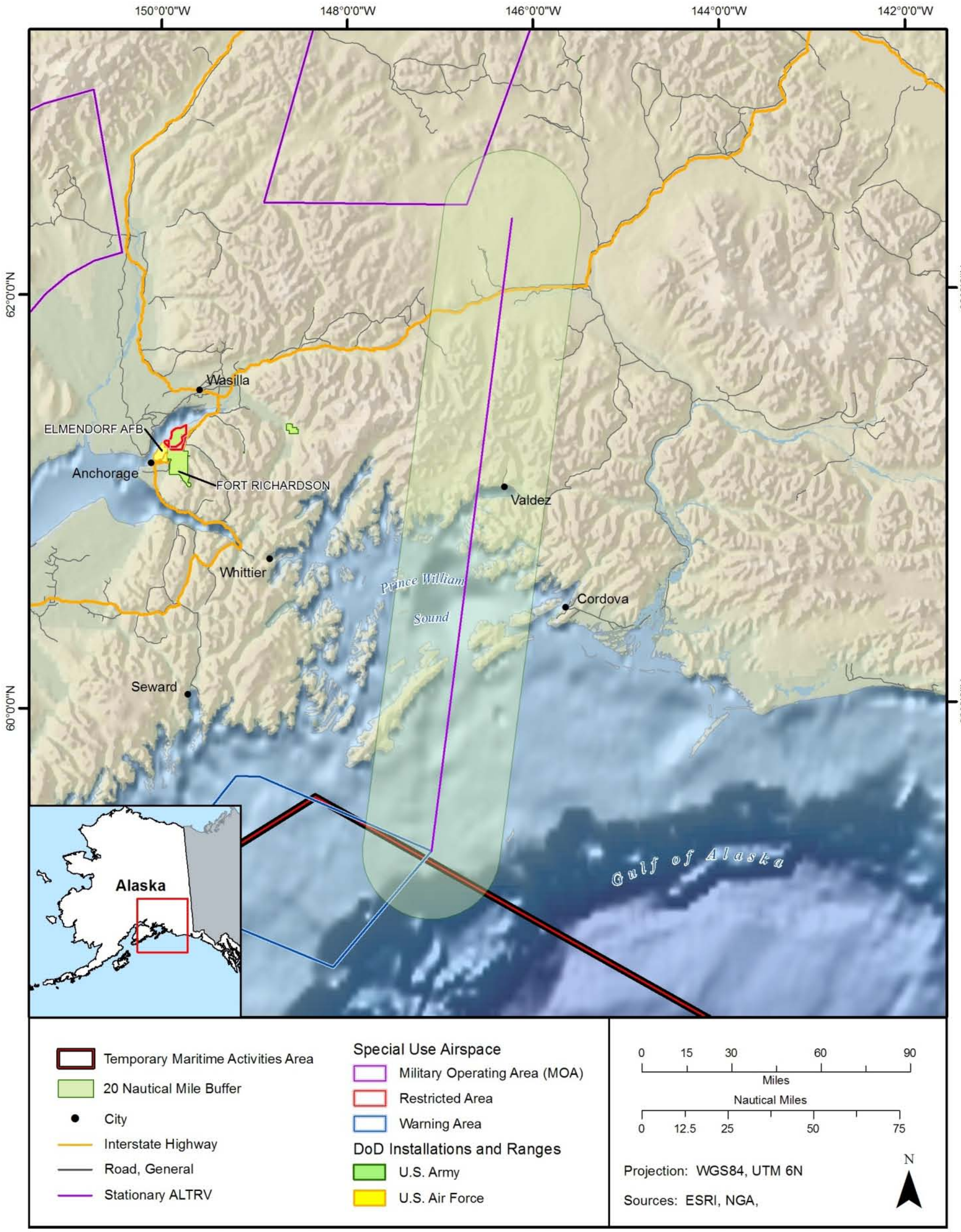

Figure 3.11-2: Example of a Temporary ALTRV between the TMAA and Inland Ranges

Marine Traffic

Military use of the TMAA is generally compatible with civilian use. Where naval vessels are conducting activities that are not compatible with other uses, they typically operate in areas away from shipping lanes to allow traffic to flow freely. If training activities occur within shipping or high traffic areas, these activity areas are communicated to all vessels and operators by NOTMARs, published by the USCG. Navy activities do not have an effect on recreational marine traffic because public activities are centered at local harbors and anchorages away from the TMAA and vessels are not precluded from entering the TMAA to transit to their desired locations. In the interest of safety, the Navy may temporarily exclude commercial and recreational marine traffic from small operational areas and require slight deviations from the intended course or the use of alternate routes. However, the use of alternative routes as a result of these temporary exclusions does not constitute a significant disruption to marine traffic. Based on the discussion above, there will be no adverse effects on commercial or recreational marine traffic under the No Action Alternative.

3.11.2.4 Alternative 1

Alternative 1 would have all the components of the No Action Alternative with the addition of one training instrumentation enhancement with the potential to impact marine traffic in the offshore area: a Portable Undersea Tracking Range (PUTR). The PUTR involves the temporary placement of seven electronics packages on the seafloor, each approximately 3 ft (0.9 m) long by 2 ft (0.6 m) in diameter. Although no specific locations have yet been identified, the electronic packages would be placed in water depths greater than 600 ft (182 m), at least 3 nm (5.5 km) from land. Because this is a temporary installation (to be recovered once training is complete), no formal restricted areas would be designated and no limitations would be placed on commercial or civilian use of the area, thus limiting impacts to marine traffic.

Air Traffic

The FAA has established warning areas for military operations, in this case, W-612. Offshore activities proposed under Alternative 1 would have all the components of the No Action Alternative, but the training tempo would increase, resulting in more air traffic. The traffic control procedures implemented under this alternative would be the same as those described above under the No Action Alternative. No additional impacts on the FAA's capabilities would be created. The remoteness of the offshore use areas, the use of LOAs and the ALTRV to better orchestrate traffic, and public notification procedures would substantially reduce possible congestion during these activities. Because of these precautions, there will be no adverse effects on commercial or general aviation activities as a result of Alternative 1.

Marine Traffic

Military use of the TMAA under Alternative 1 has all the components of the No Action Alternative, but the training tempo and number of assets would increase, resulting in more marine traffic. The same general procedures as described above under the No Action Alternative would be implemented for Alternative 1. Additionally, Alternative 1 would include the installation and use of the PUTR. Implementation of the PUTR would require the Navy to issue a NOTMAR to advise the public of the PUTRs existence and general location. Despite an increase in training tempo, marine traffic would not be affected by military operational increases. Increased Navy activities would not have an effect on marine traffic because public activities are centered at local harbors and anchorages away from the TMAA and vessels would not be precluded from entering the TMAA to transit to their desired locations.

As described above for the No Action Alternative, there will be no adverse effects on commercial or recreational marine traffic under Alternative 1. In addition, because the PUTR is a temporary installation (to be recovered once training is complete), no formal restricted areas would be designated and no formal limitations would be placed on commercial or civilian use of the area, thus limiting impacts to marine traffic from the PUTR.

3.11.2.5 Alternative 2

Alternative 2 would have all the components of Alternative 1 (accommodating training activities currently conducted, increasing specific training activities to include the use of active sonar, and accommodating force structure changes). In addition, under Alternative 2 the following activities would occur:

- Conduct one additional separate summertime CSG exercise lasting up to 21 days within the ATA.
- Conduct a Sinking Exercise (SINKEX) in each summertime exercise (a maximum of 2) in the TMAA.

Air Traffic

Effects on air traffic would be the same as those described under Alternative 1. Offshore activities proposed under Alternative 2 would have all the components of Alternative 1, but the training tempo would increase and the addition of a SINKEX would result in more air traffic. No additional impacts on the FAA's capabilities would be created. For safety purposes, the locations of SINKEX activities will be in areas that are not generally used by non-military aircraft. Prior to the commencement of a SINKEX, extensive range clearance procedures are conducted (Section 5.2.1.2) in conjunction with the defined operational parameters listed in the Letter of Instruction (LOI), which establishes precise ground rules for the safe and successful execution of the exercise.

The remoteness of the TMAA, the use of LOA's, NOTAMs, LOI, and the ALTRV to better orchestrate traffic, and public notification procedures would substantially reduce possible congestion during these activities. Because of these precautions, there will be no adverse effects on commercial or general aviation activities as a result of Alternative 2.

Marine Traffic

Effects on marine traffic would be the same as those described under Alternative 1. Despite an increase in training tempo and the inclusion of two SINKEXs, commercial and recreational interests would not be affected by military operational increases.

Navy clearance measures for live-fire training exercises would be implemented, and, therefore, marine traffic would not be affected during a SINKEX. For safety purposes, the locations of SINKEX activities will be in areas that are not generally used by non-military watercraft. Prior to the commencement of a SINKEX and following the issuance of a NOTMAR, extensive range clearance procedures are conducted (Section 5.2.1.2) in conjunction with the defined operational parameters listed in the Letter of Instruction (LOI), which establishes precise ground rules for the safe and successful execution of the exercise.

Increased Navy activities would not have an effect on marine traffic because public activities are centered at local harbors and anchorages away from the TMAA and vessels would not be precluded from entering the TMAA to transit to their desired locations. The use of NOTMARS and other public notification procedures would also be used to give the public advanced notification of Navy activities.

3.11.3 Mitigation

No adverse effects on air or marine traffic were identified. Therefore, no additional mitigation measures are necessary.

3.11.4 Summary of Effects

Current protective measures are described in Section 3.11.1.3; these procedures substantially lower the risk of Navy training activities on transportation and circulation Table 3.11-1 summarizes the effects of the No Action Alternative, Alternative 1, and Alternative 2 on transportation and circulation under both NEPA and EO 12114.

Table 3.11-1: Summary of Effects by Alternative

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
No Action Alternative	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to inland transportation and circulation would occur. • With the use of the ALTRV, overflights would have no adverse impact on non-military air or marine traffic.	• No adverse effects on commercial or general aviation would occur. Limitations are communicated to commercial airlines and general aviation by NOTAMs. • No adverse effects on marine traffic would occur. When training activities occur within shipping or high traffic areas, these activity areas are communicated to all vessels and operators by NOTMARs published by the USCG.
Alternative 1	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to inland transportation and circulation would occur. • With the use of the ALTRV, overflights would have no adverse impact on non-military air or marine traffic.	• Effects on air and marine traffic would be the same as described under the No Action Alternative. No additional impacts on the FAA's capabilities would be created as a result of proposed training increases under Alternative 1. • Marine traffic will not be affected by military operational increases. • Installation and use of the temporary PUTR will not affect air and marine traffic.
Alternative 2 (Preferred Alternative)	• Under Alternative 2, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to inland transportation and circulation would occur. • With the use of the ALTRV, overflights would have no adverse impact on non-military air or marine traffic.	• Effects on air and marine traffic would be the same as described under Alternative 1. There are no adverse effects to air or marine traffic as a result of implementation of Alternative 2. • Marine Traffic will not be affected by military operational increases. • With implementation of LOI, range clearance procedures, and NOTMARs, SINKEX will not affect non-military transportation and circulation.

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3.12 SOCIOECONOMICS

3.12.1 Affected Environment

For purposes of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the Region of Influence (ROI) for socioeconomics includes the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA). With the exception of Cape Cleare on Montague Island located over 12 nautical miles (nm) (22 kilometers [km]) from the northern point of the TMAA, the nearest shoreline (Kenai Peninsula) is located approximately 24 nm (44 km) north of the TMAA's northern boundary. The approximate middle of the TMAA is located 140 nm (259 km) offshore. Areas inland from the coastline, including United States (U.S.) Air Force (Air Force) air ranges and U.S. Army (Army) training lands, are addressed in the *Alaska Military Operations Areas EIS* (USAF 1995), *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999), and the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

3.12.1.1 Existing Conditions

Commercial Shipping

The GOA is traveled by large and small marine vessels, with several commercial ports occurring near the TMAA. Two major ports near the TMAA, Anchorage and Valdez, were ranked in the top 150 U.S. ports by tonnage in 2000 (U.S. Department of Transportation Research and Innovative Technology Administration/Bureau of Transportation Statistics 2001). Commercially used waterways traverse the TMAA, but are controlled by the use of directional shipping lanes for large vessels (cargo, container ships, and tankers). Ships traveling from major ports to the Lower 48 and Hawaii as well as marine traffic between coastal ports enter the TMAA briefly, but Navy activities are communicated to all vessels and operators by use of Notice to Mariners (NOTMARs) found at http://www.navcen.uscg.gov/lnm/d17/default.htm. In addition to large commercial vessels traversing the GOA, the Alaska Marine Highway System (AMHS) provides ferry service for passengers and vehicles between coastal communities (AMHS 2007).

Commercial Fishing

Commercial fishing takes place throughout the GOA waters and in coastal inlets and bays. The North Pacific Fishery Management Council (NPFMC) is one of eight regional fishery management councils established by the Magnuson-Stevens Fishery Conservation and Management Act of 1976 (MSFCMA) for the purpose of managing fisheries 3 to 200 miles (mi) (1.8 to 370 kilometers [km]) offshore of the U.S. coastline (Carroll 2008). The primary responsibility of the NPFMC is the groundfish fisheries in the federal waters of the Bering Sea and the GOA. The groundfish include cod, flatfish, mackerel, Pollock, sablefish, and rockfish species outside of three miles offshore. Other large Alaska fisheries such as salmon, crab and herring are managed by the State of Alaska Department of Fish & Game (ADF&G).

The commercial fish resources of Alaska are of great importance to the economies of the state and the nation (Carlile et al. 2005). Most groundfish fisheries in the U.S. Exclusive Economic Zone (EEZ) are managed by the National Marine Fisheries Service (NMFS) (ADF&G 2008a). The NMFS Alaska Regional Office maintains commercial catch data for groundfish in federal waters. The TMAA spans the Central and Eastern regulatory areas, west of Prince William Sound and east of Chirkiof (Figure 3.12-1) (NMFS 2008). In 2007, the Central regulatory area yielded 71,210 metric tons of groundfish which equaled approximately 54 percent of the total groundfish catch for the entire GOA. Groundfish fisheries in state waters are not discussed, as the TMAA exists outside of state waters.

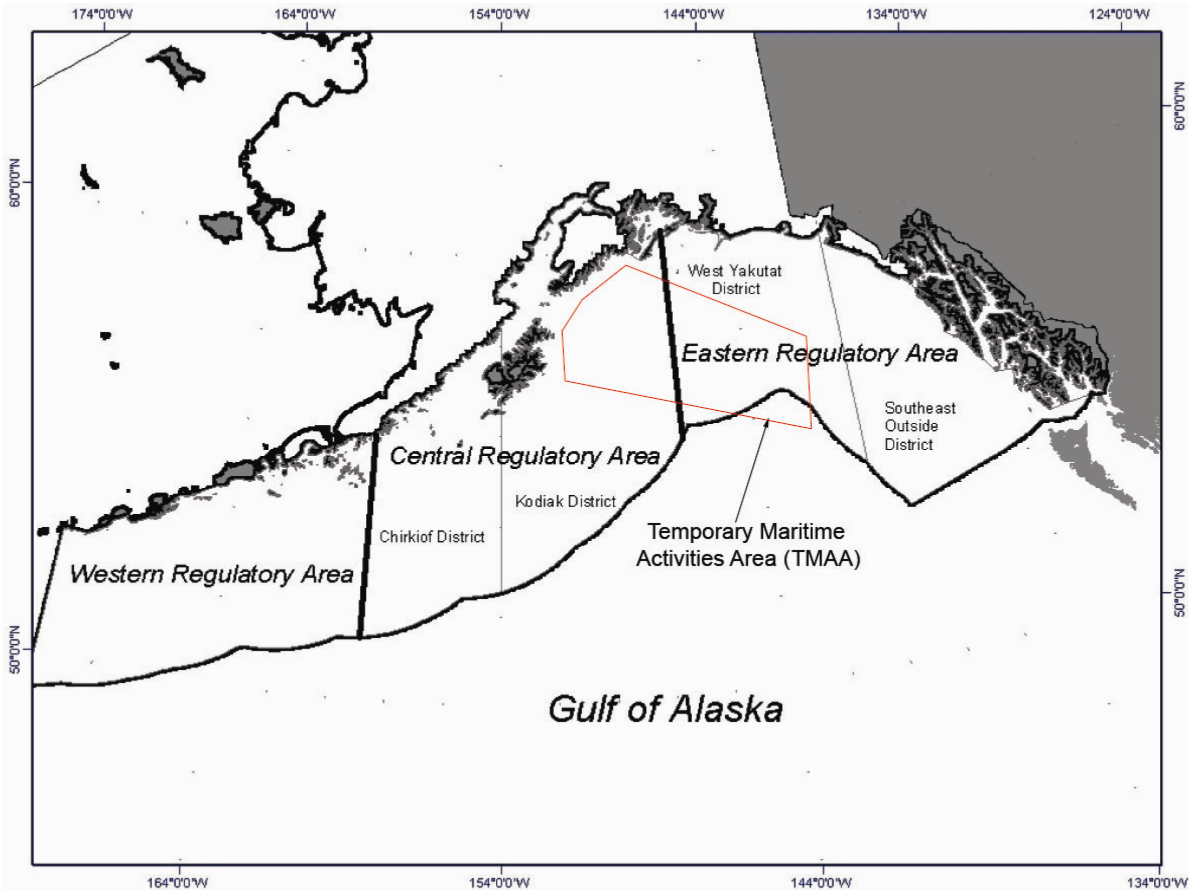

Figure 3.12-1: NMFS Regulatory Areas

Alaska's commercial fisheries produce large volumes of shellfish, including several types of crab and shrimp (ADF&G 2008b). All commercial shellfish fisheries in state and federal waters are managed by the ADF&G. Ocean areas with fisheries near the TMAA are located around Kodiak Island. Dungeness and Tanner crabs are the two types of crabs harvested near Kodiak. In 2007, fisheries near Kodiak Island yielded approximately 522 metric tons of Tanner and Dungeness crabs, approximately 2 percent of the total crustacean catch (ADF&G 2007).

Weathervane scallops are the only scallop commercially harvested in Alaska at this time (ADF&G 2008c). Commercial fishing for weathervane scallops occurs in the GOA, Bering Sea, and Aleutian Islands where scallops occur in distinct beds composed of sand, silt, and clay. A major bed in the GOA is located off the coast of Kodiak Island. Individual catch data for the Kodiak beds is not maintained; however, the ADF&G states that between 1998 and 2002, one of the largest harvests came from the Kodiak area averaging 82 metric tons each year (Carlile et al. 2005). As a comparison, 222 metric tons were collected statewide for the 2006-2007 season (ADF&G 2007).

Recreation and Tourism

Recreation and tourism is another resource of economic importance in the GOA. Recreation and tourist areas around the TMAA include the Kenai Peninsula, Kodiak Island, Prince William Sound, and Resurrection Bay (Alaska Department of Natural Resources 2008). There are 9 state parks on the Kenai Peninsula as well as Kenai Fjords National Park, 6 on the island of Kodiak, 14 marine parks in Prince William Sound, and 5 in Resurrection Bay. The parks offer a variety of activities close to shore such as sea kayaking, saltwater and freshwater fishing, and recreational boating (Figure 3.12-2). Most recreational boating occurs close to shore in protected coves because of dangerous Gulf waters (National Park Service 2007).

Many people choose to navigate the GOA on ferries giving them spectacular views of glaciers, fjords, lush forests, and concentrations of seabirds and marine wildlife. Cruise travel along the GOA is a popular recreational activity and is the fastest growing tourist trade (city-data.com 2008). With excellent fishing and stunning coastal scenery, many visitors to the GOA choose to tour the area by boat and can choose from single-day to multi-day cruises (Alaska Travel Industry Association 2008).

Whale watching in Southcentral Alaska and the GOA occurs between June and early September, with August being the prime viewing month. A number of charter boat companies run whale watching cruises throughout the area.

In 2007, a total of 69,948 boats were registered statewide with Kenai and Kodiak accounting for 9,737 and 1,789 boats, respectively (Division of Motor Vehicles 2007). The totals do not account for thousands more small boats and watercraft that do not require registration.

3.12.1.2 Current Requirements and Practices

Long-range advance notice of scheduled activities and times are made available to the public and the commercial fishing community via the Internet. The local 17th District U.S. Coast Guard (USCG) NOTMARs may be found at: http://www.navcen.uscg.gov/lnm/d17/. The Federal Aviation Administration (FAA) Notices to Airmen (NOTAMs) may be found on the FAA publication webpage: https://pilotweb.nas.faa.gov/. These sites provide commercial fishermen, recreational boaters, pilots, and other area users notice that the military will be operating in a specific area and will allow them to plan their own activities accordingly. Military actions may temporarily relocate civilian and recreational activities. Schedules will be updated when changes occur with sufficient prior notice. If activities are cancelled at any time, this information is posted and the area is identified as clear for public use (Department of the Navy [DoN] 2007). To minimize potential military/civilian interactions, the Navy would continue to publish scheduled potentially hazardous training activities using the NOTAM and NOTMAR systems as applicable.

3.12.2 Environmental Consequences

As noted in Section 3.12.1, the ROI for socioeconomics includes the TMAA. Navy training activities that occur within the Air Force inland Special Use Airspace and the Army inland ranges were evaluated under previous National Environmental Policy Act (NEPA) documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents are incorporated by reference. Environmental effects in the open ocean beyond the U.S. territorial seas (outside of 12 nm [22 km]) are analyzed in this EIS/OEIS pursuant to Executive Order (EO) 12114.

3.12.2.1 Previous Analyses

Impacts related to socioeconomics were previously evaluated in Sections 3.10 and 4.10 of the *Alaska Military Operations Areas EIS* (USAF 1995), Sections 3.2.6 and 4.0 of the *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), Sections 3.19 and 4.19 of the *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999), and Sections 3.13 and 4.13 of the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

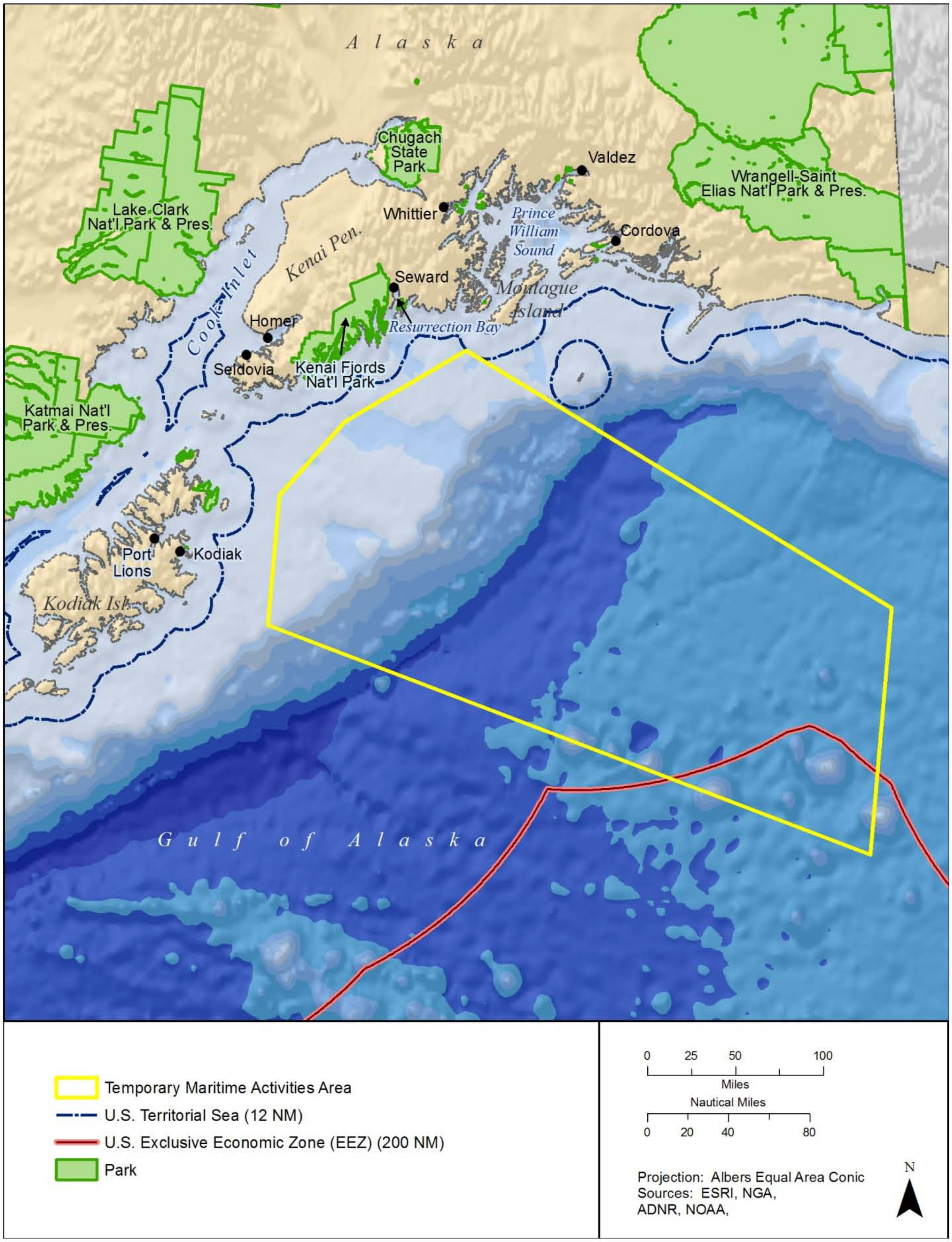

Figure 3.12-2: Parks and Recreation near the TMAA

3.12.2.2 Approach to Analysis

This analysis investigates the potential for activities associated with each of the alternatives to noticeably affect (either adversely or beneficially) socioeconomic activity in the GOA. Because there are no permanent population centers in the ROI, typical socioeconomic considerations such as population, housing, employment, economic growth, and associated services and infrastructure are not applicable. Additionally, training activities in the TMAA are not expected to significantly alter access to subsistence fishing areas or affect subsistence fishing resources because these fishing activities are generally located outside of the TMAA. The analysis for potential effects on socioeconomics focuses on those activities specific to commercial shipping, commercial fishing, recreation, and tourism in the GOA.

3.12.2.3 No Action Alternative

Civilian activities currently conducted in the TMAA include commercial shipping, commercial fishing, and tourist-related activities. These activities make an appreciable contribution to the overall economy of Alaska. The Navy has performed military activities within this region in the past and has not precluded fishing or recreational uses in the TMAA, even during peak fishing seasons. Under the No Action Alternative, training activities occur less than 6% of the year and are only conducted over a single period of up to 14 days. When training needs to be conducted during this period, a NOTMAR is issued. This measure provides mariners with Navy use areas in advance, which allows nonparticipants to select an alternate destination without appreciable effect to their activities. To help manage competing demands and maintain public access in the GOA, the Navy conducts its offshore activities in a manner that minimizes restrictions to commercial fisherman (U.S. Navy 2007).

Overflights associated with 300 sorties would occur above the TMAA. Most aircraft overflights would occur over the TMAA at elevations in excess of 15,000 ft (915 m). All aircraft overflights between the shore and 12 nm (22 km) from land would occur at altitudes at or above 15,000 ft (915 m). Though aircraft overflights produce noise and some of this sonic energy would reach the air-water interface, these activities are not expected to alter access to commercial or recreational fishing areas or affect commercial or recreational fishing resources. As described in Section 3.6.2.3, the behavioral responses that could occur from exposure to overflight noise would not compromise the general health or condition of individual fish and, as such, commercial or recreational fishing resources.

Many different types of commercial fishing gear are used in the GOA: gillnets, longline gear, troll gear, trawls, seining, and traps or pots. Damage to fishing gear from Navy activities in the TMAA is rare. When damage does occur to commercial fishing gear due to Navy actions (i.e., net entanglement, destruction of buoys), the fishermen (or the owner of the property damaged) can file a claim with the DoN under the Federal Tort Claims Act (FTCA) under the provisions of 28 U.S. Code (U.S.C.) Section 2671, et seq. and request reimbursement. Forms for filing an FTCA claim can be obtained from any Navy Legal Services Office. Reimbursement requests must be made within 2 years of incurring damage.

3.12.2.4 Alternative 1

The increase in number of activities for the TMAA amounts to a 13 percent increase in the training activities over the No Action Alternative. Though the number of activities will increase under Alternative 1, training activities will continue to occur during a single period of up to 21 days, or 6% of the available training days in a year. To minimize potential military/civilian interactions, the Navy would continue to publish scheduled potentially hazardous training activities using the NOTAM and NOTMAR systems as applicable. This ensures that commercial and recreational users are aware of the Navy’s plans, and allows users to plan their activities to avoid the scheduled activity (U.S. Navy 2007).

For years, fisheries in various parts of the world have complained about declines in their catch after acoustic activities (including naval exercises) moved into the area, suggesting that noise is seriously altering the behavior of some commercial species. Based on the analysis presented in Section 3.6 (Fish) of the EIS/OEIS, some marine fish may be able to detect mid-frequency sounds; most marine fish are hearing generalists and have their best hearing sensitivity below mid-frequency sonar. If they occur, behavioral responses would be brief, reversible, and not biologically significant. Sustained auditory damage is not expected. Sensitive life stages (juvenile fish, larvae, and eggs) very close to the sonar source may experience injury or mortality, but area-wide effects would likely be minor. The use of Navy mid-frequency sonar would not compromise the productivity of fish or adversely affect their habitat.

Under Alternative 1, a Portable Undersea Tracking Range (PUTR) would be implemented. The PUTR involves the temporary placement of seven electronics packages (sensors) on the seafloor, each approximately 3 feet (ft) (0.9 m) long by 2 ft (0.6 m) in diameter. Although no candidate locations have yet been identified, the electronic packages would be placed in water depths greater than 600 ft, at least 3 nm from land. Because this is a temporary installation—to be recovered once training is complete—no permanent restricted areas would be designated. While use of the PUTR by Fleet ships and aircraft would have no socioeconomic impact to the region, the gear placement on the seafloor could be incompatible with certain commercial fishing activities. Implementation of the PUTR would require the Navy to establish a temporary restricted area and issue a NOTMAR in order to limit any activity that could damage or disturb the sensors and could place an economic hardship on commercial fishing enterprises if the range is deployed in a viable fishing area.

The increased training tempo, addition of sonar use, and the temporary installation of a PUTR would not result in a negative effect on socioeconomics in the region due to advanced public notification, practicable range siting, and the primarily short-term duration of military activities.

3.12.2.5 Alternative 2

Alternative 2 includes all elements of Alternative 1 plus a further increase in the number of training activities in the TMAA. Training activities under Alternative 2 would occur over two distinct periods, each up to 21 days. In addition, Alternative 2 includes a Sinking Exercise (SINKEX) to be performed in each of the summer time exercises. As described in Section 2.6.1.1, SINKEX operations occur in the open ocean (at least 1,000 fathoms [6,000 ft] deep) where there are no sensitive marine resources or benthic fishing grounds. The stressors associated with SINKEX have been analyzed separately in previous sections, and while serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of several of these stressors (e.g., explosive ordnance), SINKEX under Alternative 2 would not result in impacts to fish populations and, thus, commercial fishing operations based on the low number of fish that would be affected.

To minimize potential military/civilian interactions, the Navy would continue to publish scheduled potentially hazardous training activities using the NOTAM and NOTMAR systems as applicable. This ensures that commercial and recreational users are aware of the Navy's plans, and allows users to plan their activities to avoid the scheduled activity (U.S. Navy 2007). The increased training tempo, as well as the addition of SINKEXs, would not result in a negative effect on socioeconomics in the region due to advanced public notification and the primarily short-term duration of military activities.

3.12.3 Mitigation

No effects to socioeconomics were identified; therefore, no mitigation measures are necessary.

3.12.4 Summary of Effects

Table 3.12-1 summarizes the socioeconomic effects of the No Action Alternative, Alternative 1, and Alternative 2 under both NEPA and EO 12114.

Table 3.12-1: Summary Effects by Alternative

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
No Action Alternative	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to socioeconomics would occur. • Overflights would not result in adverse effects to commercial shipping, commercial fishing, recreation, or tourism.	• No adverse impacts to commercial/recreational fishing, civilian access, or tourism would occur as a result of the No Action Alternative.
Alternative 1	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to socioeconomics would occur. • Overflights would not result in adverse effects to commercial shipping, commercial fishing, recreation, or tourism.	• No adverse impacts to commercial/recreational fishing, civilian access, or tourism would occur as a result of Alternative 1. • Use of the PUTR by Fleet ships and aircraft would have no socioeconomic impact to the region. • Gear placement for the PUTR on the seafloor could be incompatible with certain commercial fishing activities.
Alternative 2 (Preferred Alternative)	• Under Alternative 2, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to socioeconomics would occur. • Overflights would not result in adverse effects to commercial shipping, commercial fishing, recreation, or tourism.	• No adverse impacts to commercial/recreational fishing, civilian access, or tourism would occur as a result of Alternative 2. • Use of the PUTR by Fleet ships and aircraft would have no socioeconomic impact to the region. • Gear placement for the PUTR on the seafloor could be incompatible with certain commercial fishing activities. • SINKEX under Alternative 2 would not result in impacts to fish populations and thus commercial fishing operations.

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3.13 ENVIRONMENTAL JUSTICE AND PROTECTION OF CHILDREN

3.13.1 Affected Environment

For purposes of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the Region of Influence (ROI) for environmental justice and protection of children includes the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA). With the exception of Cape Cleare on Montague Island located over 12 nautical miles (nm) (22 kilometers [km]) from the northern point of the TMAA, the nearest shoreline (Kenai Peninsula) is located approximately 24 nm (44 km) north of the TMAA's northern boundary. The approximate middle of the TMAA is located 140 nm offshore. Areas inland from the coastline, including United States (U.S.) Air Force (Air Force) air ranges and U.S. Army (Army) training lands, are addressed in the *Alaska Military Operations Areas EIS* (USAF 1995), *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999), and the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

3.13.2 Environmental Consequences

As noted in Section 3.13.1, the ROI for environmental justice and protection of children includes the TMAA. No population centers are found within the TMAA. Environmental effects in the open ocean beyond the U.S. territorial seas (outside of 12 nm [22 km]) are analyzed in this EIS/OEIS pursuant to Executive Order (EO) 12114. Navy training activities that occur within the Air Force inland Special Use Airspace and the Army training lands were evaluated under previous National Environmental Policy Act (NEPA) documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents are incorporated by reference.

3.13.2.1 Previous Analyses

Impacts related to environmental justice and protection of children were previously evaluated in Appendix P of the *Alaska Military Operations Areas EIS* (USAF 1995), Sections 3.2.6 and 4.0 of the *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), Sections 3.21 and 4.21 of the *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999), and Sections 3.18 and 4.18 of the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

3.13.2.2 Regulatory Framework

Environmental Justice

Executive Order 12898 (EO 12898), *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,* was issued on February 11, 1994. This EO requires each federal agency to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies and activities on minority populations and low-income populations in the United States and its territories and possessions. The Environmental Protection Agency (EPA) and the Council on Environmental Quality (CEQ) have emphasized the importance of incorporating environmental justice review in the analyses conducted by federal agencies under the NEPA and of developing protective measures that avoid disproportionate environmental effects on minority and low-income populations. Objectives of this EO as it pertains to this EIS/OEIS include development of federal agency implementation strategies and identification of minority and low-income populations where proposed federal actions have disproportionately high and adverse human health or environmental effects.

Protection of Children

The President issued EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, in 1997. This order requires that each federal agency "(a) shall make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children; and (b) shall ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks."

Regulatory actions covered under EO 13045 include those that may be "economically significant" (under EO 12866 [*Regulatory Planning and Review*]) and "concern an environmental health risk or safety risk that an agency has reason to believe may disproportionately affect children." Furthermore, EO 13045 defines "environmental health risks and safety risks [to] mean risks to health or to safety that are attributable to products or substances that the child is likely to come in contact with or ingest (such as the air we breathe, the food we eat, the water we drink or use for recreation, the soil we live on, and the products we use or are exposed to)." To comply with the EO, this document addresses child-specific environmental health and safety risks.

3.13.2.3 Approach to Analysis

Environmental factors related to environmental justice or protection of children are identified and assessed for disproportionate effects on minority populations, low-income populations, or populations of children.

3.13.2.4 No Action Alternative

Under the No Action Alternative, no effects to air quality, water resources, acoustic environment, fish, socioeconomics, or public safety that may disproportionally affect minority or low-income populations within inland areas have been identified in previous Army or Air Force documents (discussed in Section 3.13.2.1). All discussion of effects of Navy activities on children within inland areas have been analyzed by prior Army and Air Force documents discussed in Section 3.13.2.1.

Training activities in the TMAA are not expected to significantly alter access to subsistence fishing areas or affect subsistence fishing resources because these fishing activities are generally located outside of the TMAA. Overflights associated with 300 sorties would occur above the TMAA. Most aircraft overflights would occur over the TMAA at elevations in excess of 15,000 ft (915 m). All aircraft overflights between the shore and 12 nm (22 km) from land would occur at altitudes at or above 15,000 ft (915 m). Though aircraft overflights produce noise and some of this sonic energy would reach the air-water interface, these activities are not expected to alter access to subsistence fishing areas or affect subsistence fishing resources. Therefore, because no effects are anticipated, no disproportionately high and adverse effects on any low-income or minority groups would occur as a result of implementation of the No Action Alternative. With regard to effects on children, there are no population centers within the TMAA. Therefore, no effects on children would occur as a result of implementation of the No Action Alternative.

3.13.2.5 Alternative 1

Under Alternative 1, the number of activities for the TMAA amounts to a 13 percent increase in the training activities over the No Action Alternative. Though the number of activities will increase under Alternative 1, training activities will continue to occur during a single period of up to 21 days, or 6% of the available training days in a year. However, under Alternative 1, effects would be the same as those identified under the No Action Alternative because no population centers are found within the TMAA. Potential effects on inland areas have been analyzed within existing Army and Air Force documents (discussed in Section 3.13.2.1) and no disproportionately high and adverse effects on low-income or minority populations have been identified.

3.13.2.6 Alternative 2

Alternative 2 includes all elements of Alternative 1 plus a further increase in the number of training activities in the TMAA. Training activities under Alternative 2 would occur over two distinct periods, each up to 21 days. In addition, Alternative 2 includes a Sinking Exercise to be performed in each of the summer time exercises. However, under Alternative 2, effects would be the same as those identified under the No Action Alternative because no population centers are found within the TMAA. Potential effects on inland areas have been analyzed within existing Army and Air Force documents (discussed in Section 3.13.2.1) and no disproportionately high and adverse effects on low-income or minority populations have been identified.

3.13.3 Mitigation

No effects to environmental justice or protection of children were identified; therefore, no mitigation measures are necessary.

3.13.4 Summary of Effects

Table 3.13-1 summarizes the Environmental Justice (EO 12898) and Protection of Children (EO 13045) effects of the No Action Alternative, Alternative 1, and Alternative 2 for environmental justice and protection of children under both NEPA and EO 12114.

Table 3.13-1: Summary of Effects by Alternative

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
No Action Alternative	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to environmental justice or protection of children would occur. • No effects are anticipated from training activities and overflights; no disproportionately high and adverse effects on any low-income or minority groups would occur. • There are no population centers found within the TMAA. Therefore, no effects on children would occur as a result of implementation of the No Action Alternative.	• No permanent human population centers exist in non-U.S. territorial seas and subsistence uses occur mostly outside of the TMAA. Therefore, no impacts related to environmental justice or protection of children would occur.

Table 3.13-1: Summary of Effects by Alternative (continued)

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
Alternative 1	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to environmental justice or protection of children would occur. • No effects are anticipated from training activities and overflights; no disproportionately high and adverse effects on any low-income or minority groups would occur. • There are no population centers found within the TMAA. Therefore, no effects on children would occur as a result of implementation of Alternative 1.	• No permanent human population centers exist in non-U.S. territorial seas and subsistence uses occur mostly outside of the TMAA. Therefore, no impacts related to environmental justice or protection of children would occur under Alternative 1.
Alternative 2 (Preferred Alternative)	• Under Alternative 2, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts related to environmental justice or protection of children would occur. • No effects are anticipated from training activities and overflights; no disproportionately high and adverse effects on any low-income or minority groups would occur. • There are no population centers found within the TMAA. Therefore, no effects on children would occur as a result of implementation of the Alternative 2.	• No permanent human population centers exist in non-U.S. territorial seas and subsistence uses occur mostly outside of the TMAA. Therefore, no impacts related to environmental justice or protection of children would occur under Alternative 2.

3.14 PUBLIC SAFETY

Public safety concerns are assessed in terms of the potential for Navy training activities to injure civilians or put them at risk in any way. Impacts may arise directly as physical injuries from hazardous activities or indirectly as a result of exposure to hazardous materials expended during a training event. Activities that could affect public safety include surface and subsurface ship movements, aircraft movements, use of munitions, and emissions of acoustic and electromagnetic energy (e.g., sonar and radar). These potential sources of safety risks were identified by a detailed analysis of training activities, geographic locations, and Navy standard operating procedures and protocols. It is Navy policy to prevent personal injury or property damage by observing every possible precaution in the planning and execution of all Navy training activities.

3.14.1 Affected Environment

For purposes of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the Region of Influence (ROI) for public safety includes the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA). Areas inland from the coastline, including United States (U.S.) Air Force (Air Force) air ranges and U.S. Army (Army) training lands, are addressed in the *Alaska Military Operations Areas EIS* (USAF 1995), *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999), and the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

3.14.1.1 Operating Areas

Military, commercial, institutional, and recreational activities take place in the TMAA. The Navy conducts hazardous activities, such as missile firings, naval gunfire, and air-to-surface ordnance delivery, in international waters within the TMAA. The Federal Aviation Administration (FAA) has established Warning Area 612 (W-612) for military activities; W-612 is open to public co-use most of the time. The public typically uses the TMAA for shipping, aviation, tourism, boating, and commercial fishing, which includes salmon, crab, and shellfish harvesting. Recreational activities include whale watching and fishing (Department of Navy [DoN] 2008). Commercial and recreational vessels are allowed to operate in the TMAA, the surface waters are accessible to recreational and commercial boaters, and there are no continuously restricted zones in this area. Public use of offshore marine areas is a safety concern for the Navy because training activities occur primarily in international waters.

The TMAA also is used for subsistence harvesting by Alaska Natives. Alaska Natives rely heavily on the harvesting of marine mammals and fish that inhabit the TMAA. Designated subsistence-use areas are located within 3 nautical miles (nm) (5.5 kilometers [km]) of shore. Navy training exercises will not affect subsistence harvesting because the subsistence use areas are outside of the TMAA.

When hazardous training activities occur, and the Navy requires exclusive control for public safety concerns, Notices to Mariners (NOTMARs) and Notices to Airmen (NOTAMs) about the hazards are issued. In addition, during training activities in the TMAA, weapons delivery activities are delayed or cancelled if training areas are not clear of nonparticipants. A training area is considered a “Green Range” if the ordnance-area footprint is clear of all nonparticipating surface vessels, divers, and aircraft; if the training area is not clear, then the area is considered a “Red Range.” Training can only be conducted if a “Green Range” is issued, and, if considered a “Red Range,” training must be delayed until all nonparticipants are cleared and a “Green Range” is issued. These designations assure public safety during training activities that otherwise could harm nearby nonparticipants.

Ordnance Handling

As described in Chapter 2, some training activities use ordnance. The procedures for handling and storing ordnance are found in Naval Sea Systems Command (NAVSEA) Operational Procedures (OP) 5, *Ammunition and Explosives Ashore: Safety Regulations for Handling, Storing, Production, Renovation, and Shipping* (DoN 2001).

Public Access and Proximity

The waters of the TMAA are available to civilian vessels, except during hazardous training activities. During such activities, the public is excluded because of safety concerns. NOTMARs and NOTAMs are issued to notify the public about the hazards of operating vessels or aircraft in the vicinity. Additional Standard Operating Procedures (SOPs) and best management practices to assure public safety are discussed later in this section.

3.14.1.2 Current Requirements and Practices

Navy training activities in the TMAA comply with numerous established safety procedures to ensure that neither participants nor nonparticipants engage in activities that endanger life or property.

Fleet Area Control and Surveillance Facility Safety Procedures

Fleet Area Control and Surveillance Facility (FACSFAC) provides active management of assigned airspace, operating areas, ranges, and training resources to enhance combat readiness of U.S. Pacific Fleet units in all warfare areas. Although FACSFAC does not have procedures specific to the TMAA, Navy ships will comply with the FACSFAC procedures for their home base. FACSFAC procedures for other training areas, such as Southern California (SOCAL) Range Training Complex, would be sufficient for use in the TMAA because of the greater risk to public safety along the more densely populated California coast. FACSFAC San Diego has published safety procedures for activities on the offshore and nearshore areas (DoN 1997, 1999, 2004). These guidelines apply to range users as follows:

- Commanders are responsible for ensuring that impact areas and targets are clear prior to commencing hazardous activities.
- The use of underwater ordnance must be coordinated with submarine operational authorities. The coordination also applies to towed sonar arrays and torpedo decoys.
- Aircraft or vessels expending ordnance shall not commence firing without permission of the scheduling authority for their specific range area.
- Firing units and targets must remain in their assigned areas, and units must fire in accordance with current safety instructions.
- Vessels are authorized to fire their weapons only in offshore areas and at specific distances from land, depending on the caliber and range of the weapons fired. The larger the caliber, the farther offshore the firing must take place.
- Aircraft carrying ordnance to or from ranges shall avoid populated areas to the maximum extent possible.

Aircrews must be aware that nonparticipating aircraft are not precluded from entering the area and may not comply with a NOTAM or radio warnings that hazardous activities are scheduled or occurring. Aircrews are required to maintain a continuous lookout for nonparticipating aircraft while operating under visual flight rules in warning areas.

DoD Standard Operating Procedures

All training activities will comply with Department of Defense (DoD) Directive 4540.1, *Use of Airspace by U.S. Military Aircraft and Firings Over the High Seas*, and Chief of Naval Operations Instruction (OPNAVINST) 3770.4A, *Use of Airspace by U.S. Military Aircraft and Firing Over the High Seas*, which specify procedures for conducting aircraft maneuvers and for firing missiles and projectiles. The missile and projectile firing areas are to be selected "so that trajectories are clear of established oceanic air routes or areas of known surface or air activity" (DoD 1981).

Navy Standard Operating Procedures

In addition to FACSFAC procedures, the Navy has instituted the following SOPs at the Northwest Training Range Complex (NWTRC) Operational Areas and the SOCAL Range Training Complex. These SOPs are applicable to the TMAA because Navy ships conducting training in the TMAA will typically be based out of SOCAL or the NWRTC, and the activities conducted in SOCAL and NWTRC are similar to those conducted in the TMAA.

Aviation Safety

Aircraft fly under visual flight rules and under visual meteorological conditions. This means that the commanders of military aircraft are responsible for the safe conduct of their flight. Prior to releasing any weapons or ordnance, the impact area must be clear of nonparticipating vessels, people, or aircraft. The Officer Conducting the Exercise is ultimately responsible for the safe conduct of range training. A qualified safety officer is assigned to each training event or exercise, and can terminate activities if unsafe conditions exist.

Submarine Navigation Safety

Navigation safety, while submarines are submerged, consists of several methods used to alert submarine crews to the potential dangers of collision, both during training activities within Warning Areas and during transits to and from these training areas. Training areas are typically closed to sport and commercial fishing vessels during training activities to avoid ensnaring nets towed by fishing vessels. Closures are communicated by issuing NOTMARs. The surface is scanned visually and by radar for such vessels before and during training activities. During training activities in offshore areas, weapons delivery activities are delayed or cancelled if the training area is not clear. Prior to issuing a "Green Range," Navy personnel must ensure that the hazard footprint of the ordnance being fired is clear of nonparticipating surface vessels. During transit to and from training areas, submerged submarines use sonar and navigational maps that identify known fishing areas to avoid fishing vessels.

General Exercise Safety

Surface Vessels

Prior to launching a weapon, vessels are required to determine that all safety criteria have been satisfied, that the weapons and target recovery conditions are acceptable, and that recovery helicopters and boats are ready to be deployed.

Aircraft

Only hazardous activities require exclusive use of airspace, and these periods are scheduled and broadcast by the Navy through NOTAMs. Navy personnel must ensure that the hazard footprint of the ordnance being fired is clear of nonparticipating aircraft.

Live and Inert Ordnance

Whenever live or inert ordnance is expended, a qualified Range Safety Officer (RSO) is present. Units must ensure that the area can contain the hazard footprints of the weapons employed. RSOs ensure that these footprints are clear of personnel during training activities. After live-fire events, participating units ensure that weapons are safe and clear of live rounds. The RSOs are also responsible for the emergency medical evacuation of people from the area in case of a mishap.

Sonar

The Naval Sea Systems Command Instruction (NAVSEAINST) 3150.2, *Safe Diving Distances from Transmitting Sonar*, is the Navy's governing document for human divers in relation to active sonar systems; it provides procedures for calculating safe distances from active sonars. Such procedures are derived from experimental and theoretical research conducted at the Naval Submarine Medical Research Laboratory and the Navy Experimental Diving Unit.

Safety ranges vary based on conditions that include diver dress, type of sonar, and duration of time in the water. If low-frequency sonar (160 kilohertz (kHz) to 320 kHz) is used, divers should not be in the vicinity or should be warned that exposure is likely. Low-frequency sonar can cause dizziness, vertigo, skin tingling, or vibratory sensations in the throat and abdomen.

Electromagnetic Radiation

Communications and electronic devices such as radar, electronic jammers, and other radio transmitters produce electromagnetic radiation (EMR). Equipment that produces an electromagnetic field may generate hazardous levels of EMR. An EMR hazard exists when transmitting equipment generates an electromagnetic field that induces currents or voltages large enough to trigger electro-explosive devices in ordnance. EMR also can be a health hazard to people or an explosive hazard for fuel. EMR hazards are reduced or eliminated by establishing minimum separation distances between EMR emitters and people, ordnance, and fuel.

EMR effects are directly proportional to the frequency of the EMR source. For example, the lower the frequency of the EMR source, the lower the acceptable power density threshold before a potential hazard to human health exists. Likewise, the higher the frequency of the EMR source, the higher the acceptable power density threshold before health effects occur. Hazards of EMR to personnel, ordnance, and fuel have been determined for EMR sources based on frequency and power output.

Sources of EMR include radar, navigational aids, and Electronic Warfare (EW) hardware. These systems are the same as, or similar to, civilian navigational aids and radars at local airports and television weather stations throughout the United States. EW systems emit EMR similar to that from cell phones, hand-held radios, commercial radio, and television stations. SOPs in place to protect Navy personnel and the public include setting the heights and angles of EMR transmission to avoid direct exposure, posting warning signs, establishing safe operating levels, and activating warning lights when radar systems are operational. To avoid excessive exposures from EMR, military aircraft are operated in accordance with standard procedures that establish minimum separation distances between EMR emitters and people, ordnance, and fuels.

Lasers

Lasers may be used for precision range finding and as target designation devices for guided munitions. Laser safety procedures for aircraft require an initial pass over the target prior to laser activation to ensure that target areas are clear. During actual laser use, aircraft run-in headings are restricted to avoid unintentional contact with personnel or nonparticipants. Personnel participating in laser training activities are required to complete a laser safety course. For training activities conducted in the TMAA, eye-safe lasers are used.

3.14.2 Environmental Consequences

As noted in Section 3.14.1, the ROI for public safety includes the TMAA. Navy training activities that occur within the Air Force inland Special Use Airspace and the Army inland training lands were evaluated under previous National Environmental Policy Act (NEPA) documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents are incorporated by reference. Environmental effects in the open ocean beyond the U.S. territorial seas (outside of 12 nm [22 km]) are analyzed in this EIS/OEIS pursuant to Executive Order (EO) 12114.

3.14.2.1 Previous Analysis

Impacts related to public safety were previously evaluated in Sections 3.2 and 4.2 of the *Alaska Military Operations Areas EIS* (USAF 1995), Sections 3.2.3 and 4.0 of the *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), Sections 3.16 and 4.16 of the *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999), and Sections 3.17 and 4.17 of the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

3.14.2.2 Approach to Analysis

Public safety is considered to be affected if the general public is substantially endangered as a result of Navy activities on the ranges. For each training activity or group of similar activities, an estimate of risk to the general public was formulated, based on the Navy's current set of safety procedures for range activities. Navy training activities in the TMAA would be conducted in accordance with guidance provided in FACSFAC San Diego Instruction 3120.1, *Manual of EASTPAC and MIDPAC Fleet Operating Areas*. The instruction provides operational and safety procedures for all normal range activities. Its emphasis is on providing the necessary information to range users so that they can operate safely and avoid affecting non-military activities such as shipping, recreational boating, and commercial or recreational fishing (DoN 1997). Several factors were considered in evaluating the effects of the Navy's activities on public safety, including proximity to the public, ownership, access control, scheduling, public notification of events, frequency and duration of activities, range safety procedures, operational control of training events, and safety history.

Data Sources

Available reference materials, including prior Environmental Assessments (EAs) and EISs/OEISs, were reviewed and used where their information on training activities, policies, equipment, or environmental impacts was applicable. All current and proposed training activities were examined for the possibility of civilians entering a hazardous training environment. Current Navy safety procedures in existing Navy instructions were assessed to determine whether the procedures would protect the public from the hazardous training activities proposed in the alternatives.

Methods

Each alternative analyzed in this EIS/OEIS includes training activities in several warfare areas (e.g., Anti-Air Warfare, Anti-Surface Warfare), and most warfare areas encompass more than one training activity (e.g., Surface-to-Air Gunnery Exercise, Air-to-Surface Missile Exercise [MISSILEX]). Likewise, each activity has several elements (e.g., weapons firing, target deployment). Accordingly, this analysis is organized by specific activity rather than by warfare area (Table 3.14-1). The approach to the public safety analysis includes characterizing the training activities that may affect public safety in the TMAA. These activities include: missile flights; target expenditures; ship, vessel, and aircraft movements; and weapons firing. Training materials that could affect public safety include ordnance.

3.14.2.3 No Action Alternative

Fleet training activities will continue to be conducted in the TMAA. Training activities under the No Action Alternative are conducted once per year for up to 14 days. Some offshore activities will expend ordnance, sonobuoys, or targets from vessels or aircraft. The ordnance used in offshore training activities may have either live or inert warheads. The U.S. Navy's standard range safety procedures, as outlined in the SOPs discussed in Section 3.14.1.2, are designed to avoid risks to the public and to Navy activities.

Table 3.14-1: Training Activities Affecting Public Safety

Warfare Area	Activity	Ordnance	Aircraft/Ship Movement
Anti-Air Warfare (AAW)	Air Combat Maneuvers (ACM)		✓
	Air Defense Exercise (ADEX)		✓
	Surface-to-Air Missile Exercise	✓	✓
	Surface-to-Air Gunnery Exercise (GUNEX)	✓	✓
	Air-to-Air MISSILEX	✓	✓
Anti-Surface Warfare (ASUW)	Visit Board Search and Seizure (VBSS)	✓	✓
	Air-to-Surface MISSILEX		✓
	Air-to-Surface Bombing Exercise (BOMBEX)	✓	✓
	Air-to-Surface GUNEX	✓	✓
	Surface-to-Surface GUNEX	✓	✓
	Maritime Interdiction	✓	✓
	Sea Surface Control		✓
	Sinking Exercise (SINKEX)	✓	✓
Anti-Submarine Warfare (ASW)	ASW Tracking Exercise (TRACKEX)– Helicopter		✓
	ASW TRACKEX – Maritime Patrol Aircraft		✓
	ASW TRACKEX – Extended Echo Ranging	✓	✓
	ASW TRACKEX – Surface Ship		✓
	ASW TRACKEX – Submarine		✓
Electronic Combat (EC)	EC Exercises		✓
	Chaff Exercises	✓	✓
	Counter Targeting Exercises		✓
Naval Special Warfare (NSW)	Insertion/Extraction		✓
Strike Warfare (STW)	Air-to-Ground BOMBEX	✓	✓
	Personnel Recovery		✓
Support Operations	Deck Landing Qualifications		✓

Training Area Clearance

The hazard footprint of the ordnance in use is based on the range of the weapon, and includes a large safety buffer to account for the item going off-target or malfunctioning. For activities with a large hazard footprint (e.g., MISSILEXs), special sea and air surveillance measures are taken to search for, detect, and clear the area of intended activities. Aircraft are required to make a preliminary pass over the intended target area to ensure that it is clear of boats, divers, or other nonparticipants. Aircraft carrying ordnance are not allowed to fly over surface vessels.

Target areas are cleared of nonparticipants prior to conducting training, so public safety issues will only occur if an activity exceeds the safety area boundaries or a nonparticipant is not identified prior to the start of training. Risks to public safety are reduced, in part, by providing termination systems on some of the missiles. In those cases where a weapon system does not have a flight termination capability, the target area is determined to be clear of unauthorized vessels and aircraft, based on the flight distance the vehicle can travel plus a 5-mile-long area beyond the system's performance parameters.

Naval Special Warfare Activities

Specific NSW training events include insertion/extraction activities to hone individual skills in delivery and withdrawal of personnel and equipment using unconventional methods. Access control is the key to reducing the risk to the public due to the hazardous nature of NSW training. There is public access to the TMAA, but NSW activities will pose little danger to public safety because no ordnance is expended. The Navy will ensure that the area is clear of civilian boats, divers, or aircraft before any potentially hazardous activity commences. Activities will be cancelled or delayed if there is any question about the safety of the public or the participants. Radio communications will be used extensively during training to avoid unsafe situations.

Prior public notification of Navy training activities, use of known training areas, avoidance of nonmilitary vessels and personnel, and the remoteness of the TMAA will reduce the potential for interaction between the public and Navy vessels during training activities. To date, these generally conservative safety strategies have been successful.

Aircraft Overflights

Aircraft overflights during training exercises and during transits to and from the TMAA and the inland training lands could affect public safety. Aircraft transit through an established Altitude Reservation (ALTRV). The ALTRV is a flight clearance corridor provided by the FAA. A description of a typical ALTRV is provided in Section 3.11, Transportation and Circulation. While operating within the ALTRV, aircraft are under positive control of the FAA, and comply with all FAA flight rules. Aircraft accidents are rare, but may occur during training activities. However, aircraft overflights would not have a substantial effect on public safety because of the use of the ALTRV, the FAA and military procedures, and flight rules that the participating aircraft must follow. With regard to the TMAA, there is a very low probability that an aircraft could collide with a public surface vessel or aircraft due to the remoteness of the TMAA and its relative size. Therefore, aircraft overflights pose little to no risk to public safety.

3.14.2.4 Alternative 1

Offshore activities proposed under Alternative 1 would have all the components of the No Action Alternative. Additionally, Alternative 1 would support an increase in training activities to include force structure changes associated with the introduction of new weapon systems and vessels into the fleet (Table 3.14-1). Under Alternative 1, baseline training activities generally would be increased. In addition, new ASW activities (including the use of active sonar) would be implemented. Force structure changes associated with new weapon systems would include sonobuoys, which would add a small number of detonations associated with the SSQ-110A Extended Echo-Ranging (EER)/Improved EER (IEER) sonobuoy. The safety procedures implemented under the No Action Alternative would continue to be implemented under Alternative 1. The remoteness of the TMAA, the use of temporary access restrictions, and public notification procedures would substantially reduce potential safety risks during these activities.

Several training activities would experience increases from current levels; increases in the number of individual training activities would increase the potential for conflicts with nonparticipants. However, given the Navy's comprehensive, conservative safety procedures and its excellent safety record for these activities, the actual potential for public safety impacts from training activities would remain very low. Potential for aircraft collisions with public surface vessels and aircraft would remain low because of the large area available in the GOA.

Training Area Clearance

Training area clearance procedures for hazardous activities under Alternative 1 would remain the same as under the No Action Alternative. These procedures would be adequate to prevent interactions with nonparticipants during training exercises.

NSW Activities

Alternative 1 would include all NSW training activities described under the No Action Alternative. There would be no increase in NSW activities under Alternative 1. Thus, the impacts of NSW training activities under Alternative 1 are the same as described under the No Action Alternative and would be negligible.

Aircraft Overflights

Under Alternative 1, there would be an increase in overflights from the TMAA to the Alaska inland training areas via the ALTRV. Safety procedures for participants using the ALTRV would remain consistent. Public safety would not be affected by the increase in overflights because of the light air traffic in the GOA and coordination between the Navy and the FAA.

ASW Activities

Sonar

ASW activities within the TMAA would use active sonar. The effect of sonar on humans varies with the frequency of sonar involved. Of the three types of sonar (high-, mid-, and low-frequency), mid-frequency and low-frequency have the greatest potential to affect humans. NAVSEAINST 3150.2 is the Navy's governing document for human divers in relation to active sonar systems; it provides procedures for calculating safe distances from active sonars. For example, a diver wearing a wetsuit without a hood has a permissible exposure limit of 71 minutes at a distance of 1,000 yards from the Navy's most powerful sonar. At this distance, the sound pressure level would be approximately 190 decibels (dB). At 2,000 yards, or approximately 1 nm, a diver could operate for over 3 hours. Exposure to sonar in excess of 190 dB could cause slight visual-field shifts, fogging of the faceplate, spraying of water within the mask, and general ear discomfort. (DoN 2005). Under Alternative 1, sonar could affect nonparticipants in the water nearby. However, nonparticipants in the water would not be expected in the TMAA because of the temperature of the water, the Navy safety procedures prior to training activities, and the distance from shore to the areas where ASW activities would take place. If nonparticipants were present in the training area, Navy safety procedures would delay training until nonparticipants were cleared from the range. The training area would be constantly monitored for nonparticipants during training activities that use sonar.

Sonobuoys

ASW exercises would introduce the use of sonobuoys in the TMAA. Although extremely rare, some solid training items expended at sea could migrate to the shoreline where the public could encounter them.

Included among these items are targets and sonobuoys. Targets typically would be recovered after each use. However, expendable targets such as the MK-39 Expendable Mobile Anti-Submarine Warfare Training Target (EMATT) would not be recovered. MK-39 EMATTs and sonobuoys are designed to scuttle and sink either when commanded, or when their service life has expired, no greater than 8 hours after being deployed. If either an EMATT or a sonobuoy migrated to shore, they would pose little risk to the public. Sonobuoys contain no fuel, the batteries would have lost all power, and the materials used in their construction are inert or sealed in hard plastic casings. Section 3.2, Expended Materials, discusses the hazardous materials and environmental effects of sonobuoys.

One type of sonobuoy, the EER sonobuoy, has explosive charges used to generate acoustic energy in the water. Underwater detonations would cause acoustic pressure, which could harm nonparticipants in the water nearby. Nonparticipants in the water would not be expected because of Navy safety procedures prior to training exercises. If nonparticipants were present in the training area, Navy safety procedures would delay training until nonparticipants were cleared from the range. The training area would be constantly monitored for nonparticipants during training for activities that use ordnance. This sonobuoy would present a hazard if it failed to detonate and washed ashore. These sonobuoys would be used far out to sea, however, and have several redundancies built in to assure that the charges detonate when the sonobuoy is scuttled. Management of expended materials (including hazardous materials) in conjunction with U.S. Navy training activities is addressed in Section 3.2, Expended Materials. No substantial releases of these materials to the environment are anticipated.

Portable Undersea Tracking Range (PUTR)

Alternative 1 would include the use of a Portable Undersea Tracking Range (PUTR). The PUTR requires the temporary placement of seven electronics packages on the seafloor, each approximately 3 feet (ft) (0.9 meters [m]) long by 2 ft (0.6 m) in diameter. No specific locations have yet been identified, but the electronic packages would be placed in water depths greater than 600 ft (182 m), at least 3 nm (5.5 km) from land. This is a temporary installation (to be recovered once training is complete), so no formally restricted areas would be designated and no limitations would be placed on commercial or civilian use of the area. The presence of the PUTR on the ocean floor for the duration of the training exercise would have no effect on public safety because – other than fishing trawls – these areas are not used by the public.

3.14.2.5 Alternative 2

Alternative 2, the Preferred Alternative, would include all elements of Alternative 1 (accommodating training activities currently conducted, increasing training activities, accommodating force structure changes, and conducting ASW activities with the use of active sonar). In addition, training tempo for all activities would be increased 100 percent over levels identified in Alternative 1 (see Table 2-7).

Alternative 2 would include two SINKEX. A single SINKEX would be conducted once per summertime training exercise. During a SINKEX, a decommissioned surface ship is towed to a deep-water location and sunk using a variety of ordnance. The use of live ordnance could affect public safety, but a SINKEX would occur, by rule, at least 50 nm (93 km) offshore. Public use of waters at least 50 nm (93 km) offshore would be infrequent. Navy clearance measures for live-fire training exercises would be implemented, which would greatly decrease the chance that nonparticipants would be in the training area during SINKEX. Therefore, SINKEX would not affect public safety because of the implemented range clearance measures and remoteness of the location.

With the exception of SINKEX, no new training exercises would be conducted. The safety procedures implemented under Alternative 2 would be the same as those described under the No Action Alternative. These safety procedures would substantially decrease the likelihood that Navy training in the TMAA would affect public safety. The remoteness of the TMAA, the use of temporary access restrictions, and public notification procedures would substantially reduce potential safety risks during these activities. Therefore, effects on public safety under Alternative 2 would be similar to those under Alternative 1.

NSW activities proposed under Alternative 2 would be the same as those described under Alternative 1. Safety procedures as described under Alternative 1 would ensure that nonparticipants were not endangered.

3.14.3 Mitigation

No substantial impacts have been identified. The safety procedures followed by the Navy lower the risk that Navy training activities pose on public safety. No further mitigation measures would be required.

3.14.4 Summary of Effects

Table 3.14-2 summarizes the effects of the No Action Alternative, Alternative 1, and Alternative 2 on public safety under both NEPA and EO 12114.

Table 3.14-2: Summary of Effects by Alternative

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
No Action Alternative	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts on public safety would occur. • Aircraft overflights would not affect public safety because aircraft are limited to flying within the ALTRV and follow FAA guidelines.	• Navy training exercises in the TMAA will not affect public safety. The Navy will issue NOTAMs or NOTMARs to notify the public of training exercises. If non-participants are in the training area, training activities will not proceed until non-participants have left the area.
Alternative 1	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts on public safety would occur. • Increase in aircraft overflights would not affect public safety because aircraft are limited to flying within the ALTRV and follow FAA guidelines.	• Navy training exercises in the TMAA will not affect public safety. The Navy will issue NOTAMs or NOTMARs to notify the public of training exercises. If non-participants are in the training area, training activities will not proceed until non-participants have left the area. • Impacts on public safety would be negligible, the same as under the No Action Alternative. • Installation and use of the temporary PUTR will not affect public health or safety.

Table 3.14-2: Summary of Effects by Alternative (continued)

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	EO 12114 (Non-U.S. Territorial Seas, > 12 nm)
Alternative 2 (Preferred Alternative)	• Under Alternative 2, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents concluded that no significant impacts on public safety would occur. • Increase in aircraft overflights would not affect public safety because aircraft are limited to flying within the ALTRV and follow FAA guidelines.	• Navy training exercises in the TMAA will not affect public safety. The Navy will issue NOTAMs or NOTMARs to notify the public of training exercises. If non-participants are in the training area, training activities will not proceed until non-participants have left the area. • There would be an increase in training tempo and new training activities, but impacts on public safety would be negligible, the same as under the No Action Alternative and Alternative 1. • With implementation of SOPs, range clearance procedures, and NOTMARs, SINKEX will not affect public health or safety.

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4 CUMULATIVE IMPACTS

4.1 PRINCIPLES OF CUMULATIVE IMPACTS ANALYSIS

The approach taken herein to analyze cumulative effects[1] meets the objectives of the National Environmental Policy Act (NEPA) of 1969, Council on Environmental Quality (CEQ) regulations, and CEQ guidance. CEQ regulations (40 Code of Federal Regulations [C.F.R.] §§ 1500-1508) provide the implementing procedures for NEPA. The regulations define "cumulative effects" as:

> ". . . the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." (40 C.F.R. 1508.7).

CEQ provides guidance on cumulative impacts analysis in *Considering Cumulative Effects Under the National Environmental Policy Act* (CEQ 1997). This guidance further identifies cumulative effects as those environmental effects resulting "from spatial and temporal crowding of environmental perturbations. The effects of human activities will accumulate when a second perturbation occurs at a site before the ecosystem can fully rebound from the effects of the first perturbation." Noting that environmental impacts result from a diversity of sources and processes, this CEQ guidance observes that "no universally accepted framework for cumulative effects analysis exists," while noting that certain general principles have gained acceptance. One such principal provides that "cumulative effects analysis should be conducted within the context of resource, ecosystem, and community thresholds—levels of stress beyond which the desired condition degrades." Thus, "each resource, ecosystem, and human community must be analyzed in terms of its ability to accommodate additional effects, based on its own time and space parameters." Therefore, cumulative effects analysis normally will encompass geographic boundaries beyond the immediate area of the Proposed Action, and a time frame including past actions and foreseeable future actions, to capture these additional effects. Bounding the cumulative effects analysis is a complex undertaking, appropriately limited by practical considerations. Thus, CEQ guidelines observe, "[i]t is not practical to analyze cumulative effects of an action on the universe; the list of environmental effects must focus on those that are truly meaningful."

For the Proposed Action to have a cumulatively significant impact on an environmental resource, two conditions must be met. First, the combined effects of all identified past, present, and reasonably foreseeable projects, activities, and processes on a resource, including the effects of the Proposed Action, must be significant. Secondly, the Proposed Action must make a substantial contribution to that significant cumulative impact. Finally, if the effects of the Proposed Action alone would have a significant impact on an environmental resource within its Region of Influence, then the impacts of the Proposed Action in combination with all other past, present, and reasonably foreseeable actions would normally be cumulatively significant.

4.1.1 Identifying Geographical Boundaries for Cumulative Impacts Analysis

Geographic boundaries for analyses of cumulative impacts can vary for different resources and environmental media. For air quality, the potentially affected air quality regions are the appropriate boundaries for assessment of cumulative impacts from releases of pollutants into the atmosphere. For wide-ranging or migratory wildlife, specifically marine mammals, sea turtles, fish, and sea birds, any impacts of the Proposed Action might combine with the impacts of other activities or processes within the range of the population. Due to the relatively remote location of the Proposed Action and limited

[1] CEQ Regulations provide that the terms "cumulative impacts" and "cumulative effects" are synonymous (40 C.F.R. § 1508.8[b]).

Department of Defense (DoD) and commercial project activity, the geographic boundary for the majority of resources analyzed for cumulative impacts in this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) is the Gulf of Alaska (GOA). However, migratory wildlife are analyzed for cumulative impacts based on the ecological ranges of their populations.

Activities taking place in areas inland from the coastline, including United States (U.S.) Air Force (Air Force) air ranges and U.S. Army (Army) training lands, are addressed in the *Alaska Military Operations Area EIS* (USAF 1995), *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), the *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999), and the *Transformation of U.S. Army Alaska FEIS* (Army 2004). The nature and extent of training on Air Force and Army inland training lands has not changed substantially during the past five years, and is not expected to change substantially in the foreseeable future (with the exception of the United States Army Alaska [USARAK] Stationing and Training of Increased Aviation Assets, included in Table 4-1).

4.1.2 Projects and Other Activities Analyzed for Cumulative Impacts

4.1.2.1 Past, Present, and Reasonably Foreseeable Future Actions

Identifiable present effects of past actions are analyzed, to the extent they may be additive to impacts of the Proposed Action. In general, the Navy lists and analyzes the effects of individual past actions only where appropriate; cumulative impacts analysis typically focuses on aggregate effects of past actions. This analysis depends on the availability of data and the relevancy of future effects of past, present, and future actions. Although certain data (e.g., extent of forest cover) may be available for extensive periods in the past (i.e., decades), other data (e.g., water quality) may be available only for much shorter periods. Because specific information and data on past projects and actions are usually scarce, the analysis of past effects is often qualitative (CEQ 1997). Primarily to be analyzed are all present and reasonably foreseeable future actions that may have effects additive to the effects of the Proposed Action. These actions include all likely future development of the region even when foreseeable future action is not planned in sufficient detail to permit complete analysis (CEQ 1997). Table 4-1 lists present and planned projects with the potential to contribute to cumulative impacts.

Table 4-1: Past, Present, and Reasonably Foreseeable Future Projects in the GOA

Project	Project Description	Project Timeframe		
		Past	Present	Future
Alaska Predator Ecosystem Experiment (APEX)	The APEX was initiated under Restoration Project 94163, entitled *Forage Fish Influence on Recovery of Injured Species*. This pilot project was designed to investigate prey (forage fish) distribution, abundance, and availability. The 1995 project, *95163 Seabird/Forage Fish Interactions*, merged a group of existing bird and forage fish investigations and proposals to provide an integrated research approach that examined the interactions of seabirds and their prey, the reasons that changes in prey might have occurred, and the consequences for seabirds. The primary hypothesis to be tested is that several seabird species have failed to recover from the *Exxon Valdez* oil spill because of shifts in food supply that may have occurred independently in the marine ecosystem of Prince William Sound and the northern Gulf of Alaska. In 1996 (96163), the project incorporated Cook Inlet study sites, modeling components, and broad ecosystem approaches to address the project objectives. The last year in the field for APEX was 1999, followed by a year of data analysis and production of publications.	X		
Gulf Apex Predator-Prey (GAP) Project	Initiated in 1999, GAP's primary goal is to document trophic relationships between Steller sea lions, their prey, predators, and potential competitors in waters near Kodiak Island, an area of continued sea lion declines and extensive commercial fishing. Broadly, through integrated studies that overlap spatially and temporally, GAP will assess the degree of dietary overlap among Kodiak's sympatric apex predators while exploring processes that drive populations of their prey within a dynamic marine environment. Collectively, GAP studies will indirectly test the hypothesis that Steller sea lions are prey-limited by documenting a) sea lion prey; b) the abundance, distribution, and quality of those prey species; and c) the productivity and health of other consumers of the same prey. GAP studies will also collect baseline data needed to test the hypothesis that predation by killer whales or sharks may be limiting Steller sea lion recovery in the Gulf of Alaska. Additionally, by simultaneously monitoring environmental and oceanographic parameters over time in this area, GAP researchers will test the hypothesis that environmental and oceanographic change affects Steller sea lions, their prey, predators, and potential competitors. Funding from National Marine Fisheries Service (NMFS) in Fiscal Year (FY) 02 will provide continued support of GAP's long-term goals and objectives. Some modifications and additions to the program's previous methodology are proposed in response to FY01 findings. Specifically, seasonal prey surveys will be extended to include waters surrounding Marmot Island, nearshore prey communities will be surveyed on a finer spatial and temporal scale, sea lion use of ephemeral prey resources will be monitored, and the diet and foraging patterns of sympatric harbor seals will be assessed.	X		
Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar	Final Supplemental Environmental Impact Statement (SEIS) for was issued in April 2007, and the Record of Decision (ROD) was issued in August 2007. Under the action, a maximum of four systems would be deployed in the Pacific-Indian ocean area and in the Atlantic-Mediterranean area. Of an estimated maximum 294 underway days per year, the SURTASS LFA sonar would be operated in the active mode about 240 days.	X	X	

Table 4-1: Past, Present, and Planned Future Projects in the GOA (continued)

Project	Project Description	Project Timeframe		
		Past	Present	Future
Knik Arm Crossing (KAC)	The KAC is a proposed bridge across Knik Arm to enhance access between the Municipality of Anchorage and the Matanuska-Susitna Borough (Mat Su) to the northwest. The project sponsor is the Knik Arm Bridge and Toll Authority, a public corporation established by the Alaska State Legislature in 2003 to undertake the permitting, design, financing, construction, and operation of the KAC as a toll road. The bridge crossing could be 8,000 to 14,000 feet long over Knik Arm. The Federal Highway Administration (FHWA), in coordination with the Alaska Department of Transportation and Public Facilities, prepared an EIS addressing the proposal and alternatives (*Knik Arm Crossing Final EIS: FHWA, Dec. 2007)*. This project would primarily affect biological resources, including – depending upon the alternative – wetlands and intertidal habitat.			X
Port MacKenzie Development	Mat Su Borough has been planning to build a deep-water dock facility in the Point MacKenzie area, to facilitate economic development in the borough, for about 30 years. A barge dock was completed in 2000, and a deep-water dock was completed in 2005. In addition to potentially increasing vessel traffic in the Anchorage area, the project could encourage further economic and land development activity.	X		X
Port of Anchorage Expansion	The Port of Anchorage plays a major role in the regional economy, accommodating approximately 75 percent of goods shipped into Alaska. The Port is planning a major expansion of its marine terminal capacity, including road and rail service expansion and redevelopment of the marine terminal. The contracts for initial berth expansion were awarded in early 2008, and construction is projected to occur through 2012 (Port of Anchorage 2008). The expansion project could potentially increase vessel traffic to and from the GOA.			X
Ferry Service for Knik Arm	The Mat Su Borough is developing a ferry link between Port MacKenzie and the Port of Anchorage. The Cook Inlet Ferry is expected to begin operation in summer 2010, accommodating foot passengers, tractor-trailers, and automobiles. Parking facilities and ferry landings are planned on both sides of Knik Arm. While not directly influencing the GOA, the project could increase vessel traffic in the Cook Inlet/Knik Arm area.			X
USARAK Stationing and Training of Increased Aviation Assets	The U.S. Army. Alaska intends to increase and reorganize its rotary-winged aviation assets. An increase in the number of aircraft could result in incremental increases in air pollutant emissions, noise, and airspace congestion.			X
Other Potential Coastal Development	Various commercial, industrial, transportation, and residential development is possible in the coastal areas of Alaska. Mat Su Borough, for example, has discussed building a road/rail connection to Willow; a 200-megawatt (MW) gas-fired power plant has been discussed for Mat Su Borough; residential development has been proposed near various lakes in Mat Su; and assorted growth and development proposals are regularly raised for the greater Anchorage area. These potential coastal developments may gradually reduce terrestrial habitat acreage and introduce pollutants that are associated with urbanization into the air and water.			X

4.1.3 Other Regional Activities, Processes, and Trends

In addition to analyzing those past, present, and planned future projects listed in Table 4-1, a description follows of other activities that were also considered in the cumulative impact analysis.

4.1.3.1 Fishing

Commercial fishing is by far the predominant human activity in the GOA, although a number of fisheries are at very depressed levels or are closed (Richardson and Erickson 2005). Four major commercial fisheries operate in the GOA and vicinity: the groundfish, Pacific halibut, salmon, and scallop fisheries. Several other fisheries occur in the GOA (e.g., Pacific herring, clam, crab, shrimp, sea cucumber, sea urchin, and abalone) in Alaskan State waters (Ashe et al. 2005, Sagalkin 2005, Berceli and Trowbridge 2006, Trowbridge and Goldman 2006). Commercial fisheries that occur in federal waters off southern Alaska are described below. Some of these fisheries are managed federally (by the NMFS and North Pacific Fishery Management Council [NPFMC]), some have their management activities deferred to the State level (Alaska Department of Fish and Game [ADF&G]), and others are jointly managed at the state, federal, or international levels.

The most important commercial fisheries in the GOA are groundfish fisheries. In 2007, the Central regulatory area yielded 71,210 metric tons of groundfish, which equaled approximately 54 percent of the total groundfish catch for the entire GOA. The GOA continental shelf and slope, particularly the wide shelf and banks around Kodiak Island, support a large biomass of groundfish. Groundfish fisheries in the GOA were developed in the late 1970s, and have become a major source of food and income for residents of Alaska, Washington, and Oregon. Groundfish species harvested in the GOA include “target species” such as walleye pollock, Pacific cod, sablefish, Atka mackerel, several species of flatfish and rockfish, and skates. In addition, a number of “other species” are caught, including squids, octopi, sharks, and sculpins. These species are of lesser economic value, and are generally not targeted. Groundfish are often harvested in multispecies complexes, as it is common for several species to be caught at the same time. The groundfish fishery is a complex industry, in that it is conducted across a wide range of habitats using an assortment of fishing gears, including trawls, hook-and-line gear, and pots. In 2002, 824 vessels participated in the groundfish fisheries in the GOA. Of these, 642 were hook-and-line vessels, 131 were pot vessels, and 123 were trawl vessels (NPFMC 2005a).

Commercial fisheries for Pacific halibut are managed by a treaty between the United States (U.S.) and Canada, and through recommendations of the International Pacific Halibut Commission (IPHC). Pacific halibut is considered as one large interrelated biological stock, although it is regulated by subareas through catch quotas, time-area closures, and since 1995 in Alaska, by an individual fishing quota (IFQ) program adopted by the NPFMC and implemented by the NMFS. Commercial catch limits in the GOA, located in IPHC Regulatory Area 3A, are higher than those in other areas of the eastern North Pacific because those waters are believed to be the center of Pacific halibut abundance (NMFS-AKR 2005).

Pacific salmon support numerous commercial, recreational, and subsistence fisheries in Alaskan State waters. However, only a single commercial troll fishery and three historical coastal net fisheries are allowed in federal waters of the Alaska Exclusive Economic Zone (EEZ). All five species of Alaska salmon (chinook, chum, coho, pink, and sockeye) are fully utilized, and stocks in most regions of the State generally have rebuilt to or beyond previous high levels (Clark et al. 2006). Pink and sockeye salmon are the most abundant species in catches in the GOA (Eggers 2004).

Scallop fisheries in the GOA are relatively small compared to the region’s groundfish, halibut, and salmon fisheries. As discussed in Section 3.12.1.1 (Socioeconomics), a major scallop bed in the GOA is located off the coast of Kodiak Island. Individual catch data for the Kodiak beds are not maintained; however the ADF&G states that, between 1998 and 2002, one of the largest harvests came from the

Kodiak area averaging 82 metric tons each year (Woodby et al. 2005). The weathervane scallop is the only commercially exploited scallop stock in the GOA. Weathervane scallop populations were first evaluated for commercial potential in the early 1950s, but it was not until the late 1960s that interest in a fishery off Alaska took shape. Initial commercial fishing effort took place in 1967, when two vessels harvested weathervane scallops from fishing grounds off the east side of Kodiak Island. By the following year, 19 vessels had entered the fishery. Since then, vessel participation and harvests have fluctuated greatly, but have remained below the peak levels experienced in the late 1960s (NPFMC 2005b). All commercial fisheries for scallops take place in the relatively shallow waters of the continental shelf.

Data on recreational and subsistence fishing in the GOA are limited (Richardson and Erickson 2005). Recreational fishing mainly occurs off southeastern Alaska and along the northern Gulf of Alaska coast, including Prince William Sound, Kenai Peninsula, Cook Inlet, and Kodiak Island (Squire and Smith 1977). Fishing derbies for salmon and halibut are regularly held in Seward, Cordova, Homer, and Valdez. Sportfishing charters also routinely operate out of each of these ports. Subsistence fishing primarily occurs in coastal areas to the west and north that are relatively inaccessible to most recreational anglers. Nearly all recreational and subsistence fishing activities occur in State waters, as rough waters are a limiting factor further offshore (Squire and Smith 1977, NPFMC 1990 2005b, NMFS-AKR 2005). As a result, recreational and subsistence fishing are not expected within the GOA.

Commercial fishing can affect fish habitat and managed species. Potential effects of commercial fishing include over-fishing of targeted species and by-catch, both of which affect fish stocks. Mobile fishing gears such as bottom trawls disturb the seafloor and reduce structural complexity. Indirect effects of trawls include increased turbidity, alteration of surface sediment, removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing (i.e., lost fishing gear continuing to ensnare fish and other marine animals), and generation of marine debris. Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats. Recreational fishing could affect fish habitats because of the large number of participants and the intense, concentrated use of specific habitats. Other indirect environmental effects of fishing include water pollution, air pollution from vessel engine exhaust, vessel transit noise, and vessel maintenance, which generates solid and hazardous wastes.

Commercial fishing in Alaska, including the GOA, appears to be a mature industry, with year-to-year variations in total landings of particular species, but no substantial increases in overall landings of commercial fish and other seafood (NMFS 2004, NOAA 2009). The overall numbers of fishing vessels engaged in major commercial fisheries and commercial fishing licenses in Alaska both have declined substantially in the past 8 years (State of Alaska Commercial Fisheries Entry Commission 2008). On the basis of these trends, the level of commercial fishing in the GOA is not expected to increase substantially in the foreseeable future.

4.1.3.2 Commercial and Recreational Marine Traffic

A substantial amount of ocean traffic, consisting of both large and small vessels, transits through the GOA. Vessel traffic in the GOA includes tankers, container ships, roll-on roll-off cargo ships, ferries, fishing boats, cruise ships, military and scientific vessels, whale-watching boats, and recreational watercraft of various sizes and uses. A substantial volume of small craft traffic, primarily recreational, occurs throughout the inland waters of the GOA. Inland waters surrounding the GOA offer other recreational activities, such as kayaking and rafting. Sportfishing is also popular (Outdoor Directory 2008).

Cruise travel along the GOA is a popular recreational activity, and is the fastest growing tourist trade (City Data 2008). With excellent fishing and stunning coastal scenery, many visitors to the GOA choose to tour the area by boat and can choose from single-day to multiday cruises (Travel Alaska 2008).

In addition to large commercial vessels traversing the GOA, the Alaska Marine Highway System (AMHS) provides ferry service for passengers and vehicles between coastal communities (AMHS 2007). The Southwest Alaska route services Prince William Sound, Kodiak Island, the Alaska Peninsula, and the Aleutian Islands. The ferry route closest to the GOA is in Chenega Bay in the Prince William Sound and the town of Kodiak on Kodiak Island. The route is one of the least busy routes, with only 12 sailings in 2007 (AMHS 2007).

Two major ports close to the GOA, Anchorage and Valdez, were ranked in the top 150 U.S. ports by tonnage in 2000 (Research and Innovative Technology Administration/Bureau of Transportation Statistics [RITA/BTS] 2001). Commercially used waterways traverse the GOA, but are controlled by the use of directional shipping lanes for large vessels (cargo, container ships, and tankers). Ships traveling from major ports to the Lower 48 and Hawaii, as well as marine traffic between coastal ports, enter the GOA briefly, but Navy activities are communicated to all vessels and operators by use of Notices to Mariners (NOTMARs).

Commercial vessels are sources of pollutants introduced into the water and air of the GOA. Additionally, commercial vessels are a source of transient noise, affecting the acoustic environment. Finally, commercial vessels are a source of ship strikes on marine mammals, and are implicated in many ship strikes in the GOA. Pleasure boats are sources of fuel leaks and toxins from antifouling paints (National Marine Manufacturers Association [no date], Nichols 1988).

The volumes of commercial and recreational vessel traffic in the GOA are closely tied to conditions in mainland Alaska. The population of Alaska is growing (Western Rural Development Center 2008); ferry services and private recreational fishing and boating are likely to grow in proportion to the increase in population. Additionally, cruise ship traffic and other tourism activities such as whale-watching, fishing charters, and other commercial recreational activities in the GOA are expected to increase in response to increasing demand for outdoor recreational experiences in Alaska (U.S. Fish and Wildlife Service 2009). Based on projections for freight shipments through the Port of Anchorage, freight shipments through Alaskan waters, and thus cargo vessel traffic, are expected to grow about 10 percent every five years (Port of Anchorage 2005). Further energy development in Alaska, such as expansion of Arctic oil fields or new oil and gas developments on the outer continental shelf, by encouraging population and economic growth (Institute of Social and Economic Research 2009), will indirectly increase commercial and recreational vessel traffic. On the basis of the trends mentioned above in population, recreation, and industry, the volume of commercial and recreational vessel traffic in the GOA is expected to increase substantially in the future.

4.1.3.3 Ocean Pollution

Water quality in the GOA is generally considered to be pristine because of the low population densities found in the region, compared to the large amount of shoreline. Water pollution could result from onshore and offshore oil and gas exploration and production, municipal discharges, mining wasters, timber harvesting, vessel traffic, and fish-processing discharges.

Inland contaminated sites may contribute pollutants to coastal waters through surface water. Possible sources include solid and industrial waste landfills, the open burning of solid waste, active and formerly-used defense sites, and federal, state, and privately owned contamination sites. These sites contain a variety of pollutants, with possible contaminants including persistent organic pollutants (POPs), dioxins, petroleum products, heavy metals, pesticides, and radionuclides. Inland pollutants do not substantially affect the quality of offshore waters in the GOA, however, because pollutants flushed into the ocean are rapidly buried in coastal benthic sediments and upwelling of deep oceanic water in the central GOA diverts surface waters away from this area (Sheppard 2000).

POPs are common at low concentrations in the GOA because their physical and chemical properties allow them to persist for long periods in the Arctic environment. POPs in offshore areas of the GOA result primarily from distant sources because POPs can travel large distances in ocean currents and on surface winds (Sheppard 2000). They persist for long periods in the environment, and bioaccumulate in the food chain, causing heath effects in humans and wildlife. Recent sampling of fish in Alaska by ADEC, including from the GOA, however, indicate that concentrations of organic and inorganic contaminants are generally substantially lower than concentrations in fish from other areas (ADEC, no date, Fish Monitoring Program: Analysis of Organic Contaminants; accessed in May 2009). Concentrations of POPs from distant sources are likely to increase in the GOA in the future in response to long-term trends in Pacific Ocean pollution.

Petroleum hydrocarbons may enter the marine environment during exploration, extraction, and transportation of crude oil, natural gas, coal, and coal bed methane resources. Oil may be discharged when it is discovered, during accidental blowouts, and during transportation. Low volumes of oil are continually discharged during the drilling process; drill cuttings and mud, which contain heavy metals and lubricants, are contained in process water that is deposited directly into the marine environment, estuaries, land, or deep injection wells. Process water also may include heavy metals, such as mercury, cadmium, zinc, chromium, and copper. Benthic infauna can be impacted within 15 square kilometers (km^2) of an oil rig due to disposal of water-based muds. The State of Alaska and the federal government are expanding their oil and gas leasing program in Alaska for exploration and extraction to meet the nation's energy demands, but there are no planned leases in either GOA or Kodiak planning areas (Minerals Management Service 2009).

Marine water quality in the GOA is also affected by air pollution and emissions of greenhouse gases (GHGs). Air pollutants adhere to or are absorbed by water droplets, and are rained out of the atmosphere during precipitation events, which transport these pollutants into the GOA. GHGs, especially CO_2, are absorbed into ocean surface waters and, through downwelling, mixed into deeper waters. Marine waters near the poles have a greater capacity for dissolving carbon dioxide than do waters in the tropics, making them more susceptible to ocean acidification (Congressional Research Service 2009). A study of ocean acidification released in September 2009 indicates, based on monitoring data collected by instrumented buoys, that the acidity of GOA marine waters has increased by about 25 percent from its pre-industrial level (University of Alaska, Fairbanks 2009). Based on current trends in atmospheric GHG concentrations and the known characteristics of arctic marine waters, the quantities of GHGs absorbed by ocean waters and ocean acidity are expected to increase in the foreseeable future.

Cruise ships are a substantial source of water pollutants because of the large number of passengers and the hazardous wastes generated. For example, a typical cruise ship produces 15 tons of garbage, 170,000 gallons of gray water, 21,000 gallons of sewage, and 5,000 gallons of oil-contaminated water per day (USEPA 2008). The amount of pollutants is similar to a small city, and the cruise industry is expanding. The cruise ship industry in North America has been growing at an annual rate of about five percent, and the future outlook for the industry in Alaska is for continued slow long-term growth.

Overall, to summarize the discussion above, based on long-term regional trends and anticipated developments, water quality in the GOA is expected to degrade slowly over time.

4.1.3.4 Scientific Research

There are currently scientific research permits and General Authorizations for research issued by the NMFS for cetacean work in the wild in the North Pacific. The most invasive research involves tagging or biopsy, while the remainder focuses on vessel and aerial surveys and close approach for photo-identification. NMFS has also issued General Authorizations for commercial photography of non-listed marine mammals, provided that the activity does not rise to Level A harassment of the animals. These authorizations are usually issued for no more than 1 or 2 years, depending on the project.

The impacts of this type of research are largely unmeasured. However, given the analysis and scrutiny given to permit applications, it is assumed that any adverse effects are largely transitory (e.g., inadvertent harassment, biopsy effects). Data to assess population level effects from research are not available. Even if data were available, it is uncertain that research effects could be separately identified from other adverse effects on cetacean populations. Levels of research-related vessel and aircraft activities in the GOA are assumed to remain relatively unchanged for the foreseeable future.

4.1.3.5 Commercial and General Aviation

Ted Stevens Anchorage International Airport is the primary airport that services the GOA region. Other primary airports in Alaska, but outside of the GOA region, include Fairbanks International Airport, Juneau International Airport, and Ketchikan International Airport. Numerous other commercial and smaller general aviation airports are located throughout the GOA region, and add to the increase in low-altitude traffic.

Private aviation is an important and basic mode of transportation in Alaska because approximately 90 percent of Alaska is not served by roads. Alaska has six times as many pilots per capita and 16 times as many aircraft per capita as the rest of the United States. Aircraft operating under visual flight rules (VFR) can fly along the Alaska coast, largely unconstrained, except by safety requirements and mandated traffic flow requirements. Aircraft operating under instrument flight rules (IFR) clearances authorized by the FAA normally fly on the airway route structures. These routes include both high- and low-altitude routes between neighboring airports. When Warning Area (W)-612 is active, aircraft on IFR clearances are precluded from entering the Warning Area by the FAA. However, since W-612 is located entirely over international waters, nonparticipating aircraft operating under VFR are not prohibited from entering the area. Examples of aircraft flights of this nature include light aircraft, fish spotters, and whale watchers.

The intensity of commercial air traffic and private aviation in Alaska is expected to increase somewhat in the future (ADEC 2008), due to increases in the resident population (Western Rural Development Center 2008), increased summer tourism (U.S. Fish and Wildlife Service 2009), and increased air cargo shipments (Alaska Department of Labor and Workforce Development 2005).

4.1.4 Habitats of Migratory Marine Animals and Sea Turtles

Migratory or wide-ranging marine mammals and sea turtles that may be present in the GOA may be affected by natural events and anthropogenic activities that occur in areas far removed from Alaska waters, on breeding grounds, migration routes, wintering areas, or other habitats within a species' range. Events and activities that affect the habitats and populations of these marine species outside the GOA include the following:

- Disease
- Natural toxins
- Weather and climatic influences
- Navigational errors
- Natural predation
- Fishing
- Hunting (including sea turtle egg predation)
- Ocean pollution

- Habitat modification or destruction
- Commercial shipping, fishing, and other vessel traffic
- Scientific whaling

These stressors on marine habitats in migratory wintering areas and on marine mammals and sea turtles when those animals are outside the GOA are discussed in detail in Section 3.8. In general, both natural and anthropogenic factors affect the health of marine mammal populations.

4.2 CUMULATIVE IMPACTS ANALYSIS

The cumulative impacts of training activities over land were previously analyzed in Section 1.6.2.1 and Appendix L of the *Alaska MOA EIS* (USAF 1995); Section 3.0 and Appendix C of the *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007); Sections 3.18, 4.18, and 4.23 of the *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999); and Sections 3.12, 4.12, and 9.3 of the *Transformation of U.S. Army Alaska FEIS* (Army 2004). The nature and extent of training on Air Force and Army inland training lands has not changed substantially during the past five years, and is not expected to change substantially in the foreseeable future (with the exception of the USARAK Stationing and Training of Increased Aviation Assets included in Table 4-1).

4.2.1 Air Quality

4.2.1.1 Air Pollution

The offshore area of the GOA has few sources of air pollutants and good atmospheric ventilation. The intensity of ocean uses, and correspondingly the density of air pollutant sources, generally declines with increasing distance from the coast. Air pollutant sources affecting air quality in the GOA are primarily mobile sources such as vessels and aircraft. Commercial ocean industries, such as fishing and ocean transport, are dispersed over broad areas. Typical air pollutants include engine exhaust gases and process emissions from fishing vessels or other ocean vessels. Local meteorological conditions and atmospheric transport processes disperse these emissions over a large area. Because most of the GOA (that portion more than 3 nautical miles [nm] from the coast) is beyond the jurisdiction of the State of Alaska, no emissions inventory for the GOA is available. The air quality of Pacific Ocean offshore waters generally is relatively high, however, indicating that current air pollutant emissions in the region are generally not causing substantial adverse effects.

Air pollutant concentrations in the GOA will likely increase in the future. Some of the projects listed in Table 4-1 (bridge and port projects) are expected to increase vessel traffic, with attendant increases in air pollutant emissions. The expected regional trends in fishing (Section 4.1.3.1), marine traffic (Section 4.1.3.2), and commercial aviation (Section 4.1.3.3) also are expected to increase air pollutant emissions. New coastal development (see Table 4-1), especially large point sources such as power plants or extractive industries could – depending upon their locations relative to the GOA – contribute to increased levels of air pollutants. The degree to which these activities will cumulatively increase regional air pollutant concentrations is not known; current aircraft and vessels are more fuel-efficient than in the past, and these design trends are expected to continue due both to the increased cost of fossil fuels and to the imperative to reduce emissions of GHG. Under any foreseeable scenario, however, increases in air pollutant emissions in the GOA region would not be sufficient to measurably degrade air quality within the GOA. Therefore, past, present, and reasonably foreseeable activities in the GOA, including the Proposed Action, would not have a cumulatively significant impact on regional air quality.

4.2.1.2 Greenhouse Gases

<u>Greenhouse Gases</u>

It has been generally accepted in the scientific community that anthropogenic emissions of GHG over the past century, in the aggregate, have led to increasing global air temperatures. GHG, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases, have a propensity to trap heat in the atmosphere. CO_2 is the predominant greenhouse gas emitted by human activities, primarily from the combustion of fossil fuels such as coal, oil, and natural gas. The observed increase in average global air temperatures since the mid-20th Century is very likely a result of increased atmospheric concentrations of GHG (Intergovernmental Panel for Climate Change [IPCC] 2007). This phenomenon is commonly referred to as "global warming." Global warming due to GHG emissions induces climate change through the complex interaction of increased temperature with various natural processes such as ocean and atmospheric circulation. Effects of climate change in turn create complex feedback loops, such as loss of reflective snow and ice cover, that increase the rate of climate change. Scientists are now in general agreement that climate change is occurring (American Meteorological Society 2007, Alaska State Legislature 2008), and that current trends are very likely to continue unless worldwide emissions and atmospheric concentrations of CO_2 and other GHG are substantially reduced (Ledley et al 1999, Energy Information Agency 2008).

Climate Change

As noted by the IPCC, climate change in the Arctic over the last half-century has been well documented. Alaska's climate has warmed by about 4°F (2.2°C) since the 1950s, and about 7°F (3.9°C) in interior Alaska during the winter. The State experienced a 30-percent average increase in precipitation between 1968 and 1990. The growing season has lengthened by about two weeks. Changes in the climate of Alaska have had several direct and indirect effects on animals, indigenous peoples, and coastal communities. Among the effects are rising air and ground temperatures, loss of sea ice, loss of protection from fall storms, and retreat of the permafrost boundaries. Sea ice has retreated by about 14 percent since 1978, and thinned by 60 percent since the 1960s, resulting in widespread effects on marine ecosystems, coastal climates, and human settlements. Permafrost has melted, causing erosion, landslides, and damaged infrastructure in central and southern Alaska. Recent warming has been accompanied by increases in forest disturbances, including insect infestations. A sustained infestation of spruce bark beetles, limited in the past by low temperatures, has caused widespread tree mortality over 2.3 million acres (906,000 hectares) on Kenai Peninsula since 1992, the largest loss of trees to insects ever recorded in North America (IPCC 2007).

Effects of climate change on Arctic marine mammals are poorly understood, due to lack of integrated baseline data (Burek et al., 2008). This lack of data on health, diseases, and toxicant effects in Arctic marine mammals severely limits our ability to predict the effects of climate change on marine mammal health. The overall health of an individual animal is the result of complex interactions among immune status, body condition, pathogens and their pathogenicity, toxicant exposure, and the various environmental conditions that interact with these factors. Climate change could affect these interactions in several ways. There may be direct effects of loss of the sea ice habitat, elevations of water and air temperature, and increased occurrence of severe weather. Some of the indirect effects of climate change on animal health will likely include alterations in pathogen transmission due to a variety of factors, effects on body condition due to shifts in the prey base/food web, changes in toxicant exposures, and factors associated with increased human habitation in the Arctic (e.g., chemical and pathogen pollution in the runoff due to human and domestic-animal wastes and chemicals and increased ship traffic with the attendant increased risks of ship strike, oil spills, ballast pollution, and possibly acoustic injury). The extent to which climate change will impact marine mammal health will also vary among species, with some species more sensitive to these factors than others. Baseline data on marine mammal health parameters along with matched data on the population and climate change trends are needed to document these changes (Burek et al., 2008).

Ocean Acidity

It has been posited that the continued emission of CO_2 is resulting in seawater becoming more acidic as CO_2 from the atmosphere dissolves in the oceans. Ocean acidification from the invasion of CO_2 is a recognized phenomenon (Cicerone et al. 2004, Feely et al. 2004, Sabine et al. 2004). Scientists estimate that the oceans are now about 25 percent more acidic than they were at the start of the industrial revolution about 300 years ago.

The negative effects of ocean acidification are likely to be felt on biological processes such as calcification (Orr, et al. 2005, Kleypas et al. 2006). Ocean acidification from CO_2 invasion and reduced ventilation also may result in decreases in sound absorption for frequencies lower than 10 kHz (Hester et al. 2008). This would result in increases in ambient noise levels in ocean environments, and enhanced propagation of anthropogenic sound. The scale of potential acidification is presently unknown, due to lack of data and challenges associated with sampling on a basin-wide or regional scale. While this phenomenon is under study (cf. Hester et al. 2008), the effects of CO_2 emissions on ocean acidity and the resultant potential for enhanced sound propagation remain indeterminate due to incomplete information.

The cold water and broad, shallow continental shelves bordering the GOA could make this area more susceptible to acidification than warmer portions of the ocean. The colder the water, the higher its dissolved gases content; cold water absorbs more CO_2 than warm water. The vast shallow continental margins around the GOA also could maintain higher concentrations of CO_2 because there is less mixing of surface layers with deeper ocean waters (University of Alaska 2009). Atmospheric CO_2 concentrations are expected to increase, at least in the near-term, and increases in ocean acidity are expected to generally reflect those increases.

Cumulative Effects

The potential effects of proposed GHG emissions are by nature global and cumulative impacts, as individual sources of GHG emissions are not large enough to have an appreciable effect on climate change. Therefore, an appreciable impact on global climate change would only occur when proposed GHG emissions combine with GHG emissions from other man-made activities on a global scale.

Currently, there are no formally adopted or published NEPA thresholds of significance for GHG emissions. Formulating such thresholds is problematic, as it is difficult to determine what level of proposed emissions would substantially contribute to global climate change. Therefore, in the absence of an adopted or science-based NEPA significance threshold for GHGs, this EIS compares GHG emissions that would occur from the Preferred Alternative to the U.S. GHG baseline inventory of 2006 to determine the relative increase in proposed GHG emissions.

CO_2, N_2O, and CH_4 are generated during Navy training activities primarily through combustion of fossil fuels by vessels, aircraft, and energetic or powered training items (e.g., missiles, bombs). For purposes of determining the project contribution to global climate change, all GHG emitted during a training exercise are included. For ease of expression, the amounts of GHG other than CO_2 are added to the total amount of CO_2 to produce a single CO_2-equivalent ($CO_{2\text{-}e}$) value.

On a per-molecule basis, N_2O and CH_4 have more effect on global climate change than CO_2. Therefore, these values are weighted based on their Global Warming Potential (GWP) relative to CO_2. The GWP of N_2O is 310 and the GWP of CH_4 is 21. Thus, the calculation of $CO_{2\text{-}e}$ is:

$$CO_{2\text{-}e} = CO_2 + 310*N_2O + 21*CH_4$$

Navy training activities in the TMAA under the No Action Alternative will generate an estimated 22,000 TPY of $CO_{2\text{-}e}$. This amount is approximately 0.0003 percent of the nationwide GHG emissions in 2006 (USEPA 2008).

Navy training activities in the TMAA under Alternative 1 would generate an estimated 23,171 TPY of CO_{2-e}, an increase of about 1,200 TPY over that generated under the No Action Alternative. The amounts of GHG emitted under Alternative 1 are approximately 0.0003 percent of the nationwide GHG emissions in 2006 (USEPA 2008).

Navy training activities in the TMAA under Alternative 2 would generate an estimated 48,530 TPY of CO_{2-e}, an increase of 26,530 TPY over that generated under the No Action Alternative. This amount is approximately 0.0007 percent of the nationwide GHG emissions in 2006 (USEPA 2008).

Table 4-2 summarizes the annual GHG emissions associated with implementation of the Preferred Alternative. Under any of the alternatives, the contribution of the Proposed Action to national GHG emissions, and thus to climate change and ocean acidity, would be insignificant.

Table 4-2: Annual GHG Emissions

Scenario	Emissions, tons/year[1]			
	CO_2	N_2O	CH_4	CO_{2-e}
Alternative 2 (Preferred Alternative)	47,881	1.6	7.9	48,530
U.S. 2006 Baseline Emissions (10^6 metric tons)[2]	-	-	-	7,054.2
Preferred Alternative Emissions as a % of U.S. Emissions	-	-	-	0.0007

Notes:
1 $CO_{2-e} = (CO_2 * 1) + (CH_4 * 21) + (N_2O * 310)$.
2 (USEPA 2008)

Navy Stewardship

In response to concerns over climate change, Department of the Navy leadership has initiated broad programs to reduce energy consumption and shift energy demand to renewable and alternative fuels to the extent consistent with its national security mission, thereby reducing emissions of CO_2 and other GHG. The Navy has implemented a number of shore installation and fleet programs that have substantially reduced the generation of GHG, primarily through conservation of fossil fuels and electricity.

Ashore, the Navy has aggressively encouraged its installations to reduce energy costs, both through facility competitions and through investments in solar, wind, and geothermal technologies. Since 1985, the Navy has sponsored a world-wide energy management program that has reduced its energy use by more than 29 percent (Naval Facilities Engineering Command [NAVFAC] Public Affairs, 10/26/2005). At Pearl Harbor, for example, the installation of approximately 2,800 energy-efficient light fixtures has reduced electricity use by about 758 megawatt-hours (MWh) per year, equal to 448 tons per year (TPY) of CO_2 emissions (NAVFAC Public Affairs, 3/18/2008). New air conditioning chillers also installed at this installation will save another 252 MWh of electricity per year, equal to about 149 TPY of CO_2 emissions. Implementing similar energy conservation measures at Navy shore installations world-wide has substantially decreased the Navy's carbon footprint, and the Navy continues to identify new energy conservation measures.

Energy conservation aboard Navy vessels at sea also has achieved substantial reductions in fuel consumption, and thus emissions of GHG. Naval Sea Systems Command has established an Energy Conservation Awards Program to reward leading fuel conservers among underway surface ships with special recognition and cash incentives, During the first half of 2009, this program reduced the Navy's fuel consumption by about 682,000 barrels, or about 346,000 tons of CO_2 emissions (Navy News Service 5/14/2009).

The Navy also is researching and implementing new technologies that may result in substantial additional fuel savings. The new amphibious assault ship Makin Island, using a new hybrid power propulsion system, saved an estimated 900,000 gallons of fuel (equal to about 11,000 tons of CO_2) on its initial voyage from the Gulf of Mexico to San Diego. As new Navy ships are placed into service and older ships are retired, the overall fuel efficiency of the Navy's fleet will substantially increase. The Navy also is investigating new hull-cleaning technologies that could substantially reduce drag from fouling of vessel hulls by marine organisms, potentially saving millions of gallons of fuel per year. Finally, the Navy is investigating the use of biofuels such as camelina oil to power its ships and aircraft; camelina jet biofuel produces 80 percent less carbon emissions than conventional jet fuels (Scientific American on line, September 14, 2009).

These examples illustrate the Navy's leadership role in achieving large-scale energy reductions that will substantially contribute to a long-term national effort to mitigate global climate change.

4.2.2 Expended Materials

Cumulative impacts of expended materials on ocean resources would consist of the effects of the Proposed Action in combination with the other past, present, and future actions and activities listed in Sections 4.1.2 and 4.1.3 that would expend hazardous and nonhazardous materials in offshore areas of the GOA, or that would affect the regional hazardous waste management system.

4.2.2.1 Materials Expended in the GOA

The international waters offshore of the GOA are considered to be relatively pristine. Overall, the quality of offshore Pacific Ocean waters and bottom sediments offshore are relatively high, indicating that local releases of hazardous materials are generally not causing substantial adverse effects. There is no central point of contaminant discharge, but the intensity of ocean uses, and correspondingly the density of hazardous materials discharges, generally declines with increasing distance from the coast. Commercial ocean industries, such as fishing and ocean transport, are dispersed over broad areas of the Pacific Ocean. Relevant activities would include releases of hazardous constituents from fishing vessels or other ocean vessels. Ocean currents and sediment transport processes disperse the released materials over a large area.

Quantities of solid wastes and other manmade materials deposited in the GOA each year are expected to remain at about current levels. Fishing gear is likely the largest component of expended materials, and the intensity, duration, and geographic range of fishing activity in the GOA are unlikely to substantially increase, as discussed in Section 4.1.3. Commercial, scientific, and recreational vessel traffic are expected to increase substantially as a result of the projects described in Section 4.12 (e.g., port expansion, ferry service) and the regional processes and trends described in Section 4.13, but these ocean users typically do not discard large quantities of materials in the ocean. Coastal development (see Table 4-1) could increase deposition of manmade materials in coastal areas, but such materials are not likely to be transported into the GOA in substantial quantities. No hazardous materials or wastes are expected to be deposited in State or federal waters, in the absence of upset conditions such as a natural disaster, and deposition of hazardous materials or wastes in international waters of the GOA is expected to be negligible. Most of the expended materials deposited in the GOA are denser than seawater and inert, and thus persist for long periods on the ocean bottom, but because of their inert character they have little effect on benthic organisms or resources. Overall, the cumulative impacts on GOA ocean resources of manmade materials expended by past, present, and reasonably foreseeable actions, projects, and activities, including the Proposed Action, would be less than significant.

4.2.2.2 Hazardous Materials Management

The current and reasonably foreseeable projects and activities described in Sections 4.1.2 and 4.1.3 will result in increased numbers of aircraft and vessels in the GOA. The quantities of hazardous materials used and hazardous wastes generated by these activities, and subsequently sent to hazardous waste management facilities in the region, are anticipated to be relatively small. Construction of new infrastructure in coastal areas and expansion of port facilities (see Table 4-1) likely will generate substantial quantities of hazardous wastes requiring disposal. While the regional costs for hazardous waste transport, treatment, storage, and disposal could increase substantially in response to increased cumulative demand, the hazardous waste management industry generally has sufficient physical capacity to respond to this increased demand. Past, present, and reasonably foreseeable projects and activities in the GOA region thus will not have a cumulatively significant impact on the hazardous waste management industry or the environment.

Navy vessels engaged in training activities under the Proposed Action would offload used hazardous materials to the Navy shore facilities at their home ports, where the used materials would become part of the overall hazardous waste stream managed by the appropriate Navy facility. Increased levels of training would result in increased throughput of hazardous wastes, but likely would not require additional storage, transport, or disposal facilities ashore for these materials. The Navy's hazardous waste management system and procedures are adequate to accommodate an increase in hazardous waste volumes. While the costs for hazardous waste transport, treatment, storage, and disposal could increase substantially in response to increased cumulative demand, the hazardous waste management industry generally has sufficient physical capacity to respond to this increased demand.

4.2.3 Water Resources

Cumulative impacts on water resources would consist of the effects of the Proposed Action in combination with other past, present, and reasonably foreseeable actions (as listed in Sections 4.1.2 and 4.1.3). Marine hydrology, marine water quality, deposition of sediment or debris, or public uses of State or federal waters could be affected by these actions and continuing activities, possibly to a significant degree.

Some of the major infrastructure projects planned for the region, such as the Knik Arm Crossing, Port MacKenzie development, Port of Anchorage expansion, and new ferry service (see Table 4-1) could affect ocean water quality near the coast. New coastal development could release urban pollutants, such as oils and grease, that would be flushed into coastal waters. As discussed in Section 4.1.3.3, however, such pollutants do not substantially affect the quality of ocean waters in the GOA because they are rapidly buried in coastal benthic sediments and upwelling of deep oceanic water diverts surface waters away from the GOA.

Anticipated future activities within the GOA, however, could affect water quality there. Expansion of oil and gas leases in the GOA could increase releases of petroleum products, heavy metals, and drilling muds. Increased commercial, scientific, and recreational vessel traffic, especially cruise ships, would increase releases of gray water and oil and grease. Compliance with federal and state regulations, where they apply, would limit the release of such pollutants to *de minimis* amounts. Concentrations of POPs originating from outside the GOA also would increase. These activities and processes are expected to have cumulative but non-significant effects on ocean water quality. The degree of degradation in the foreseeable future is not anticipated to be substantial, except perhaps for ocean acidification (see Section 4.2.1.2), and GOA waters are expected to continue to be relatively pristine. The amounts of materials expended in the ocean by the Proposed Action would not alter these conditions, as described in Section 3.3.2. Therefore, cumulative impacts on ocean water resources from implementation of the Proposed Action, in combination with past, present, or planned projects and other activities within the GOA, would not be significant.

4.2.4 Acoustic Environment (Airborne)

Cumulative impacts on the acoustic environment would consist of the effects of the Proposed Action in combination with other past, present, and reasonably foreseeable actions (as listed in Sections 4.1.2 and 4.1.3). To the extent that the aggregate effects of these actions and activities increased long-term average or short-term peak sound levels in the GOA or otherwise resulted in long-term degradation of the acoustic environment of the GOA, those cumulative effects could be significant.

Environmental noise in the GOA primarily results from transportation and resource extraction activities. Aircraft noise that exceeds background sound levels typically occurs under airport approach / departure corridors and under air traffic patterns near an airfield. As aircraft gain altitude, their noise contribution at ground level decreases, eventually merging with the background noise level. Commercial airliners and private planes traversing the GOA at a cruise altitude generally are not audible at the surface. Therefore, these sources can be excluded from the cumulative acoustic environment analysis.

Commercial ship traffic and fishing activities contribute occasional, short-term noise in the GOA. The airborne sounds they generate include steady low- to moderate-level passby noise, which from the standpoint of a fixed observer is a short-term event, and occasional short-term intrusive noise events in different locations at different times. In a region as large as the GOA, vessels do not often pass near each other, so these noise events seldom overlap in time or location. Thus, these discrete noise events generally are not additive, and produce no cumulative effect.

The intensity and geographical extent of fishing activities are expected to remain about the same for the foreseeable future, as discussed in Section 4.1.3. The projects described in Section 4.1.2 (e.g., port development and expansion); however, are expected to increase vessel traffic in the GOA, and commercial vessel traffic is generally expected to increase over time (see Section 4.1.3.2). Numbers of low-flying commercial and private aircraft (e.g., small planes, fish spotters, whale watchers) are expected to increase, as described in Section 4.1.3.5. The Proposed Action also would increase the numbers of intrusive noise events in the GOA. This generally more-intense use of the GOA is expected to increase the number of intrusive noise events and the potential for two or more sound events to overlap. Because the GOA is a very large geographic area and vessels and aircraft are not often near each other, however, the potential for overlapping sound events would remain low. Peak and average noise levels at a specific location would remain largely unchanged. Accordingly, cumulative impacts on the marine noise environment would be less than significant.

4.2.5 Marine Plants and Invertebrates

The GOA is among the world's most productive marine regions, supporting large and relatively healthy populations of phytoplankton, zooplankton, and commercially valuable pelagic and benthic invertebrates. At present, water quality is relatively high which supports the productivity of the GOA region.

Cumulative projects and processes affecting future marine conditions in the GOA (see Sections 4.1.2 and 4.1.3) include increased vessel traffic as a result of port development (see Table 4-1) and increased resident populations; increased runoff of sediments and urban pollutants from new coastal development (see Table 4-1); and continuing seabed damage, water pollution, deposition of debris, and underwater noise from fishing and other vessel operations. Future climate change is expected to increase average ocean water temperature, increase CO_2 concentrations, and increase acidity. Potential effects on marine plants and invertebrates in the GOA include long-term changes in species abundance or diversity, loss or degradation of sensitive habitats, and adverse effects to rare species. In addition, marine invertebrates may experience direct mortality or injury from commercial fishing operations or other resource extraction industries (e.g., oil and gas development). Plant and invertebrate populations may both experience long-term changes in abundance and diversity as a result of climate change and ocean acidification. Cumulative effects on marine plants and invertebrates are expected to be less than significant in the foreseeable future.

The Proposed Action was evaluated for long-term effects on marine communities that would result from explosions based on their force, location, and proximity to the bottom. Based on the short duration of annual training activities and the analysis presented in Section 3.5, the Proposed Action would not result in long-term changes in species abundance or diversity, loss or degradation of sensitive habitats, or effects on threatened and endangered species. The Proposed Action would not affect the sustainability of marine resources, the regional ecosystem, or the human community. Therefore, the Proposed Action would not contribute substantially to the cumulative effects on marine plants and invertebrates resulting from past, present, or planned projects and other activities within the GOA.

4.2.6 Fish

The GOA is a highly productive region for various fish populations, largely as a result of a rich population of microscopic organisms that form the basis of the food chain. The GOA also is an important spawning area for many fish species, supporting a diverse array of fish larvae. The fish fauna in offshore portions of the GOA is dominated by large epipelagic species, and offshore areas provide the principal feeding habitat for many species.

Current and anticipated future projects and ongoing processes in the GOA region, particularly port development and new coastal development, as described in Table 4-1, and general population growth in Alaska, would increase vessel traffic through the GOA. Increased vessel traffic would, in turn, incrementally increase marine pollution, including the frequency and extent of underwater noise. Coastal development could increase the amount of sediments and urban pollutants released into coastal waters but, due to the circulation patterns of the GOA, such releases probably would not affect water quality in the GOA. Ongoing commercial fishing operations would affect commercially valuable fish species and ongoing recreational fishing could affect populations of game fish, although proper management of these industries would prevent any substantial declines in fish populations. Ocean bottom disturbance and damage from fish trawls would continue; recovery of these areas is very gradual, so degradation of the ocean floor and attendant loss of habitat for some fish species is cumulative within the foreseeable future. Climate change and ocean acidification (see Section 4.2.1.2) may alter prey abundance and distribution, or alter the distribution and abundance of competitors and predators. With the possible exception of climate change and ocean acidification, the long-term effects of which are not well understood, the cumulative impacts of past, present, and reasonably foreseeable projects and processes in the GOA would be less than significant.

Potential contributions of Navy training exercises to cumulative impacts on fish include releases of chemicals into the ocean, introduction of debris into the water column and onto the seafloor, mortality and injury of marine organisms and fish near the detonation or impact point of ordnance or explosives, and physical and acoustic impacts of vessel activity. Based on the short duration of the Proposed Action and the analysis provided in Section 3.6, impacts on fish from explosions would have a low potential for occurrence. Disturbance of the water column would be short-term and local, while disturbance of benthic habitats would be unlikely due to the water depths where training activities occur. Habitat disturbance and fish injury and mortality from explosions are reduced by Navy mitigation measures (Section 3.6). No long-term changes in species abundance or diversity and no loss or degradation of sensitive or critical habitats are anticipated. The overall contribution of the Proposed Action to cumulative impacts on fish stocks in the GOA would be negligible.

4.2.7 Sea Turtles

The only species of sea turtle expected to occur regularly in the GOA is the leatherback turtle, which is globally distributed, although likely low in number in the GOA. Adult leatherbacks can tolerate a wide range of water temperatures, and have been sighted along the west coast of the United States as far north as the GOA. Leatherback turtles appear to forage in the GOA in limited numbers, but no nesting grounds are located in the region. Leatherback turtles are endangered throughout their range (National Oceanic and Atmospheric Administration [NOAA] 2007).

Leatherback turtle populations can be affected both directly and indirectly by human activities. Incidental "take" in fishing operations, or bycatch, is one of the most serious direct threats to sea turtle populations. In the Pacific, NMFS requires measures (e.g., gear modifications, changes to fishing practices, and time/area closures) to reduce sea turtle bycatch in the Hawaii- and California-based pelagic longline fisheries and the California/Oregon drift gillnet fishery. In 2000, an estimated 50,000 leatherbacks were incidentally taken in worldwide as pelagic longline bycatch (Lewison et al. 2004).

Sea turtles also can ingest marine debris or become entangled in debris (e.g., tar balls, plastic bags, plastic pellets, balloons, and ghost fishing gear). Marine pollution from coastal runoff, marina and dock construction, dredging, aquaculture, oil and gas exploration and extraction, increased underwater noise, and boat traffic can also degrade marine habitats used by sea turtles. In addition, sea turtles swimming or feeding at or just beneath the surface of the water are vulnerable to boat and vessel strikes, which can result in serious propeller injuries and death. Global warming could affect all aspects of a leatherback turtle's life cycle, as well as the abundance and distribution of its prey.

Current and anticipated future projects that increased the volume of vessel traffic (see Table 4-1) and ongoing processes that increased the volume of marine vessel traffic (see Sections 4.1.3.1, 4.1.3.2, and 4.1.3.4) would increase the potential for vessel strikes and increase the volume of marine debris. Bycatch from fishing operations would not change substantially because the intensity and extent of fishing operations in the GOA are not expected to change, as discussed in Section 4.1.3.1. Marine pollution, including the frequency and intensity of underwater noise, is expected to increase in response to increased vessel traffic and increased coastal development. Climate change (see Section 4.2.1.2) may alter prey abundance and distribution, or alter the distribution and abundance of competitors and predators. These anticipated future conditions are generally not expected to substantially affect the level of foraging by leatherback turtles in the GOA, although climate change may result in a northward expansion of sea turtle foraging activity. Thus, cumulative impacts on leatherback turtles in the GOA, including those of the Proposed Action, would be less than significant. Additionally, the incremental effects of the Proposed Action would not substantially contribute to the cumulative impacts on leatherback turtles.

4.2.8 Marine Mammals

During the past few decades, marine mammal mortalities have increased in association with a variety of human activities (Geraci et al. 1999, NMFS 2007a) (Figure 4-1). These activities include fisheries interactions (bycatch, directed catch), ship strikes (Laist et al., 2001) pollution (marine debris, toxic compounds), habitat modification (degradation, prey reduction), and gunshots. Other concerns include entanglement, underwater noise, and climate change, and associated changes in the physical characteristics and chemistry of marine waters, and other environmental factors. Potential cumulative impacts of past, present, and reasonably foreseeable future projects and activities (Sections 4.1.2 and 4.1.3) on marine mammals would result primarily from increased commercial and recreational vessel traffic (underwater noise, ship strikes, air and water pollutants), as discussed in Table 4.1 and Section 4.1.3.2, and ongoing commercial fishing (bycatch, entanglement, prey reduction, marine debris, and habitat degradation), as discussed in Section 4.1.3.1.

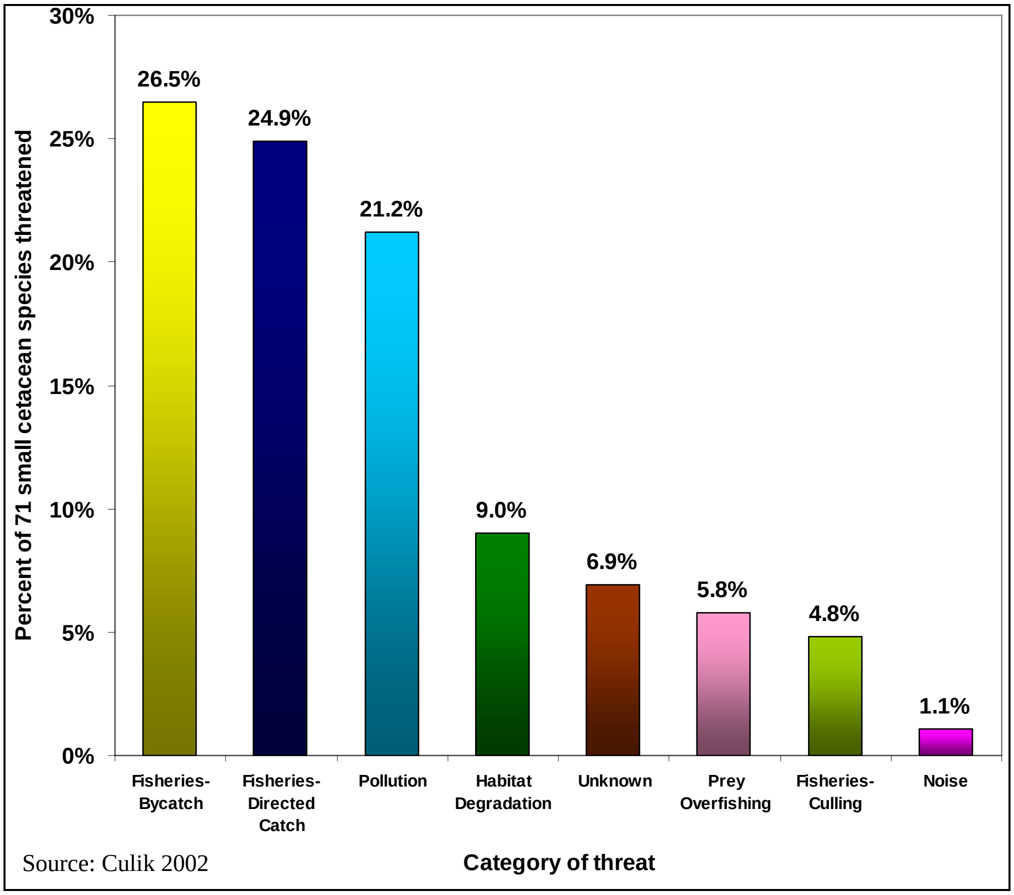

Figure 4-1: Human Threats to World-wide Small Cetacean Populations

4.2.8.1 Fisheries Interaction: By-Catch, Directed Catch, and Entanglement

The incidental catch of marine mammals in commercial fisheries is a significant threat to the survival and recovery of many populations of marine mammals (Geraci et al. 1999, Baird et al. 2002, Culik 2002, Carretta et al. 2004, Geraci and Lounsbury 2005, NMFS 2007a). Interactions with fisheries and entanglement in discarded or lost gear continue to be a major factor in marine mammal deaths worldwide (Geraci et al. 1999, Nieri et al. 1999, Geraci and Lounsbury 2005, Read et al. 2006, Zeeberg et al. 2006). For instance, baleen whales and pinnipeds have been found entangled in nets, ropes, monofilament line, and other fishing gear that has been discarded out at sea (Geraci et al. 1999, Campagna et al. 2007).

Bycatch- Bycatch is the catching of non-target species within a given fishing operation and can include non-commercially used invertebrates, fish, sea turtles, birds, and marine mammals (NRC 2006). Read et al. (2006) attempted to estimate the magnitude of marine mammal bycatch in U.S. and global fisheries. Within U.S. fisheries, between 1990 and 1999, the mean annual bycatch of marine mammals was 6,215 animals. Eighty-four percent of cetacean bycatch occurred in gill-net fisheries, with dolphins and porpoises constituting most of the cetacean bycatch (Read et al. 2006). Over the last decade marine mammal bycatch declined by 40 percent, primarily in response to conservation measures that were implemented during this period. Based on the mature state of the Alaskan fishing industry and the continuing implementation of conservation measures, the amount of marine mammal bycatch associated with commercial fishing in the GOA is expected to remain steady or decline slightly in the future. The Proposed Action would have no direct or indirect effects on the level of fisheries bycatch in the GOA.

Entanglement- Entanglement in active fishing gear is a major cause of death or severe injury among the whale species in the GOA. Entangled marine mammals may drown, escape with pieces of gear still attached to their bodies, or be set free either by their own efforts or by fishermen. Many large whales carry off fishing gear after becoming entangled (Read et al. 2006). When a marine mammal swims off with gear attached, the result can be fatal. The gear may be too cumbersome for the animal or it may be wrapped around a crucial body part and tighten over time. Stranded marine mammals frequently exhibit signs of previous fishery interaction, such as scarring or gear attached to their bodies. Deaths of stranded marine mammals often are attributed to such interactions (Baird and Gorgone 2005). Marine mammals that die from fisheries interactions may not wash ashore and not all animals that do wash ashore exhibit clear signs of interactions, so data probably underestimate fishery-related mortality and serious injury (NMFS 2005).

From 1998-2005, based on observer records, five fin whales (CA/OR/WA stock), 12 humpback whales (ENP stock), and six sperm whales (CA/OR/WA stock) were either seriously injured or killed in fisheries off the west coast of the United States (California Marine Mammal Stranding Network Database 2006). Reported entanglements thus average about three whales per year for the entire west coast. Fishing practices are unlikely to change substantially in the foreseeable future, so this source of whale injury and mortality is expected to remain about the same for the foreseeable future. The Proposed Action would have no direct or indirect effects on the level of marine mammal entanglements in the GOA.

4.2.8.2 Ship Strikes

Ship strikes of marine mammals are another cause of mortality and stranding (Laist et al. 2001, Geraci and Lounsbury 2005, de Stephanis and Urquiola 2006). An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or an animal just below the surface could be cut by a vessel's propeller. The severity of injuries typically depends on the size and speed of the vessel and the size of the animal (Knowlton and Kraus 2001, Laist et al. 2001, Vanderlaan and Taggart 2007).

While there are reports and statistics of whales struck by vessels in U.S. waters, the magnitude of the risks that commercial ship traffic poses to marine mammal populations is difficult to quantify or estimate. In addition, information on vessel strike interactions between ships and marine mammals outside of U.S. waters is limited (de Stephanis and Urquiola 2006). Laist et al. (2001) concluded that ship collisions may have a negligible effect on marine mammal populations, except for small regional populations or population segments where the relative significance of a few collisions would be greater.

Commercial ports and associated commercial vessel traffic have grown as a result of the globalization of trade. The Final Report of the NOAA International Symposium on "Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology" stated that the worldwide commercial fleet has grown from approximately 30,000 vessels in 1950 to over 85,000 vessels in 1998 (NRC 2003, Southall 2005). Current statistics support the prediction that the international shipping fleet will continue to grow at the current rate or at greater rates in the future. Shipping densities in specific areas and trends in routing and vessel design are as significant, or more significant, than the total number of vessels. Densities along existing domestic and international coastal routes are expected to increase. New routes are also expected to develop as new ports are opened and existing ports are expanded. New vessel propulsion systems are also advancing toward faster ships operating in higher sea states at lower costs; and container ships are expected to become larger along certain routes (Southall 2005).

Among the regional projects identified in Section 4.1.2 are developments at Port MacKenzie and at the Port of Anchorage, both of which are expected to increase the amount of commercial vessel traffic in the GOA. Ferry service and cruise ship traffic also are expected to increase, and new oil and gas developments also may encourage additional vessel traffic in the GOA. The numbers and sizes of fishing vessels operating in the GOA are expected to remain about the same as at present. The cumulative effect of these projects and trends is expected to be a moderate increase in large commercial vessel traffic in the GOA in the foreseeable future. Ship strikes on marine mammals in the future are expected to increase in rough proportion to the increased volume of ship traffic and an increase in the average speed of these vessels. Based on the most recent scientific information, however, the cumulative impact of ship strikes on marine mammal populations in the GOA is unlikely to be significant (Laist et al. 2001).

U.S. Navy vessel traffic is a small fraction of the commercial and fishing vessel traffic in the GOA. While U.S. Navy vessel movements may incrementally contribute to the ship strike threat, given the lookout and mitigation measures adopted by the U.S. Navy, the probability of vessel strikes is greatly reduced. Furthermore, actions to avoid close interaction of U.S. Navy ships and marine mammals, such as maneuvering to avoid any observed marine mammal are part of existing at-sea protocols and standard operating procedures. Navy ships have up to three or more dedicated and trained lookouts as well as two to three bridge watchstanders during at-sea movements who would be searching for any whales or other obstacles on the water surface. Such lookouts are expected to further reduce the chances of a collision. Accordingly, the Proposed Action would not contribute substantially to the cumulative impact of ship strikes on marine mammals in the GOA.

Ingestion of Plastic Objects and Other Marine Debris and Toxic Pollution Exposure

Ingestion. For many marine mammals, debris is a great hazard. Not only is debris a hazard because of possible entanglement, but animals may mistake plastics and other debris for food (NMFS 2007b). Sperm whales have been known to ingest plastic debris, such as plastic bags (Evans et al. 2003, Whitehead 2003). While ingestion has led to mortality, the scale on which ingestion affects sperm whale populations is unknown, but Whitehead (2003) suspects it is not substantial at this time. The cumulative effect of the projects identified in Section 4.1.2 and the trends and processes described in Section 4.1.3 probably would be a minor increase in the levels of marine debris present in the GOA, and thus a minor increase in the instances of ingestion of marine debris by marine mammals. Given that this source of marine mammal mortality is not now substantial, and assuming a minor increase, then ingestion of marine debris is not expected to be a substantial source of marine mammal mortality in the future. Furthermore, the limited annual duration of Navy training activities in the GOA under the Proposed Action and Navy afloat procedures would assure that the Navy’s contribution to cumulative marine debris pollution would be negligible (see Section 3.3.1.2 and Table 3.3-1 in Water Resources).

Toxic Pollution. High concentrations of potentially toxic substances within marine mammals, along with an increase in new diseases, have been documented in recent years. Scientists are considering possible links between pollutants and marine mammal mortality. The manmade chemicals called polychlorinated biphenyls (PCBs) and the pesticide dichlorodiphyenyltrichloroethane (DDT), for example, are both considered persistent organic pollutants; they are banned in the United States because of their harmful effects in wildlife and humans (NMFS 2007c). Despite having been banned for decades, the levels of these compounds in marine mammal tissue samples taken along U.S. coasts are still high (Hickie et al. 2007, Krahn et al. 2007, NMFS 2007c). Both compounds are long-lasting, reside in marine mammal fat tissues (especially in the blubber), and can have toxic effects such as reproductive impairment and immunosuppression (NMFS 2007c).

The effects of toxic pollutants on marine mammals are difficult to measure. However, some researchers have correlated contaminant exposure with possible adverse health effects in marine mammals (Borell 1993, O’Shea and Brownell 1994, O’Hara and Rice 1996, O’Hara et al. 1999). In addition to direct effects, marine mammals are indirectly affected by habitat contamination that degrades prey species availability or that increases disease susceptibility (Geraci et al. 1999). Vessel traffic and commercial fishing both contribute incrementally to marine pollution in the GOA through deliberate discharges of allowable wastes and byproducts, incidental and accidental discharges of petroleum products, and equipment and materials losses. Based on the projects and processes identified in Sections 4.1.2 and 4.1.3, a moderate increase is anticipated in the levels of toxic pollutants in the GOA in the foreseeable future. Thus, the cumulative impact would be less than significant.

U.S. Navy vessel operations in the GOA could release small amounts of pollutants into the water column. U.S. Navy vessels are not a typical source, however, of contaminants with bioaccumulation potential such as pesticides and PCBs. Furthermore, any vessel discharges associated with the vessels, such as bilge water and deck runoff, would be in accordance with international and U.S. requirements for eliminating or minimizing discharges of oil, garbage, and other substances, and are not likely to contribute substantially to cumulative changes in ocean water quality or to affects on marine mammals.

4.2.8.3 Anthropogenic Sound

Many marine mammals use sound to communicate, navigate, locate prey, and sense their environment. Underwater anthropogenic sound may interfere with these functions, although comprehension of the type and magnitude of any behavioral or physiological responses resulting from man-made sound, and how these responses may contribute to strandings, is rudimentary at best (NMFS 2007). Marine mammals may respond both behaviorally and physiologically to anthropogenic sound exposure (e.g., Richardson et al. 1995, Finneran et al. 2000, Finneran et al. 2003, Finneran et al. 2005). However, the range and magnitude of the behavioral responses of marine mammals to various sound sources is highly variable (Richardson et al.,1995), and appears to depend on the species involved, the experience of the animal with the sound source, the motivation of the animal (e.g., feeding, mating), and the context of the exposure.

Marine mammals are regularly exposed to several sources of natural and anthropogenic sounds. Anthropogenic noise sources that could affect ambient noise levels arise from several types of activities in or near the ocean, any combination of which can contribute to the total noise level at any one place and time. These noise sources include: transportation; dredging; construction; oil, gas, and mineral exploration; geophysical (seismic) surveys; sonar; explosions; and ocean research (Richardson et al. 1995). Commercial fishing vessels, cruise ships, transport and recreational boats, and aircraft all generate underwater sound in the ocean (NRC 2003; NRC 2006). Several investigators have argued that anthropogenic sources of noise have increased ambient noise levels in the ocean over the last 50 years (NRC 1994, 2003, 2005; Richardson et al. 1995; Jasny et al. 2005; McDonald et al. 2006). Much of this increase is due to increased shipping because ships are becoming more numerous and of larger tonnage (NRC 2003, McDonald et al. 2006). Andrew et al. (2002) compared ocean ambient sound levels from the 1960s with those from the 1990s for a receiver off the California coast. The data showed an increase in ambient noise of approximately 10 decibel (dB) in the frequency range of 20 to 80 Hertz (Hz) and 200 and 300 Hz, and about 3 dB at 100 Hz over a 33-year period.

Sound emitted by large vessels, particularly during transit, is the principal source of noise in the ocean today, primarily due to the properties of sound emitted by civilian cargo vessels (Richardson et al. 1995, Arveson and Vendittis 2000). Ship propulsion and electric generation engines, engine gearing, compressors, bilge and ballast pumps, as well as hydrodynamic flow around a ship’s hull and any hull protrusions, contribute to a large vessels’ underwater noise emissions. Propeller-driven vessels also generate noise through cavitation, which accounts for much of the noise emitted by a large vessel and which is related to its speed. Military vessels underway or involved in naval activities or exercises also generate anthropogenic noise in the marine environment. Noise emitted by large vessels is low-frequency, continuous, and tonal. The sound pressure levels around the vessel vary according to its speed, burden, capacity, and length (Richardson et al. 1995, Arveson and Vendittis,2000). Vessels ranging from 135 to 337 meters generate peak sound levels of 169 - 200 dB between 8 Hz and 430 Hz, although Arveson and Vendittis (2000) documented components of higher frequencies (10-30 kHz) as a function of newer merchant ship engines and higher speeds. Given the propagation of low-frequency sounds, a large vessel in this sound range can be heard 139-463 kilometers away (Ross 1976 in Polefka 2004). U.S. Navy vessels, however, have incorporated significant underwater ship-quieting technology to reduce their acoustic signature, compared to a vessel of similar size, thus reducing their vulnerability to detection by enemy passive acoustics (Southall 2005).

As noted in Section 4.1.3.2, commercial and recreational vessel traffic in the GOA are expected to increase moderately in the foreseeable future, and underwater noise levels associated with vessel transits are expected to increase in rough proportion to this increase. Fishing vessel traffic in the GOA is expected to remain about the same as at present, although the average size and speed of fishing vessels may change over time. Oil and gas development, especially exploration, could be a substantial new source of underwater noise in the GOA, but this activity is expected to occur primarily along the northern and western margins of the GOA on the continental shelf. Overall, the level and geographic range of underwater noise in the GOA are expected to increase in the future in response to past, present, and reasonably foreseeable projects and processes, including the Proposed Action, but this cumulative increase would be less than significant.

Navy vessels would be present in the GOA for a small portion of the year under the Proposed Action, and thus their contribution to cumulative ship noise would be minimal. As noted above, U.S. Navy vessels have underwater ship-quieting technology that reduces their acoustic signature compared to vessels of similar size, further reducing their contribution to cumulative underwater noise impacts. Naval sonars would operate in a limited number of areas, as discussed in Section 3.8, and most likely would not contribute substantially to underwater noise levels in the GOA. Modeling of atmospheric and underwater ordnance detonations for the Proposed Action (Section 3.8) indicated that few marine mammals, if any, would be exposed to underwater noise from these sources. In summary, the contribution of the Proposed Action to cumulative increases in underwater sound in the GOA would be minimal.

4.2.8.4 Climate Change

The effect of large-scale climatic changes on the world's oceans, and how these changes impact marine mammals and influence strandings, are difficult to quantify, given the broad spatial and temporal scales involved and the cryptic movement patterns of marine mammals (Moore 2005; Learmonth et al. 2006). The most immediate, although indirect, effect would be decreased prey availability during unusual conditions. This, in turn, would result in increased search effort required by marine mammals (Crocker et al. 2006), potential starvation, and corresponding stranding due directly to starvation, disease, or predation while in a weakened or stressed state (Selzer and Payne 1988, Geraci et al. 1999, Moore 2005, Learmonth et al. 2006, Weise et al. 2006). Future changes in climate and ocean acidification resulting from human development and natural processes are likely to be cumulatively significant, based on current projections by the U.S. government. As discussed in Section 3.1, however, the contribution of the Proposed Action to this cumulative impact would be negligible.

4.2.8.5 Summary

Cumulative impacts on marine mammals from past, present, and reasonably foreseeable projects, processes, and trends would result primarily from climate change and fisheries interactions, with ship strikes, ingestion of and entanglement by marine debris, effects of toxic pollutants, and underwater noise all minor sources of impacts. The Proposed Action would not contribute to fisheries interactions, and its contributions to future ship strikes, ingestion of marine debris, health effects of marine pollutants, and climate change would be negligible. The Proposed Action would contribute minimally to cumulative increases in underwater sound in the GOA. Overall, the Proposed Action would not contribute substantially to cumulative impacts on marine mammals.

4.2.9 Seabirds

Seabird populations within the GOA are affected by direct and indirect perturbations of breeding and foraging habitat on the coastal mainland and inshore islands. The single greatest concern is the loss of suitable habitat for nesting and roosting seabirds throughout the coastal northwest due to land development and human encroachment. Historically, seabird populations have sustained numerous impacts from pollution and human activities within the GOA from a variety of sources, including the discharge of hazardous chemicals and sewage. Seabird populations in the GOA have become more susceptible to impacts due to their increased concentration. Large-scale effects on seabird populations such as global warming, reduced fish populations, and development in other regions or countries are not well defined for individual species but have been cited as contributing to the overall decline of seabirds.

Past, present and reasonably foreseeable future actions discussed in Section 4.1.2 (vessel traffic from port development, coastal development) and other activities described in Section 4.1.3 (increased commercial and recreational vessel traffic), together with the Proposed Action, would elevate the potential for direct and indirect impacts on seabirds, including the short-tailed albatross (a species listed under the federal Endangered Species Act). Increased vessel and low-flying aircraft traffic would result in a greater level of day-to-day disturbance of seabirds and interference with foraging activities. Increased ocean pollution could degrade the health of seabirds through direct exposure and through ingestion of trash or contaminated prey. New coastal development (see Table 4-1) would decrease lands available for seabird nesting and roosting. The cumulative effects of increased disturbance, decreased health, and decreased terrestrial habitat on seabird populations would be adverse, but less than significant. The contributions of the Proposed Action to cumulative habitat disturbance and ocean pollution (the Proposed Action would not directly affect land areas) would not be substantial.

4.2.10 Cultural Resources

Consultation with the Alaska SHPO was conducted during the preparation of the *Alaska MOA EIS* and the *Transformation of U.S. Army Alaska FEIS*. A copy of SHPO correspondence regarding the *Alaska MOA EIS* is provided in Appendix C of this EIS/OEIS. Based on the previous consultations, no further analysis of prehistoric and historic archaeological resources on land is required.

Underwater archaeological resources are submerged sites that may have a cultural affiliation. This type of site includes shallow water or nearshore prehistoric or historic sites or isolated artifacts, historic shipwrecks, airplanes, or pieces of ship components, such as cannons or guns. Ship and aircraft wrecks are the only potential cultural resource of concern in the open ocean portions of the GOA. There are no known prehistoric or historic archaeological resources, architectural resources, or traditional cultural properties within the GOA.

Cumulative impacts on cultural resources would consist of the effects of the Proposed Action in combination with other cumulative actions and processes (as listed in Sections 4.1.2 and 4.1.3), that would affect shipwrecks and associated open ocean-bottom resources. Of the cumulative projects and activities identified in the GOA, only fish trawling could have such an effect. Trawling for bottom fish and invertebrates in the GOA is a widespread and long-standing practice. In light of the effects of trawling on deep sea corals, it is unlikely that any wrecks in the GOA retain sufficient integrity to be considered as cultural resources. Trawling is expected to continue at current levels for the foreseeable future.

The analysis presented determined that the Proposed Action would have no potential to affect underwater cultural resources on the floor of the ocean. Project activities would not disturb the ocean floor where cultural resources may be present. Navy activities in the GOA will not add to any cumulative impacts on cultural resources from other ongoing and anticipated ocean activities.

4.2.11 Transportation and Circulation

Cumulative impacts on airspace and marine traffic would consist of the effects of the Proposed Action in combination with other past, present, and reasonably foreseeable actions and processes (Sections 4.1.2 and 4.1.3) that would increase air and marine traffic volumes or conflicts within the GOA region. As discussed in Section 4.1.3.2, marine vessel traffic is expected to increase. As discussed in Section 4.1.3.5, commercial air traffic is expected to increase. Specific projects that would contribute to these general processes include port development, new ferry service, and new bridge crossings (see Table 4-1).

At present, commercial air traffic through the TMAA is minimal, and this situation is not expected to change substantially in the future as a result of other projects and processes (e.g., growth in commercial airliner traffic, fish spotting aircraft, and oil and gas development. Airspace within the TMAA is only restricted by the Navy during hazardous training activities (a maximum of 42 days per year); these activities are coordinated with the FAA, and Notices to Airmen (NOTAMs) are issued. Aircraft in the vicinity are required to detour around the training area, and adjacent air corridors may experience more intense use. When hazardous activities occur on the inland ranges, military flight plans are coordinated with Anchorage and Fairbanks Air Route Traffic Control Center (ARTCC). Coordination with the FAA on matters affecting airspace and adherence to established operating rules within and around Special Use Airspace reduces or eliminates the possibility of indirect adverse impacts and associated cumulative impacts on civil aviation and airspace use. Thus, cumulative impacts on air transportation are expected to be less than significant.

Vessel traffic through the TMAA (other than fishing boats, which are addressed in Sections 3.6 and 3.11 Fish and Transportation and Circulation respectively) consists primarily of cargo vessels and tankers; whale-watching boats, cruise ships, and other vessel traffic in the GOA mostly use coastal areas outside of the TMAA. For hazardous training activities in the TMAA or W-612, the Navy issues a NOTMAR to notify non-participants to avoid the affected area. Although the resultant detours for cargo or tanker vessels traversing the TMAA may be inconvenient, they do not preclude the affected vessels from reaching their destinations.

Other current, planned, and reasonably foreseeable projects and processes in the GOA are not expected to have a substantial effect on vessel traffic and circulation. The volume of cargo vessels traversing the GOA is expected to increase moderately, while the volume of tanker traffic is not expected to change substantially. For hazardous training activities in the TMAA or W-612, the Navy would continue to issue NOTMARs. With cumulative increases in vessel traffic, the numbers of vessels detouring around the TMAA would increase, but the affected vessels would not be prevented from reaching their destinations. Thus, cumulative impacts on marine transportation are expected to be less than significant.

4.2.12 Socioeconomics

The economy of the coastal communities is based on commercial fishing of pink and red salmon, fish processing, timber, minerals, agriculture and tourism. Current socioeconomic conditions in the GOA primarily are associated with fishing. Several native communities rely on the harvesting of marine resources (fish, shellfish, marine mammals, birds) for subsistence. Tourism also is a socioeconomic factor in the area, but tourism activities mostly occur in coastal waters. Vessels and aircraft transiting across the GOA value it as a relatively short, unimpeded route between source and destination; disruption or displacement of this traffic would incrementally increase operating costs for the transportation industry. The area has some potential for oil and gas development, primarily on the continental shelves on its northern and western margins. Fishing in the GOA is a mature industry with little remaining potential for substantial growth, and the possibility exists that one or more major fisheries will be further restricted in the future to protect fish stocks from overfishing.

Several native communities rely for their subsistence on the harvesting of marine resources (fish, shellfish, marine mammals, birds). The economy of the coastal communities is based on commercial fishing of pink and red salmon, fish processing, timber, minerals, agriculture and tourism. Shellfish fisheries developed in the 1960s in the Gulf of Alaska (see Our Living Oceans, 1999). Conflicts have emerged between coastal and offshore interests. In 1998, there was an increase of visitors to over 1 million a year. The livelihood of 70,000 full-time residents living in the area was directly affected by the Exxon Valdez oil spill. They had to overcome the effects of the oil-related fish mortalities. Others using the area seasonally for work or recreation were also affected.

Cumulative impacts on socioeconomics would consist of the effects of the Proposed Action in combination with other past, present, and reasonably foreseeable future actions and processes that would significantly affect regional employment, income, housing, or infrastructure. Port development and coastal development (see Table 4-1) would contribute to long-term economic growth. Increased marine vessel traffic (Section 4.1.3.2) and commercial air traffic (Section 4.1.3.5) would incrementally increase regional employment. Employment and income could be substantially affected by changes in fishing or tourism activities, or development of other resource extraction industries (e.g., oil and gas). Based on the socioeconomic resources available and sectors represented in the GOA, no direct cumulative impacts on housing or infrastructure are expected, although declines in employment and income could indirectly affect housing demand or funding for infrastructure projects.

Implementation of the Proposed Action alone would not produce any significant regional employment, income, housing, or infrastructure impacts. Effects on commercial and recreational fishermen, and boaters would be short-term and would produce some temporary access limitations. Some activities in the TMAA, especially if coincident with peak fishing locations and periods, could cause temporary displacement of and potential economic loss to individual fishermen. However, most activities within the TMAA are short in duration and have a small operational footprint. Effects on fishermen are mitigated by a series of Navy initiatives, including public notification of scheduled activities, near-real time schedule updates, prompt notification of schedule changes, and adjustment of hazardous activities areas. In selected instances where safety requires exclusive use of a specific area, fishermen may be asked to relocate to a safer nearby area for the duration of the activity. These measures would not have a noticeable effect on any individual fisherman, overall commercial revenue, or public recreational opportunities.

Other current, planned, and reasonably foreseeable projects and processes would have little effect on socioeconomic conditions in the GOA. The fishing industry is not expected to change substantially (see Section 4.1.3.1). An expected moderate increase in cargo vessels (see Table 4-1 and Section 4.1.3.2) would have a small, but positive effect on socioeconomic conditions in the region, as would development of oil and gas resources on the outer continental shelf. Moderate growth in the tourism industry, especially in cruise ship traffic, as well as the local economic stimulus of planned infrastructure projects in coastal areas (see Table 4-1) would have a moderate, beneficial economic effect in communities on the northern and western margins of the GOA.

The aggregate effects of cumulative projects and processes on socioeconomic factors in the GOA region are expected to be moderately beneficial, but not significant. The Proposed Action, as noted above, would not contribute to these cumulative impacts. Therefore, the Proposed Action would not result in significant cumulative socioeconomic impacts.

4.2.13 Environmental Justice and Protection of Children

No permanent human population exists in the GOA, and no cumulative effects on environmental justice or protection of children are possible without resident populations. Populations within the greater GOA region are not affected by Navy training activities because of the rare and inconsistent nature of these activities. Based on these factors, no disproportionately high and adverse human health or environmental effects on minority or low-income populations would occur from implementation of the Proposed Action.

Therefore, no cumulative impacts would occur because the aggregate impacts of the Proposed Action and other past, present, and reasonably foreseeable future projects, are not significant.

4.2.14 Public Safety

Despite the size of the GOA, the frequently severe weather, and the large number of vessels and aircraft that operate in or traverse the area, substantial accidents posing a safety risk to the public are rare. Most reported accidents involve commercial vessels. Of these, on-board fires appear to be the most common type of accident, followed by groundings. Vessel sinkings and collisions and aircraft accidents are very rare. The potentials for vessel groundings and collisions, moreover, are much higher in coastal waters where vessel traffic is substantially more congested than in the open GOA and obstacles to navigation are much more common. Thus, current risks to public safety in the GOA from past and present activities are very low.

Cumulative impacts on public safety would consist of the combined effects of the Proposed Action and other past, present, and reasonably foreseeable future actions and processes (as listed in Sections 4.1.2 and 4.1.3) on public safety conditions in the GOA. Navy training poses potential risks to the public in the GOA primarily through aircraft and vessel movements, live ordnance fire, and explosive ordnance, in combination with the accidental presence of non-participants in a designated temporary training area. Aircraft and ship collisions would be the primary public safety concern. These risks are minimized through standard Navy practices and procedures. The incremental increase in public safety risk from temporary Navy operations in the GOA probably is offset by the availability of substantial Navy physical assets and communications systems to assist in search-and-rescue operations in the event of an accident involving a commercial or private aircraft or vessel.

Other projects and activities that would increase the number aircraft or vessels in the GOA, or the duration of their presence there, such as additional cruise ship and marine cargo traffic (see Section 4.1.3.2) and increased commercial airliner traffic (see Section 4.1.3.5), could increase public safety risks in the future. Projects that increased the number of individuals present in the GOA also could increase the public safety risk by increasing the population exposed to such risks. Other proposed or operational commercial, industrial, and recreational activities in the GOA would not substantially affect public safety. Based on the existing low incidence of vessel and aircraft accidents and an anticipated moderate increase in aircraft and vessel activities in the GOA in the foreseeable future, the overall public safety risk in the GOA is expected to remain less than significant.

The Proposed Action would not contribute substantially to the public safety risks in the GOA resulting from other past, present, and reasonably foreseeable future actions. As noted above, the Proposed Action could have a beneficial effect on cumulative public safety risk in this remote region of the GOA because Navy assets could assist commercial or private aircraft or vessels in distress. Therefore, the cumulative impact on public safety from implementation of the Proposed Action, when added to past, present, or reasonably foreseeable projects in the GOA would be less than significant.

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5 MITIGATION MEASURES

Effective training in the Alaska Training Areas (ATA) dictates that aircraft, ship, and submarine participants utilize their sensors and weapon systems to their optimum capabilities as required by the training objectives. The Navy recognizes that such use has the potential to cause behavioral disruption of some marine mammal species in the vicinity of training (as outlined in Chapter 3). National Environmental Policy Act (NEPA) regulations require that an Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) include analysis of appropriate mitigation measures not already included in the Proposed Action or Alternatives (40 Code of Federal Regulations [C.F.R.] § 1502.14 [h]). Each of the Alternatives, including the Proposed Action considered in this EIS/OEIS, includes mitigation measures intended to reduce the environmental effects of Navy activities as discussed throughout this EIS/OEIS.

This chapter presents the Navy's standard protective measures in detail, outlining steps that would be implemented to protect marine mammals and federally listed species during training activities. These protective measures will mitigate impacts resulting from training. It should be noted that protective measures have been standard operating procedures since 2004 for all levels of training from unit-level training through Major Exercises. This chapter also presents a discussion of other measures that have been considered but not adopted because they were determined either (1) not feasible, (2) to present a safety risk, (3) to provide no known or ambiguous protective benefit, or (4) to have an unacceptable impact on training fidelity.

As previously mentioned, the majority of training activities conducted by the Navy are contained within the Temporary Maritime Activities Area (TMAA). For Navy training activities that do occur in the inland ranges of the United States (U.S.) Air Force (USAF) and the training lands of the U.S. Army, applicable rules, regulations, safety procedures, standard operating procedures, and mitigation measures of those installations and training areas will be observed by all Navy participants. As such, this chapter focuses on protective measures specific to activities conducted within the TMAA and Warning Area 612 (W-612).

5.1 CURRENT REQUIREMENTS AND PRACTICES

5.1.1 Air Quality

Emissions that may affect air quality are heavily regulated under the Clean Air Act and its implementing regulations, through a comprehensive federal/state regulatory process (see Section 3.1). Consistent with these regulatory requirements and processes, the Navy has implemented comprehensive air quality management programs to ensure compliance.

5.1.2 Expended Materials

Releases or discharges of hazardous materials are heavily regulated through comprehensive federal and state processes. In addition, the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) prohibits certain discharges of oil, garbage, and other substances from vessels. The MARPOL convention is implemented by national legislation, including the Act to Prevent Pollution from Ships (33 U.S.C. 1901, et seq.) and the Federal Water Pollution Control Act ("Clean Water Act"; 33 U.S.C. 1321, et seq.). These and other requirements are implemented by the *Navy Environmental and Natural Resources Program Manual* (DoN 2007) and related Navy guidance documents that require hazardous materials to be stored and handled appropriately, both onshore and afloat.

The Navy has also implemented hazardous materials management programs to ensure compliance and provide guidance on handling and disposing of such materials. Navy instructions include stringent discharge, storage, and pollution prevention measures and require facility managers to reduce, to the extent possible, quantities of toxic substances released into the environment. All Navy vessels and facilities have comprehensive programs in place that implement responsible stewardship, hazardous materials management and minimization, pollution prevention, recycling, and spill prevention and response. These and other programs allow Navy ships to retain used and excess hazardous material on board for shore offload within 5 working days of arrival at a Navy port. All activities can return excess and unused hazardous materials to the Navy's Hazardous Material Minimization Centers. Additional information regarding water discharge restrictions for Navy vessels is provided in Table 5-1, Water Resources.

5.1.3 Water Resources

Environmental compliance policies and procedures applicable to operations ashore and at sea are identified in Navy instructions that include directives regarding waste management, pollution prevention, and recycling. The protective measures implemented by the Navy for water resource protection are commonly referred to as Standard Operating Procedures (SOPs) and Best Management Practices (BMPs). Measures that reduce potential impacts to water resources include creation and adherence to storm water management plans, erosion control, maintaining vegetative buffers adjacent to waterways, and enforcement of pollution permit requirements (National Pollutant Discharge Elimination System [NPDES]).

At sea, Navy vessels are required to operate in a manner that minimizes or eliminates any adverse impacts to the marine environment. Environmental compliance policies and procedures applicable to shipboard operations afloat are defined in the *Navy Environmental and Natural Resources Program Manual* (DoN 2007), Chapter 4, "Pollution Prevention," and Chapter 22, "Environmental Compliance Afloat"; Department of Defense (DoD) Instruction 5000.2-R (§C5.2.3.5.10.8, "Pollution Prevention"). In addition, provisions in Executive Order (EO) 12856, *Federal Compliance With Right-To-Know Laws and Pollution Prevention Requirements*, and EO 13101, *Greening the Government through Waste Prevention, Recycling, and Federal Acquisition* reinforce the Clean Water Act's (CWA's) prohibition against discharge of harmful quantities of hazardous substances into or upon U.S. waters out to 200 nautical miles (nm) (371 kilometers [km]), and mandate stringent hazardous waste discharge, storage, dumping, and pollution prevention requirements. Table 5-1 provides information on Navy SOPs and BMPs for shipboard management, storage, and discharge of hazardous materials and wastes, and on other pollution protection measures intended to protect water quality. Although not applicable to the Gulf of Alaska (GOA) Navy Training Activities EIS/OEIS, onshore policies and procedures related to spills of oil and hazardous materials are detailed in OPNAVISNT 5090.1C, Chapter 12.

Shipboard waste-handling procedures governing the discharge of nonhazardous waste streams have been established for commercial and Navy vessels. These categories of wastes include solids (garbage) and liquids such as "black water" (sewage), "gray water" (water from deck drains, showers, dishwashers, laundries, etc.), and oily wastes (oil-water mixtures). Table 5-1 summarizes the waste stream discharge restrictions for Navy vessels at sea.

Table 5-1: Waste Discharge Restrictions for Navy Vessels

Zone (nm from shore)	Type of Waste	
	Black Water (Sewage)	**Gray Water**
U.S. Waters (0-3 nm)	No discharge.	If vessel is equipped to collect gray water, pump out when in port. If no collection capability exists, direct discharge permitted.
U.S. Contiguous Zone (3-12 nm)	Direct discharge permitted.	Direct discharge permitted.
>12 nm from shore	Direct discharge permitted.	Direct discharge permitted.
Zone	**Oily Waste**	**Garbage (Non-plastic)**
U.S. Waters (0-3 nm)	Discharge allowed if waste has no visible sheen. If equipped with Oil Content Monitor (OCM), discharge < 15 ppm oil.	
U.S. Contiguous Zone (3-12 nm)	Same as 0-3 nm.	
>12 nm from shore	If equipped with OCM, discharge < 15 ppm oil. Vessels with oil/water separator but no OCM must process all bilge water through the oil-water separator.	
Zone	**Garbage (Plastic)**	**Garbage (Non-plastic)**
U.S. Waters (0-3 nm)	No discharge.	No discharge.
U.S. Contiguous Zone (3-12 nm)	No discharge.	Pulped or comminuted food and pulped paper and cardboard waste may be discharged >3nm.
12-25 nm from shore	No discharge.	Bagged shredded glass and metal waste may be discharged >12nm[1]
> 25 nm from shore	No discharge.	Direct discharge permitted[2].

Note: (1) Submarines may discharge compacted, sinkable garbage between 12 nm and 25 nm provided that the depth of water is greater than 1,000 fathoms.

(2) Surface ships shall use pulpers and shredders for all discharges of food products, paper, cardboard, glass and metal wastes

Source: DoN 2007

5.1.4 Acoustic Environment (Airborne)

Navy activities in the TMAA comply with numerous established acoustic control procedures to ensure that neither participants nor non-participants engage in activities that would endanger life or property. SOPs for minimizing airborne noise impacts in the TMAA are mainly centered on aircraft SOPs.

Aircraft SOPs are largely oriented toward safety, which also provide significant noise abatement benefits. For example, many SOPs involve flight routing and minimum altitudes. Each of these procedures increases the range of the noise source from human receptors, thus reducing noise impacts. Additionally, each aircrew will be familiar with the noise profiles of their aircraft and shall be committed to minimizing noise impacts without compromising operational and safety requirements. Flights of naval aircraft shall be conducted so that a minimum of annoyance is experienced by persons that may be below. It is not enough for the pilot to be satisfied that no person is actually endangered. Definite and particular effort shall be taken to fly in such a manner that individuals do not believe they or their property are endangered.

Military personnel who might be exposed to sound in the air from military activities, such as military aircraft or at sea explosions heard on the surface of the ocean, are required to take precautions, such as the wearing of protective equipment, to reduce or eliminate potential harmful effects of such exposure. With regard to potential exposure of non-military personnel in the ocean, precautions are taken pursuant to SOPs to prevent such exposure. These include advance notice of scheduled training activities to the public and the commercial fishing community via the worldwide web, Notices to Mariners (NOTMARs), and Notices to Airmen (NOTAMs). In addition, range safety SOPs ensure that civilians are excluded from, and if necessary removed from areas of military activities, or that military activities do not occur when civilians are present. These procedures have proven to be effective at minimizing potential military / civilian interactions in the course of training or other military activities.

5.1.5 Marine Plants and Invertebrates

The Navy has no existing protective measures in place specifically for marine plants and invertebrates. However, protected areas (Conservation Areas) throughout the GOA restrict groundfish harvest to minimize harmful impacts of fishing methodology and equipment to ocean bottom habitat (Witherell 2004). Additionally, marine plants and invertebrates benefit from measures in place to protect marine mammals and sea turtles (see Section 5.2.1).

Subsequently, the buffer zones that have been established to reduce or eliminate potential effects of Navy activities on marine mammals serve to reduce or eliminate potential effects on marine plants and invertebrates as well. The buffer zones for marine mammals have been designated for training events using both explosive and nonexplosive ordnance. Lookouts are posted to visually survey for floating kelp, plants, or algal mats which are objects that sea turtles and other marine mammals are drawn to. For training activities using explosive ordnance, the intended impact area shall not be within 600 yards (yd) (585 meters [m]) of known or observed kelp beds, floating plants, or algal mats. For training events using nonexplosive ordnance, intended impact area shall not be within 200 yd (183 m) of known or observed kelp beds, floating plants, or algal mats. For air-to-surface missile exercises, the buffer zone is extended to 1,800 yd (1,646 m) around hard bottom communities, kelp forests, floating plants, and algal mats, for both explosive and nonexplosive ordnance.

5.1.6 Fish

Mitigation measures for at-sea activities involving explosive ordnance, implemented for marine mammals and sea turtles, also offer protections to habitats associated with fish communities. No additional mitigation measures are proposed or warranted because no substantial effects on fish or fish habitat were identified.

5.1.7 Birds

The majority of aircraft activities that might affect seabirds are concentrated within the TMAA where the potential for bird aircraft strikes exists. Pursuant to Navy instruction (OPNAVINST 3750.6R), measures to evaluate and reduce or eliminate this hazard to aircraft, aircrews, and birds are implemented during activities in the TMAA. Additionally, guidance involving land or at sea activities involving explosive ordnance contains instructions to personnel to observe the surrounding area within 700 yd (640 m) for 30 minutes prior to detonation. If birds (or marine mammals or sea turtles) are seen, the activity must be relocated to an unoccupied area or postponed until animals leave the area. Monitoring of seabird populations and colonies by conservation groups and researchers is conducted intermittently within coastal areas and offshore islands with limited support from various military commands.

5.1.8 Cultural Resources

Section 3.10 details protective measures implemented with regard to cultural resources in the TMAA. There are no prehistoric or historic archaeological resources, architectural resources, or traditional cultural properties identified within the TMAA, but there are submerged cultural resources. Within the TMAA, these submerged cultural resources are unaffected by Navy activities because of the type of training activities and the low density of submerged cultural resources.

The Navy has established protective measures to reduce potential effects on cultural and natural resources from training activities. Some are generally applicable, while others apply to particular geographic areas during specific times of year for certain types of Navy training activities. These measures are based on environmental analyses conducted by the Navy for coastal waters and for land and sea ranges.

Most of these protective measures are focused on protection of the natural environment. Such protective measures also benefit culturally valued natural resources such as salmon and shellfish. Some of the protective measures include use of inert ordnance and passive tracking and acoustical tools, avoidance of sensitive habitats, and visually monitoring areas to ensure significant concentrations of sea life are not present.

5.1.9 Transportation and Circulation

The Navy strives to ensure that it retains access to ocean training areas and special use airspace (SUA) as necessary to accomplish its mission, while facilitating joint military-civilian use of such areas to the extent practicable and consistent with safety. These goals of military access, joint use, and safety are promoted through various coordination and outreach measures, including:

- Publication of NOTAMs advising of the status and nature of activities being conducted in the TMAA and Warning Area (W)-612.
- Return of Special-Use Airspace (SUA) to civilian Federal Aviation Administration (FAA) control when not in use for military activities. To accommodate the joint use of SUA, a Letter of Agreement is in place between the military and the Anchorage Air Route Traffic Control Center (ARTCC). The Letter of Agreement defines the conditions and procedures to ensure safe and efficient joint use of the TMAA and Warning Area.
- Publication of NOTMARs and other outreach mechanism. The Navy provides information about training activities planned for the TMAA, for publication by the U.S. Coast Guard in NOTMARs.
- Developing methods of outreach with the fishing community.

5.1.10 Socioeconomics

Given the nature and location of Navy activities addressed in this EIS/OEIS, mitigation and protective measures are unnecessary with respect to socioeconomic considerations.

5.1.11 Environmental Justice and Protection of Children

Given the nature and location of Navy activities addressed in this EIS/OEIS, mitigation and protective measures are unnecessary with respect to environmental justice and protection of children considerations.

5.1.12 Public Safety

Navy activities in the TMAA comply with numerous established safety procedures to ensure the safety of participants and the public. Safety procedures for activities on the offshore and nearshore areas are published in multiple documents (DoN 1997, 1999, 2004b) that are applicable to the TMAA. These guidelines are directive for users of the training areas. They provide, among other measures, that:

- Commanders are responsible for ensuring that impact areas and targets are clear prior to commencing activities that are hazardous.
- Aircraft or vessels expending ordnance shall not commence firing without permission of the scheduling authority for their specific range area.
- Firing units and targets must remain in their assigned areas, and units must fire in accordance with current safety instructions.
- Ships are authorized to fire their weapons only in offshore areas and at specific distances from land, depending on the caliber and range of the weapons fired.
- The use of pyrotechnic or illumination devices and marine markers such as smoke or dye markers will be allowed only in the assigned areas, to avoid the launch of Search and Rescue forces when not required. Aircraft carrying ordnance to or from ranges shall avoid populated areas to the maximum extent possible.
- Aircrews operating in the TMAA and W-612 are aware that nonparticipating aircraft are not precluded from entering the area and may not comply with a NOTAM or radio warning that hazardous activities are scheduled or occurring. Aircrews are required to maintain a continuous lookout for non-participating aircraft while operating under Visual Flight Rules (VFRs) in the TMAA or W-612.

In addition to the above-mentioned procedures, the Navy has instituted the following SOPs for use in the TMAA.

5.1.12.1 Aviation Safety

Potential hazardous activities conducted within the TMAA are conducted under VFR and under visual meteorological conditions. This means that the commanders of military aircraft are responsible for the safe conduct of their flight. Prior to releasing any weapons or ordnance, the impact area must be clear of non-participating vessels, people, or aircraft. The Officer Conducting the Exercise (OCE) is ultimately responsible for the safe conduct of range training. A qualified Safety Officer is assigned to each training event or exercises and can terminate activities if unsafe conditions exist.

5.1.12.2 Submarine Safety

Vertical separation of at least 100 ft (30.5 m) is required between the top of a submarine's sail and the depth of a surface ship's keel. If a submarine (or submarine simulated target, the MK-30) is at periscope depth, at least a 1,500 yd (1,372 m) horizontal separation from other vessels must be maintained.

5.1.12.3 Surface Ship Safety

During training events, surface ships maintain radio contact with the OCE. Prior to launching a weapon, ships are required to obtain a "Green Range," which indicates that all safety criteria have been satisfied, and that the weapons and target recovery conditions and recovery helicopters and boats are ready to be employed.

5.1.12.4 Missile Exercise Safety

Safety is the top priority and paramount concern during missile exercises. These exercises can be surface-to-surface, subsurface-to-surface, surface-to-air, or air-to-air. A Missile Exercise (MISSILEX) Letter of Instruction is prepared prior to any missile firing exercise. This instruction establishes precise ground rules for the safe and successful execution of the exercise. Any MISSILEX participant who observes an unsafe situation can communicate a "Red Range" order over any voice communication systems. Range control is in radio contact with participants at all times during a MISSILEX.

5.2 MITIGATION MEASURES

As part of the Navy's commitment to sustainable use of resources and environmental stewardship, the Navy incorporates measures that are protective of the environment into all of its activities. These include employment of best management practices, standard operating procedures (SOPs), adoption of conservation recommendations, and other measures that mitigate the impacts of Navy activities on the environment. Some of these measures are generally applicable and others are designed to apply to certain geographic areas during certain times of year, for specific types of military training. Mitigation measures covering habitats and species occurring in the ATA have been developed through various environmental analyses conducted by the Navy for land and sea ranges and adjacent coastal waters.

The Navy has implemented a variety of marine mammal mitigation measures over the last two decades. The following discussion briefly describes the genesis and status of those mitigation measures.

The Navy has developed and implemented mitigation measures as a result of environmental analysis or in consultation with regulatory agencies for research, development, test, and evaluation activities (RDT&E) and training exercises involving various sonar systems. These measures included visual detection by trained lookouts, power down and shut down procedures, the use of passive sensors to detect marine mammals, and avoidance of marine mammals.

In December 2000, the Navy issued a memorandum entitled "Compliance with Environmental Requirements in the Conduct of Naval Exercises or Training at Sea" (DoN 2000). This memorandum clarified Navy policy for continued compliance with certain environmental requirements including preparation of environmental planning documents, consultations pursuant to the Endangered Species Act (ESA), and applications for "take" authorizations under the Marine Mammal Protection Act (MMPA).

In 2003, the Navy issued the Protective Measures Assessment Protocol (PMAP) that implemented Navy-wide mitigation measures for various types of routine training events. Following the implementation of PMAP, the Navy agreed to additional mitigation measures as part of MMPA authorization and ESA consultation processes for specific training exercises from 2004-2007.

This Section describes mitigation measures applicable to the military readiness activities described in Chapter 2 within the study area of the GOA Draft EIS/OEIS.

5.2.1 Marine Mammals (and Sea Turtles)

The comprehensive suite of mitigation measures implemented by the Navy to reduce impacts to marine mammals also serves to mitigate potential impacts on sea turtles. In particular, personnel and watchstander training, establishment of turtle-free exclusion zones for underwater detonations of explosives, and pre- and post-exercise surveys, all serve to reduce or eliminate potential impacts of Navy activities on sea turtles that may be present in the vicinity.

Effective training in the GOA dictates that ship, submarine, and aircraft participants utilize their sensors and exercise weapons to their optimum capabilities as required by the mission. This section is a comprehensive list of mitigation measures that would be utilized for training activities analyzed in the EIS/OEIS in order to minimize potential for impacts on marine mammals and sea turtles in the GOA.

Marine mammals may be exposed to sound energy levels sufficient to cause a physiological effect. As described in Section 3.8, specific received sound energy levels are associated with permanent threshold shift (PTS), a permanent hearing loss over a subsection of an animal's hearing range (injury); and with temporary threshold shift (TTS), a temporary hearing loss and associated behavioral disruption. Received sound energy level thresholds for PTS and TTS from exposure to mid-frequency sonar are 215 dB re

1µPa^2-s and 195dB 1µPa^2-s respectively. The predicted ranges, or distances, to received sound energy levels associated with marine mammal PTS and TTS for the most powerful and the most commonly used shipboard mid-frequency active sonar used in the Gulf of Alaska are shown in Table 5-2.

The typical ranges, or distances, from the most powerful and common active sonar sources used in the ATA to received sound energy levels associated with TTS and PTS are shown in Table 5-2. Due to spreading loss, sound attenuates logarithmically from the source, so the area in which an animal could be exposed to potential injury (PTS) is small. Because the most powerful sources would typically be used in deep water and the range to effect is limited, spherical spreading is assumed for 195 decibels referenced to 1 micro-Pascal squared second (dB re 1µPa^2-s) and above. Also, due to the limited ranges, interactions with the bottom or surface ducts are rarely an issue.

Table 5-2. Range to Effects for Shipboard Mid-Frequency Active Sonar

Active Sonar Source	PTS level dB re 1µPa^2-s	Range to PTS (ft/m)	TTS level dB re 1µPa^2-s	Range To TTS (ft/m)
SQS-53 ship	215	33/10	195	459/140
SQS-56 ship	215	11/3.2	195	108/33

Current mitigation measures employed by the Navy include applicable training of personnel and implementation of activity specific procedures resulting in minimization and/or avoidance of interactions with protected resources.

5.2.1.1 General Maritime Measures

Personnel Training – Watchstanders and Lookouts

The use of shipboard lookouts is a critical component of all Navy mitigation measures. Navy shipboard lookouts (also referred to as “watchstanders”) are highly qualified and experienced observers of the marine environment. Their duties require that they report all objects sighted in the water to the Officer of the Deck (OOD) (e.g., trash, a periscope, marine mammals, sea turtles) and all disturbances (e.g., surface disturbance, discoloration) that may be indicative of a threat to the vessel and its crew. There are personnel serving as lookouts on station at all times (day and night) when a ship or surfaced submarine is moving through the water.

- All Commanding Officers (COs), Executive Officers (XOs), lookouts, OODs, Junior OODs (JOODs), maritime patrol aircraft aircrews, and Anti-Submarine Warfare (ASW)/Mine Warfare (MIW) helicopter crews will complete the NMFS-approved Marine Species Awareness Training (MSAT) by viewing the U.S. Navy MSAT digital versatile disk (DVD). MSAT may also be viewed on-line at https://portal.navfac.navy.mil/go/msat. MSAT training must be reviewed at least annually and again prior to the first use of mid-frequency active (MFA) sonar and/or IEER during major ASW exercises (e.g., Composite Training Unit Exercise [COMPTUEX] and Rim of the Pacific Exercise [RIMPAC]). This training must be recorded in the individual’s training record.

- Navy lookouts will undertake extensive training to qualify as a watchstander in accordance with the Lookout Training Handbook (Naval Education and Training Command [NAVEDTRA] 12968-D).
- Lookout training will include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, lookouts will complete the Personal Qualification Standard Program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged

objects). Personnel being trained as lookouts can be counted among required lookouts as long as supervisors monitor their progress and performance.

- Lookouts will be trained in the most effective means to ensure quick and effective communication within the command structure to facilitate implementation of mitigation measures if marine species are spotted.
- Lookouts' ability to detect objects in the water, including marine mammals and sea turtles, is critical to Navy environmental compliance and will be evaluated by Navy and contracted biologists.

Operating Procedures & Collision Avoidance

- Prior to major exercises, a Letter of Instruction, Mitigation Measures Message or Environmental Annex to the Operational Order will be issued to further disseminate the personnel training requirement and general marine species mitigation measures.
- COs will make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.
- While underway, surface vessels will have at least two lookouts with binoculars; surfaced submarines will have at least one lookout with binoculars. Lookouts already posted for safety of navigation and man-overboard precautions may be used to fill this requirement. As part of their regular duties, lookouts will watch for and report to the OOD the presence of marine mammals and sea turtles.
- On surface vessels equipped with a MFA sonar, pedestal mounted "Big Eye" (20x110) binoculars will be properly installed and in good working order to assist in the detection of marine mammals in the vicinity of the vessel.
- Personnel on lookout will employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook.
- After sunset and prior to sunrise, lookouts will employ Night Lookout Techniques in accordance with the Lookout Training Handbook.
- Personnel on lookout will be responsible for reporting all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the OOD, since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may be indicative of a threat to the vessel and its crew, or indicative of a marine species that may need to be avoided as warranted. Navy environmental compliance relies heavily on the abilities of lookouts to detect and avoid protected species. Therefore, it is critical that lookouts be vigilant in their reporting.
- While in transit, naval vessels will be alert at all times, use extreme caution, and proceed at a "safe speed" so that the vessel can take proper and effective action to avoid a collision with any marine animal and can be stopped within a distance appropriate to the prevailing circumstances and conditions.
- When sea turtles or marine mammals have been sighted in the area, Navy vessels will increase vigilance and take reasonable and practicable actions to avoid collisions and activities that might result in close interaction of naval assets and marine mammals. Actions may include changing speed and/or direction and are dictated by environmental and other conditions (e.g., safety, weather).
- Naval vessels will maneuver to keep at least 1,500 ft (500 yds) away from any observed whale in the vessel's path and avoid approaching whales head-on. These requirements do not apply if a vessel's safety is threatened, such as when change of course will create an imminent and serious

threat to a person, vessel, or aircraft, and to the extent vessels are restricted in their ability to maneuver. Restricted maneuverability includes, but is not limited to, situations when vessels are engaged in dredging, submerged activities, launching and recovering aircraft or landing craft, minesweeping activities, replenishment while underway and towing activities that severely restrict a vessel's ability to deviate course. Vessels will take reasonable steps to alert other vessels in the vicinity of the whale. Given rapid swimming speeds and maneuverability of many dolphin species, naval vessels would maintain normal course and speed on sighting dolphins unless some condition indicated a need for the vessel to maneuver.

- Floating weeds and kelp, algal mats, clusters of seabirds, and jellyfish are good indicators of marine mammals. Therefore, where these circumstances are present, the Navy will exercise increased vigilance in watching for marine mammals.
- Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine mammals as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties. Marine mammal detections will be immediately reported to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species as appropriate when it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.
- All vessels will maintain logs and records documenting training operations should they be required for event reconstruction purposes. Logs and records will be kept for a period of 30 days following completion of a major training exercise.

5.2.1.2 Measures for Specific Training Events

<u>Mid-Frequency Active Sonar Activities</u>

General Maritime Mitigation Measures: Personnel Training

- All lookouts onboard platforms involved in ASW training events will review the NMFS-approved MSAT material prior to use of MFA sonar.
- All COs, XOs, and officers standing watch on the bridge will have reviewed the MSAT material prior to a training event employing the use of MFA sonar.
- Navy lookouts will undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook.
- Lookout training will include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, lookouts will complete the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). This does not forbid personnel being trained as lookouts from being counted as those listed in previous measures so long as supervisors monitor their progress and performance.
- Lookouts will be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of mitigation measures if marine species are spotted.

General Maritime Mitigation Measures: Lookout and Watchstander Responsibilities

- On the bridge of surface ships, there will always be at least three people on watch whose duties include observing the water surface around the vessel.

- All surface ships participating in ASW training events will, in addition to the three personnel on watch noted previously, have at all times during the exercise at least two additional personnel on watch as marine mammal lookouts.
- Personnel on lookout and officers on watch on the bridge will have at least one set of binoculars available for each person to aid in the detection of marine mammals.
- On surface vessels equipped with MFA sonar, pedestal mounted “Big Eye” (20x110) binoculars will be present and in good working order to assist in the detection of marine mammals in the vicinity of the vessel.
- Personnel on lookout will employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook.
- After sunset and prior to sunrise, lookouts will employ Night Lookout Techniques in accordance with the Lookout Training Handbook.
- Personnel on lookout will be responsible for reporting all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the OOD, since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may be indicative of a threat to the vessel and its crew or indicative of a marine species that may need to be avoided as warranted.

Operating Procedures

- A Letter of Instruction, Mitigation Measures Message, or Environmental Annex to the Operational Order will be issued prior to the exercise to further disseminate the personnel training requirement and general marine mammal mitigation measures.
- COs and OICs will make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible, consistent with safety of the ship.
- All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) will monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action.
- During MFA sonar operations, personnel will utilize all available sensor and optical systems (such as night vision goggles) to aid in the detection of marine mammals.
- Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.
- Aircraft with deployed sonobuoys will use only the passive capability of sonobuoys when marine mammals are detected within 200 yd (183 m) of the sonobuoy. Only the sonobuoys that are impacted by the mammal presence within 200 yd (183 m) need to be used in passive mode.
- Marine mammal detections will be immediately reported to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species, as appropriate, where it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.
- Safety Zones—When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) within 1,000 yd (914 m) of the sonar dome (the bow), the ship or submarine will limit active transmission levels to at least 6 decibels (dB) below normal operating levels. (A 6 dB reduction equates to a 75 percent power reduction. The reason is that decibel levels are on a logarithmic scale, not a linear scale. Thus, a 6 dB reduction results in a power level only 25 percent of the original power.)

  - Ships and submarines will continue to limit maximum transmission levels by this 6-dB factor until the animal has been seen to leave the 1,000 yd safety zone, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yd (1,829 m) beyond the location of the last detection.
  - Should a marine mammal be detected within 500 yd (457 m) of the sonar dome, active sonar transmissions will be limited to at least 10 dB below the equipment's normal operating level. (A 10 dB reduction equates to a 90 percent power recuction from normal operating levels.) Ships and submarines will continue to limit maximum ping levels by this 10-dB factor until the animal has been seen to leave the 500 yd safety zone, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yd (1,829 m) beyond the location of the last detection.
  - Should the marine mammal be detected within 200 yd (183 m) of the sonar dome, active sonar transmissions will cease. Sonar will not resume until the animal has been seen to leave the 200 yd safety zone, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yd (1,829 m) beyond the location of the last detection.
  - Special conditions applicable for dolphins and porpoises only: If, after conducting an initial maneuver to avoid close quarters with dolphins or porpoises, the OOD concludes that dolphins or porpoises are deliberately closing to ride the vessel's bow wave, no further mitigation actions are necessary while the dolphins or porpoises continue to exhibit bow wave riding behavior.
  - If the need for power-down should arise as detailed in “Safety Zones” above, the Navy will follow the requirements as though they were operating at 235 dB, the normal operating level (i.e., the first power-down will be to 229 dB, regardless of at what level above 235 dB active sonar was being operated).
- Prior to start up or restart of active sonar, operators will check that the Safety Zone radius around the sound source is clear of marine mammals.
- Active sonar levels (generally)—Navy will operate active sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.
- Helicopters will observe/survey the vicinity of an ASW training event for 10 minutes before the first deployment of active (dipping) sonar in the water.
- Helicopters will not dip their active sonar within 200 yd (183 m) of a marine mammal and will cease pinging if a marine mammal closes within 200 yd (183 m) after pinging has begun.
- Submarine sonar operators will review detection indicators of close-aboard marine mammals prior to the commencement of ASW training events involving MFA sonar.
- Night vision goggles will be available to all ships and air crews, for use as appropriate.
- Increased vigilance during major ASW training exercise with tactical active sonar when critical conditions are present.

  The Navy should avoid planning major ASW training exercises with MFA sonar in areas where they will encounter conditions which, in their aggregate, may contribute to a marine mammal stranding event. Of particular concern are beaked whales, for which strandings have been associated with MFA sonar operations.

  The conditions to be considered during exercise planning include:

  - Areas of at least 1,000 m (3,280 ft) depth near a shoreline where there is a rapid change in bathymetry on the order of 1,000-6,000 m (3,280-19,685 ft) occurring across a relatively short horizontal distance (e.g., 5 nm).
  - Cases for which multiple ships or submarines (≥ 3) operating MFA sonar in the same area over extended periods of time (≥ 6 hours) in close proximity (≤ 10 nm apart).
  - An area surrounded by land masses, separated by less than 35 nm and at least 10 nm in length, or an embayment, wherein operations involving multiple ships/submarines (≥ 3) employing MFA sonar near land may produce sound directed toward the channel or embayment that may cut off the lines of egress for marine mammals.
  - Though not as dominant a condition as bathymetric features, the historical presence of a significant surface duct (i.e., a mixed layer of constant water temperature extending from the sea surface to 100 ft [30 m] or more).

If the Major exercise must occur in an area where the above conditions exist in their aggregate, these conditions must be fully analyzed in environmental planning documentation. Requests to conduct an exercise that meet these conditions must be sent to the applicable U.S. Navy Component Commander no later than 90 days prior to the scheduled exercise. At a minimum, the request must contain dates of the exercise, location, participating units, and anticipated total time of MFA sonar use. The Navy will increase vigilance under these circumstances by undertaking the following additional mitigation measures:

- A dedicated aircraft (Navy or contracted) will conduct reconnaissance of the embayment or channel ahead of the exercise participants to detect marine mammals that may be in the area exposed to active sonar. Where practical, the advance survey should occur within 2 hours prior to MFA sonar use, and periodic surveillance should continue for the duration of the exercise. Any sightings of sensitive species, groups of species milling out of habitat, and any stranded animals, shall be reported to the Office in Tactical Command, who should give consideration to delaying, suspending, or altering the exercise.
- All safety zone power-down requirements described above apply.
- The post exercise report must include specific reference to any event conducted in areas where the above conditions exist, with exact location, time, and duration of the event, and noting results of surveys conducted.

Surface-to-Surface Gunnery (up to 5-inch explosive rounds)

- Lookouts will visually survey for floating weeds and kelp. Intended impact (i.e., where the Navy is aiming) will not be within 600 yd (549 m) of known or observed floating weeds and kelp, and algal mats.
- A 600 yd (549 m) radius buffer zone will be established around the intended target.
- From the intended firing position, lookouts will survey the buffer zone for marine mammals prior to commencement and during the exercise as long as practicable.
- For exercises using targets towed by a vessel or aircraft, target-towing vessels/aircraft will maintain a trained lookout for marine mammals, if applicable. If a marine mammal is sighted in the vicinity, the tow aircraft/vessel will immediately notify the firing vessel, which will suspend the exercise until the area is clear.
- The exercise will be conducted only when the buffer zone is visible and marine mammals are not detected within it.

Surface-to-Surface Gunnery (nonexplosive rounds)

- Lookouts will visually survey for floating weeds and kelp, and algal mats. Intended impact will not be within 200 yd (183 m) of known or observed floating weeds and kelp, and algal mats.
- A 200 yd (183 m) radius buffer zone will be established around the intended target.
- From the intended firing position, trained lookouts will survey the buffer zone for marine mammals prior to commencement and during the exercise as long as practicable.
- If applicable, target towing vessels will maintain a lookout. If a marine mammal is sighted in the vicinity of the exercise, the tow vessel will immediately notify the firing vessel in order to secure gunnery firing until the area is clear.
- The exercise will be conducted only when the buffer zone is visible and marine mammals are not detected within the target area and the buffer zone.

Surface-to-Air Gunnery (explosive and nonexplosive rounds)

- Vessels will orient the geometry of gunnery exercises in order to prevent debris from falling in the area of sighted marine mammals.
- Vessels will expedite the recovery of any parachute deploying aerial targets to reduce the potential for entanglement of marine mammals.
- Target towing aircraft will maintain a lookout, if applicable. If a marine mammal is sighted in the vicinity of the exercise, the tow aircraft will immediately notify the firing vessel in order to secure gunnery firing until the area is clear.

Air-to-Surface Gunnery (explosive and nonexplosive rounds)

- If surface vessels are involved, lookouts will visually survey for floating kelp in the target area. Impact will not occur within 200 yd (183 m) of known or observed floating weeds and kelp or algal mats.
- A 200 yd (183 m) radius buffer zone will be established around the intended target.
- If surface vessels are involved, lookout(s) will visually survey the buffer zone for marine mammals prior to and during the exercise.
- Aerial surveillance of the buffer zone for marine mammals will be conducted prior to commencement of the exercise. Aircraft crew/pilot will maintain visual watch during exercises. Release of ordnance through cloud cover is prohibited, aircraft must be able to actually see ordnance impact areas.
- The exercise will be conducted only if marine mammals are not visible within the buffer zone.

Air-to-Surface At-Sea Bombing Exercises (explosive and nonexplosive bombs)

- If surface vessels are involved, trained lookouts will survey for floating kelp and marine mammals. Ordnance will not be targeted to impact within 1,000 yd (914 m) of known or observed floating kelp or marine mammals.
- A 1,000 yd (914 m) radius buffer zone will be established around the intended target.
- Aircraft will visually survey the target and buffer zone for marine mammals prior to and during the exercise. The survey of the impact area will be made by flying at 1,500 ft (457 m) or lower, if safe to do so, and at the slowest safe speed. Release of ordnance through cloud cover is prohibited, aircraft must be able to actually see ordnance impact areas. Survey aircraft should employ most effective search tactics and capabilities.

- The exercises will be conducted only if marine mammals are not visible within the buffer zone.

Air-to-Surface Missile Exercises (explosive and nonexplosive)

- Ordnance will not be targeted to impact within 1,800 yd (1,646 m) of known or observed floating kelp.
- Aircraft will visually survey the target area for marine mammals. Visual inspection of the target area will be made by flying at 1,500 ft (457 m) or lower, if safe to do so, and at slowest safe speed. Firing or range clearance aircraft must be able to actually see ordnance impact areas. Explosive ordnance will not be targeted to impact within 1,800 yd (1646 m) of sighted marine mammals.

Sinking Exercise (SINKEX)

The selection of sites suitable for SINKEX involves a balance of operational suitability and requirements established under the Marine Protection, Research and Sanctuaries Act (MPRSA) permit granted to the Navy (40 Code of Federal Regulations § 229.2). To meet operational suitability criteria, locations must be within a reasonable distance of the target vessels' originating locations. The locations should also be close to active military bases to allow participating assets access to shore facilities. For safety purposes, these locations should also be in areas that are not generally used by non-military air or watercraft. The MPRSA permit requires vessels to be sunk in waters which are at least 1,000 fathoms (6,000 ft [2,000 yds/1,829 m]) deep and at least 50 nm (92.6 km) from land.

In general, most marine mammals prefer areas with strong bathymetric gradients and oceanographic fronts for significant biological activity such as feeding and reproduction. Typical locations include the continental shelf and shelf-edge.

SINKEX Mitigation Plan

The Navy has developed range clearance procedures to maximize the probability of sighting any ships or marine mammals in the vicinity of an exercise, which are as follows:

- All weapons firing will be conducted during the period one hour after official sunrise to 30 minutes before official sunset.
- Extensive range clearance operations would be conducted in the hours prior to commencement of the exercise, ensuring that no shipping is located within the hazard range of the longest-range weapon being fired for that event.
- An exclusion zone with a radius of 1.5 nm will be established around each target. This 1.5 nm zone includes a buffer of 0.5 nm to account for errors, target drift, and animal movement. In addition to the 1.5 nm exclusion zone, a further safety zone, which extends from the exclusion zone at 1.5 nm out an additional 0.5 nm, will be surveyed. Together, the zones (exclusion and safety) extend out 2 nm from the target.
- A series of surveillance over-flights will be conducted within the exclusion and the safety zones, prior to and during the exercise, when feasible. Survey protocol will be as follows:
    - Overflights within the exclusion zone will be conducted in a manner that optimizes the surface area of the water observed. This may be accomplished through the use of the Navy's Search and Rescue Tactical Aid, which provides the best search altitude, ground speed, and track spacing for the discovery of small, possibly dark objects in the water based on the environmental conditions of the day. These environmental conditions include the angle of sun inclination, amount of daylight, cloud cover, visibility, and sea state.

- All visual surveillance activities will be conducted by Navy personnel trained in visual surveillance. At least one member of the mitigation team will have completed the Navy's marine mammal training program for lookouts.
- In addition to the overflights, the exclusion zone will be monitored by passive acoustic means when assets are available. This passive acoustic monitoring would be maintained throughout the exercise. Potential assets include sonobuoys, which can be utilized to detect any vocalizing marine mammals (particularly sperm whales) in the vicinity of the exercise. The sonobuoys will be re-seeded as necessary throughout the exercise. Additionally, passive sonar onboard submarines may be utilized to detect any vocalizing marine mammals in the area. The OCE would be informed of any aural detection of marine mammals and would include this information in the determination of when it is safe to commence the exercise.
- On each day of the exercise, aerial surveillance of the exclusion and safety zones will commence two hours prior to the first firing.
- The results of all visual, aerial, and acoustic searches will be reported immediately to the OCE. No weapons launches or firing may commence until the OCE declares the safety and exclusion zones free of marine mammals.
- If a protected species observed within the exclusion zone is diving, firing will be delayed until the animal is re-sighted outside the exclusion zone, or 30 minutes have elapsed. After 30 minutes, if the animal has not been re-sighted it would be assumed to have left the exclusion zone.
- During breaks in the exercise of 30 minutes or more, the exclusion zone will again be surveyed for any protected species. If marine mammals are sighted within the exclusion zone, the OCE would be notified, and the procedure described above would be followed.
- Upon sinking of the vessel, a final surveillance of the exclusion zone will be monitored for two hours, or until sunset, to verify that no marine mammals were harmed.

- Aerial surveillance will be conducted using helicopters or other aircraft based on necessity and availability. The Navy has several types of aircraft capable of performing this task; however, not all types are available for every exercise. For each exercise, the available asset best suited for identifying objects on and near the surface of the ocean would be used. These aircraft would be capable of flying at the slow safe speeds necessary to enable viewing of marine vertebrates with unobstructed, or minimally obstructed, downward and outward visibility. The exclusion and safety zone surveys may be cancelled in the event that a mechanical problem, emergency search and rescue, or other similar and unexpected event preempts the use of one of the aircraft onsite for the exercise.
- Where practicable, the Navy will conduct the exercise in sea states that are ideal for marine mammal sighting, i.e., Beaufort Sea State Level 3 or less. In the event of a Level 4 or above, survey efforts will be increased within the exercise area. This will be accomplished through the use of an additional aircraft, if available, and conducting tight search patterns.
- The exercise will not be conducted unless the exclusion zone can be adequately monitored visually.
- In the event that any marine mammals are observed to be harmed in the area, a detailed description of the animal will be taken, the location noted, and if possible, photos taken. This information will be provided to NMFS via the Navy chain of command for purposes of identification (see the Stranding Plan for detail).

- An after action report detailing the exercise time line, the time the surveys commenced and terminated, amount, and types of all ordnance expended, and the results of survey efforts for each event will be submitted to NMFS.

Mitigation Measures Related to Explosive Source Sonobuoys (AN/SSQ-110A)

AN/SSQ-110A Pattern Deployment

- Crews will conduct visual reconnaissance of the drop area prior to laying their intended sonobuoy pattern. This search will be conducted below 1,500 ft (457 m) at a slow speed, if operationally feasible and weather conditions permit. In dual aircraft operations, crews are allowed to conduct coordinated area clearances.
- Crews will conduct a minimum of 30 minutes of visual and aural monitoring of the search area prior to commanding the first post (source/receiver sonobuoy pair) detonation. This 30-minute observation period may include pattern deployment time.
- For any part of the briefed pattern where a post (source/receiver sonobuoy pair) will be deployed within 1,000 yd (914 m) of observed marine mammal activity, the Navy will deploy the receiver ONLY and monitor while conducting a visual search. When marine mammals are no longer detected within 1,000 yd (914 m) of the intended post position, the Navy will co-locate the explosive source sonobuoys (AN/SSQ-110A) (source) with the receiver.
- When able, Navy crews will conduct continuous visual and aural monitoring of marine mammal activity. This is to include monitoring of aircraft sensors from first sensor placement to checking off-station and out of Radio Frequency (RF) range of these sensors.

AN/SSQ-110A Pattern Employment

- Aural Detection:
    - If the presence of marine mammals is detected aurally, then that will cue the Navy aircrew to increase the diligence of their visual surveillance.
    - Subsequently, if no marine mammals are visually detected, then the crew may continue multi-static active search.
- Visual Detection:

    If marine mammals are visually detected within 1,000 yd (914 m) of the explosive source sonobuoys (AN/SSQ-110A) intended for use, then that payload will not be detonated. Aircrews may utilize this post once the marine mammals have not been re-sighted for 30 minutes, or are observed to have moved outside the 1,000 yd (914 m) safety buffer. Aircrews may shift their multi-static active search to another post where marine mammals are outside the 1,000 yd (914 m) safety buffer.

AN/SSQ-110A Scuttling Sonobuoys

- Aircrews will make every attempt to manually detonate the unexploded charges at each post in the pattern prior to departing the operations area by using the “Payload 1 Release” command, followed by the “Payload 2 Release” command. Aircrews will refrain from using the “Scuttle” command when two payloads remain at a given post. Aircrews will ensure a 1,000 yd (914 m) safety buffer, visually clear of marine mammals, is maintained around each post as is done during active search operations.
- Aircrews will only leave posts with unexploded charges in the event of a sonobuoy malfunction, an aircraft system malfunction, or when an aircraft must immediately depart the area due to issues such as fuel constraints, inclement weather, and in-flight emergencies. In these cases, the sonobuoy will self-scuttle using the secondary or tertiary method.

- The Navy will ensure all payloads are accounted for. Explosive source sonobuoys (AN/SSQ-110A) that cannot be scuttled will be reported as unexploded ordnance via voice communications while airborne, then upon landing via naval message.
- Mammal monitoring will continue until out of own-aircraft sensor range.

5.2.1.3 Conservation Measures

Monitoring: Integrated Comprehensive Monitoring Program

The U.S. Navy is committed to demonstrating environmental stewardship while executing its National Defense mission and is responsible for compliance with a suite of federal environmental and natural resources laws and regulations that apply to the marine environment. As part of those responsibilities, an assessment of the long-term and/or population-level effects of Navy training activities as well as the efficacy of mitigation measures is necessary. The Navy is developing an Integrated Comprehensive Monitoring Program (ICMP) for marine species in order to assess the effects of training activities on marine species and investigate population trends in marine species distribution and abundance in various range complexes and geographic locations where Navy training occurs. This program will emphasize active sonar training.

The primary goals of the ICMP are to:

- Monitor Navy training events, particularly those involving MFA sonar and at sea explosions, for compliance with the terms and conditions of Endangered Species Act (ESA) Section 7 consultations or Marine Mammal Protection Act (MMPA) authorizations;
- Collect data to support estimating the number of individuals exposed to sound levels above current regulatory thresholds;
- Assess the efficacy of the Navy's current marine species mitigation;
- Add to the knowledge base on potential behavioral and physiological effects to marine species from mid-frequency active sonar and underwater detonations; and,
- Assess the practicality and effectiveness of a number of mitigation tools and techniques (some not yet in use).

Adaptive Management

Adaptive management principles consider appropriate adjustments to mitigation, monitoring, and reporting as the outcomes of the proposed actions and required mitigation are better understood. NMFS includes adaptive management principles in the regulations for the implementation of the proposed action, and any adaptive adjustments of mitigation and monitoring would be led by NMFS via the MMPA process and developed in coordination with the Navy. Continued opportunity for public input would be included via the MMPA process, as appropriate (i.e. via the "Letter of Authorization" process). The intent of adaptive management here is to ensure the continued proper implementation of the required mitigation measures, to conduct appropriate monitoring and evaluation efforts, and to recommend possible adjustments to the mitigation/monitoring/reporting to accomplish the established goals of the mitigation and monitoring which include:

Mitigation

- Avoidance or minimization of injury or death of marine mammals wherever possible,
- A reduction in the numbers of marine mammals (total number or number at biologically important time or location) exposed to received levels of sound associated with the proposed active sonar activities,

- A reduction in the number of times (total number or number at biologically important time or location) individuals would be exposed to received levels,
- A reduction in the intensity of exposures (either total number or number at biologically important time or location) to received levels,
- A reduction in effects to marine mammal habitat, paying special attention to the food base, activities that block or limit passage to or from biologically important areas, permanent destruction of habitat, or temporary destruction/disturbance of habitat during a biologically important time, and
- For monitoring directly related to mitigation—an increase in the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation measures (shut-down zone, etc.).

Monitoring

- An increase in the probability of detecting marine mammals, both within the safety zone (thus allowing for more effective implementation of the mitigation) and in general to generate more data to contribute to the effects analyses.
- An increase in our understanding of how many marine mammals are likely to be exposed to levels of MFA sonar/High-Frequency Active (HFA) sonar (or explosives or other stimuli) that we associate with specific adverse effects, such as behavioral harassment, Temporary Threshold Shift (TTS), or Permanent Threshold Shift (PTS).
- An increase in our understanding of how marine mammals respond to MFA sonar/HFA sonar (at specific received levels), explosives, or other stimuli expected to result in take and how anticipated adverse effects on individuals (in different ways and to varying degrees) may impact the population, species, or stock (specifically through effects on annual rates of recruitment or survival).
- An increased knowledge of the affected species.
- An increase in our understanding of the effectiveness of certain mitigation and monitoring measures.

Generally speaking, adaptive management supports the integration of NEPA's principles into the ongoing implementation and management of the Proposed Action, including a process for improving, where needed, the effectiveness of the identified mitigations. Note that any adjustment of mitigation and monitoring would be within the scope of the environmental analyses and considerations presented in this EIS/OEIS.

Research

The Navy provides a significant amount of funding and support to marine research. In the past 5 years the agency funded over $100 million ($26 million in Fiscal Year [FY] 08 alone) to universities, research institutions, federal laboratories, private companies, and independent researchers around the world to study marine mammals. The U.S. Navy sponsors 70 percent of all U.S. research concerning the effects of human-generated sound on marine mammals and 50 percent of such research conducted worldwide. Major topics of Navy-supported research include the following:

- Better understanding of marine species distribution and important habitat areas,
- Developing methods to detect and monitor marine species before and during training,
- Understanding the effects of sound on marine mammals, sea turtles, fish, and birds, and

- Developing tools to model and estimate potential effects of sound.

This research is directly applicable to Fleet training activities, particularly with respect to the investigations of the potential effects of underwater noise sources on marine mammals and other protected species. Proposed training activities employ active sonar and underwater explosives, which introduce sound into the marine environment.

The Marine Life Sciences Division of the Office of Naval Research currently coordinates six programs that examine the marine environment and are devoted solely to studying the effects of noise and/or the implementation of technology tools that will assist the Navy in studying and tracking marine mammals. The six programs are as follows:

- Environmental Consequences of Underwater Sound,
- Non-Auditory Biological Effects of Sound on Marine Mammals,
- Effects of Sound on the Marine Environment,
- Sensors and Models for Marine Environmental Monitoring,
- Effects of Sound on Hearing of Marine Animals, and
- Passive Acoustic Detection, Classification, and Tracking of Marine Mammals.

The Navy has also developed the technical reports referenced within this document, including the Marine Resource Assessment. Furthermore, research cruises by the National Marine Fisheries Service (NMFS) and by academic institutions have received funding from the U.S. Navy. For example, in April 2009, the Navy funded a vessel-based line-transect survey in the GOA on board the NOAA ship *Oscar Dyson* to determine marine mammal species distribution and abundance. The survey cruise employed multiple observation techniques, including visual and passive acoustic observations, as well as photographic identifications (Rone et al. 2009).

The Navy has sponsored several workshops to evaluate the current state of knowledge and potential for future acoustic monitoring of marine mammals. The workshops brought together acoustic experts and marine biologists from the Navy and other research organizations to present data and information on current acoustic monitoring research efforts and to evaluate the potential for incorporating similar technology and methods on instrumented ranges. However, acoustic detection, identification, localization, and tracking of individual animals still requires a significant amount of research effort to be considered a reliable method for marine mammal monitoring. The Navy supports research efforts on acoustic monitoring and will continue to investigate the feasibility of passive acoustics as a potential mitigation and monitoring tool.

Overall, the Navy will continue to fund ongoing marine mammal research, and is planning to coordinate long term monitoring/studies of marine mammals on various established ranges and operating areas. The Navy will continue to research and contribute to university/ external research to improve the state of the science regarding marine species biology and acoustic effects. These efforts include mitigation and monitoring programs; data sharing with NMFS and via literature for research and development efforts; and future research as described previously.

5.2.1.4 Monitoring: GOA TMAA Marine Species Monitoring Plan

The U.S. Navy has developed a GOA TMAA Monitoring Plan to provide marine mammal and sea turtle monitoring as required under the MMPA of 1972 and the ESA of 1973. In order to issue an Incidental Take Authorization (ITA) for an activity, Section 101(a) (5) (a) of the MMPA states that NMFS must set forth "requirements pertaining to the monitoring and reporting of such taking". The MMPA implementing regulations at 50 CFR Section 216.104 (a) (13) note that requests for Letters of Authorization (LOAs) must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present.

The GOA TMAA Monitoring Plan proposes monitoring goals for marine mammals that are unique with regard to their breadth as well as their focus on potential impacts of mid-frequency active sonar (MFAS) and underwater explosions on marine mammals and sea turtles. To accomplish these goals, the Navy will use similar methods of implementation and data analysis which have demonstrated success in comparable monitoring programs studying the effects of anthropogenic sound on marine animals. To this end, the Navy in consultation with NMFS designed a series of focused "study questions" to gather data in various combinations within the Navy's range complexes to address:

- Question 1. Are marine mammals and sea turtles exposed to mid-frequency active sonar (MFAS), especially at levels associated with adverse effects (i.e., based on NMFS' criteria for behavioral harassment, TTS, or PTS)? If so, at what levels are they exposed?

- Question 2. If marine mammals and sea turtles are exposed to MFAS in the TMAA, do they redistribute geographically as a result of continued exposure? If so, how long does the redistribution last?

- Question 3. If marine mammals and sea turtles are exposed to MFAS, what are their behavioral responses to various levels?

- Question 4. What are the behavioral responses of marine mammals and sea turtles that are exposed to explosives at specific levels?

- Question 5. Is the Navy's suite of mitigation measures for MFAS and explosives (e.g., Protective Measures Assessment Protocol [PMAP]), major exercise measures agreed to by the Navy through permitting) effective at avoiding TTS, injury, and mortality of marine mammals and sea turtles?

Given the larger scope of training events within other Navy range complexes as compared to GOA, not every one of these original five study questions will be addressed within the TMAA. Rather, data collected from the GOA TMAA monitoring will be used to supplement a consolidated range complex marine mammal monitoring report incorporating data from the Atlantic Fleet Active Sonar Training Range, Hawaii Range Complex, Northwest Training Range Complex, Marianna Islands Range Complex, and Southern California (SOCAL) Range Complex.

Monitoring methods proposed for the TMAA include use of passive acoustic monitoring to primarily focus on providing additional data for study questions 2, 3, and 4. In addition, in April of 2009, the Navy contributed approximately $150,000 in funding to support a NMFS marine mammal density survey of the offshore waters in GOA. The goal of this validation monitoring was increase the state of awareness on marine mammal occurrence, density, and distribution within GOA, an area that has not had significant visual survey effort. In addition to the U.S. Pacific Fleet funded monitoring initiative, the Chief of Naval Operations (CNO) Environmental Readiness Division and the Office of Naval Research (ONR) have developed a coordinated Science & Technology and Research & Development program focused on marine mammals and sound. Total investment in this program from 2004-2008 was $100 million. FY09 funding was $22 million. Continued funding at levels greater than $14 million is foreseen in subsequent years (2010 and beyond).

This GOA TMAA Monitoring Plan has been designed to attempt gathering data on all species of marine mammals and sea turtles observed in the TMAA study area. However, the Navy will prioritize monitoring efforts for species based on regulatory requirement due to ESA-listing, and on non-ESA-listed beaked whales. Therefore, offshore species for study within the Monitoring Plan that regularly occur within TMAA will be prioritized for research as follows:

- Beaked whale species (Baird's beaked whale, Cuvier's beaked whale, Stejneger's beaked whale)
- ESA-listed cetacean species (blue whale, fin whale, humpback whale, North Pacific right whale, sei whale, and sperm whale)

As an adaptive management strategy, the GOA TMAA Monitoring Plan will integrate elements from Navy-wide marine mammal research into the regional monitoring and data analysis proposed in this Plan when new technologies and techniques become available. Specific areas within the TMAA will be selected after consultations with NMFS and the regional science community for the most appropriate monitoring technique. Each monitoring technique has advantages and disadvantages that vary temporally and spatially, as well as support one particular study objective better than another. Given potential sea states and ocean conditions during winter, and the relatively infrequent Navy presence in the GOA, passive acoustic monitoring represents the best current technique to employ within the TMAA. There may be a number of potential additional marine mammal monitoring techniques, or variations of those already described, that could be attempted under this Plan. Future modifications to the TMAA Monitoring Plan may include integration of additional marine mammal monitoring techniques and research as either new technology or new information becomes available. As part of future dialogue to begin in the summer of 2010 with NMFS marine mammal scientists, Alaska academic scientists, and other subject matter experts with extensive field monitoring experience, the Navy will continually solicit input and recommendations to this Plan. An annual formal review with NMFS is being proposed at the end of each year's monitoring to capture lessons learned, and seek concurrence as to the best mix of monitoring techniques to employ in the next year's sampling based on scientific merit, applicability to the direct research questions posed in this Plan, and logistic and economic feasibility.

5.2.1.5 Stranding Response Plan for Major Navy Training Exercises in the TMAA

NMFS and the Navy will develop a draft Stranding Response Plan for Major Exercises in the TMAA. Pursuant to 50 CFR Section 216.105, the proposed plan outlined below will be included by reference and included in the TMAA proposed and final rules from NMFS, and included fully as part of (attached to) the Navy's MMPA LOA. This Stranding Response plan is specifically intended to outline the applicable requirements the authorization is conditioned upon in the event that a marine mammal stranding is reported in the TMAA during a major training exercise (MTE) (see glossary). As mentioned above, NMFS considers all plausible causes within the course of a stranding investigation. However, this plan in no way presumes that any strandings are related to, or caused by, Navy training activities, absent a determination made in a Phase 2 Investigation as outlined in this plan, indicating that MFAS or explosive detonation in the TMAA were a cause of and/or contributed to the stranding. This plan is designed to address the following three issues:

- Mitigation – When marine mammals are in a situation that can be defined as a stranding (see glossary below), they are experiencing physiological stress. When animals are stranded, and alive, NMFS believes that exposing these compromised animals to additional known stressors would likely exacerbate the animal's distress and could potentially cause its death. Regardless of the factor(s) that may have initially contributed to the stranding, it is NMFS' goal to avoid exposing these animals to further stressors. Therefore, when live stranded cetaceans are in the water and engaged in what is classified as an Uncommon Stranding Event (USE) (see Appendix F), the shutdown component of this plan is intended to minimize the exposure of those animals to MFAS and explosive detonations, regardless of whether or not these activities may have initially played a role in the event.

- Monitoring – This plan will enhance the understanding of how MFAS (as well as other environmental conditions) may, or may not, be associated with marine mammal injury or strandings. Additionally, information gained from the investigations associated with this plan may be used in the adaptive management of mitigation or monitoring measures in subsequent LOAs, if appropriate. We note that detections of stranded marine mammals off the southern Alaskan Coast are typically accomplished using passive surveillance, i.e. individuals conducting their normal activities happen to see an animal and report it to the stranding network. If surveys or expanded active detection efforts are specifically used during Navy training exercises, we expect that the number of strandings detected during training may be higher relative to other times because of the increased targeted effort.
- Compliance – The information gathered pursuant to this protocol will inform NMFS' decisions regarding compliance with Sections 101(a) (5) (B and C) of the MMPA. In addition to outlining the necessary procedural steps for the Navy to undertake in the event of a USE during an MTE (as required by the LOA), this document describes NMFS' planned participation in stranding responses off the Alaskan Coast, as NMFS' response relates specifically to the Navy requirements described here. The NMFS Marine Mammal Health and Stranding Response Program (MMHSRP) and the participating Regional Stranding Networks have specific responsibilities regarding unusual marine mammal mortality events (UMEs) pursuant to Title IV of the MMPA. This standing plan does not serve to replace or preclude any of the procedures currently in place for NMFS' response to UMEs or to any normal operations of the stranding network. NMFS will pursue any activities to fulfill obligations relative to UMEs any time that a trigger is reached as determined by the Working Group on Marine Mammal Unusual Mortality Events. This document highlights (or adds to) applicable existing (and in development) protocols and procedures to be used with the specific circumstances and specific subset of strandings addressed here, namely a USE off the Alaskan Coast during the MTE. This document has been reviewed and approved by the NMFS staff responsible for conducting and overseeing the referenced activities and this plan will be implemented by NMFS to the degree that resources are available and logistics are feasible.

General Notification Provision

If, at any time or place (i.e., not just in TMAA and not just during the activities covered under NMFS' regulations), Navy personnel find a stranded marine mammal either on the shore, nearshore, or floating at sea, NMFS requests the Navy contact NMFS immediately (or as soon as clearance procedures allow) as described in the TMAA Stranding Communication Protocol (currently under development, but subject to incorporation into this plan upon mutual agency approval). NMFS will request the Navy provide NMFS with species or description of animal(s), the condition of the animal (including carcass condition if the animal is dead, location, time of first discovery, observed behaviors (if alive), and photo or video (if available).

In addition, NMFS requests that in the event of a ship strike by any Navy vessel, at any time or place, the Navy do the following:

- Navy immediately report to NMFS the species identification (if known), location (lat/long) of the animal (or the strike if the animal has disappeared), and whether the animal is alive or dead (or unknown).
- As soon as feasible, report to NMFS the size and length of animal, an estimate of the injury status (e.g., dead, injured but alive, injured and moving, unknown, etc.), vessel class/type, and operational status.
- Report to NMFS the vessel length, speed, and heading as soon as feasible.
- Provide NMFS a photo or video, if possible.

Operational Response Plan

This section describes the specific actions the Navy must take in order to comply with NMFS' GOA TMAA LOA if a USE is reported to the Navy off the southern Alaskan Coast coincident to, or within 72 hours of, an MTE. This Stranding Response Plan will include an associated TMAA Stranding Communication Protocol (currently under development, but subject to incorporation into the Stranding Plan upon mutual agency approval), which will indicate, among other things, the specific individuals (NMFS Office of Protected Resources - HQ senior administrators) authorized to advise the Navy that certain actions are prescribed by the Stranding Response Plan.

1. Initial Stranding Response – The NMFS regional stranding network will respond to reports of stranded marine mammals in areas where there is geographic coverage by the stranding network, when feasible. All cetaceans that are responded to will receive examination appropriate to the condition code of the animal and the feasibility of the logistics. If a qualified individual determines that the stranding is a USE, NMFS staff (or other qualified individual) will initiate a Phase 1 Investigation. NMFS will immediately contact appropriate NMFS and Navy personnel (pursuant to the TMAA Stranding Communication Protocol). NMFS and Navy will maintain a dialogue, as needed, regarding the identification of the USE and the potential need to implement shutdown procedures.

2. Shutdown Procedures – Shutdown procedures are not related to the investigation of the cause of the stranding and their implementation is in no way intended to imply that MFAS is the cause of the stranding. Rather, as noted above, shutdown procedures are intended to protect cetaceans exhibiting indicators of distress and involved in a USE by minimizing their exposure to possible additional stressors (MFAS or explosive detonations), regardless of the factors that initially contributed to the USE. Only individuals specifically identified in the TMAA Stranding Communication Protocol (NMFS Protected Resources – HQ senior administrators) will be authorized to advise the Navy of the need to implement shutdown procedures (pursuant to the Stranding Response Plan/LOA).

a) If live or freshly dead cetaceans are involved in the USE, the Navy will implement the following procedures:

- If live cetaceans involved in the USE are in the water (i.e., could be exposed to sonar), NMFS will advise the Navy of the need to implement shutdown procedures defined in the glossary (pursuant to the Stranding Response Plan/LOA).
- NMFS will coordinate internally, with the Navy, and with other agencies and entities with the intent of obtaining aerial survey arrangements. If an aircraft is available, a survey will be conducted within 14 miles (on the shore and in the water near the coast) of the stranding to look for additional animals that meet the USE criteria. NMFS will request that the Navy assist with aerial surveys, as resources are available.
- If no additional animals that meet the USE criteria are found (including if no aircraft were available to conduct a survey), and the originally detected animals are not in the water, and will not be put back in the water for rehabilitation or release purposes, or are dead, NMFS will advise the Navy that shutdown procedures need not be implemented at any additional locations.
- If additional cetacean(s) meeting the USE criteria are detected by surveys, the shutdown procedures will be followed for the newly detected animal(s) beginning at 2(a) above.
- If a qualified individual determines that it is appropriate to put live animals that were initially on the beach back in the water for rehabilitation or release purposes, NMFS will advise the Navy of the need to implement shutdown procedures pursuant to the Stranding Response Plan/LOA.

b) If the Navy finds an injured (or entangled) or dead cetacean floating at sea during an MTE, the Navy shall notify NMFS (pursuant to TMAA Stranding Communication Protocol) immediately or as soon as operational security considerations allow. The Navy should provide NMFS with the information outlined in the general notification provision above, as available. Based on the information provided, NMFS will determine if a modified shutdown (i.e., a shutdown other than those described here, based on specific information available at the time) is appropriate on a case-by-case basis.

c) In the event, following a USE, that: a) qualified individuals are attempting to herd animals back out to the open ocean and animals are not willing to leave, or b) animals are seen repeatedly heading for the open ocean but turning back to shore, NMFS and the Navy will coordinate (including an investigation of other potential anthropogenic stressors in the area) to determine if the proximity of MFAS operations or explosive detonations, though farther than 14 nm from the distressed animal(s), is likely decreasing the likelihood that the animals return to the open water. If so, NMFS and the Navy will further coordinate to determine what measures are necessary to further minimize that likelihood and implement those measures as appropriate. Navy and NMFS will maintain a dialogue regarding the plan to return the animal(s) to the water.

d) If no live (Condition Code 1) or freshly dead (Condition Code 2) cetaceans are involved in the USE, NMFS will advise the Navy that shutdown procedures need not be implemented. Aerial surveys will be conducted if feasible (see second bullet below).

3. Restart Procedures

- If at any time, the subject(s) of the USE die or are euthanized, NMFS will immediately advise the Navy that the shutdown around that animal(s)' location is no longer needed.
- Shutdown procedures will remain in effect until NMFS determines that, and advises the Navy that, all live animals involved in the USE have left the area (either of their own volition or herded). Leading up to restart, NMFS will coordinate internally, with the Navy, and with other federal and state agencies with the intent of securing arrangements to track the movement of the animals (via aircraft, vessel, tags, etc.) following the dispersal of the USE. If the Navy has restarted operations in the vicinity of the animals, NMFS and the Navy will further coordinate to determine (based on location and behavior of tracked animals and location/nature of Navy activities) if the proximity of MFAS operations is likely increasing the likelihood that the animals re-strand. If so, NMFS and the Navy will further coordinate to determine what measures are necessary to minimize that likelihood and implement those measures as appropriate.

4. Information – Within 72 hours of the notification of the USE the Navy will inform NMFS where and when they were operating MFAS or conducting explosive detonations (within 80 nm and 72 hours prior to the event). Within 7 days of the completion of any exercises that were being conducted within 80 nm or 72 hours prior to the event, the Navy will further provide available information to NMFS (per the GOA Stranding Communication Protocol) regarding the number and types of acoustic/explosive sources, direction and speed of units using MFAS, and marine mammal sightings information associated with those training activities. Information not initially available regarding the 80 nm, 72 hours, period prior to the event will be provided as soon as it becomes available. The Navy will provide NMFS investigative teams with additional relevant unclassified information as requested (or classified information to designated NMFS staff), if available.

5. Phase 1 Investigation – Because of the variability of available resources across stranding network agencies in the Alaska region, NMFS cannot currently commit, in advance, to the specific degree of investigation that will be conducted for any given stranding. NMFS stranding coordinators are currently assessing available resources with the goal of setting forth a plan that realistically outlines the possible responses in a given area. Meanwhile, the ideal responses (Phase 1 and 2 Investigations) are described in the Biomonitoring Protocols and are referred to below (here and in # 7), and NMFS will respond in the indicated manner when resources are available and it is logistically feasible:

Within 4 weeks of a USE (when feasible), NMFS will conduct and complete the Phase 1 Investigation (list of procedures typically included in Phase 1 investigation are included in the glossary of this document, description of actual procedures are contained in the Biomonitoring Protocols) for all USEs that occur along the southern Alaskan Coast coincident with MTEs. Results from the Phase 1 Investigation will be categorized in one of the two ways discussed below and trigger the indicated action:

- If the results of the Phase 1 Investigation indicate that the USE was likely caused by something (such as entanglement or ship strike) other than MFAS or explosive detonations authorized by the Navy's LOA, then the USE investigation will be considered complete as related to the MMPA authorization.
- If NMFS cannot conclude that the stranding was likely caused by something other than MFAS or explosive detonations authorized by the Navy LOA, rather, the results of the Phase 1 Investigation range from completely inconclusive to including potential early indicators that acoustic exposure could have played a role, then a Phase 2 Investigation will be conducted by qualified individuals, under the direction of NMFS staff, and an individual case report will be prepared for each animal (list of procedures typically included in Phase 2 investigation are included in the Glossary of this document, description of actual procedures are contained in the Biomonitoring Protocols).

6. Memorandum of Agreement (MOA) – The Navy and NMFS will develop an MOA, or other mechanism consistent with federal fiscal law requirements (and all other applicable laws), that allows the Navy to assist NMFS with the Phase 1 and 2 Investigations of USEs through the provision of in-kind services, such as (but not limited to) the use of plane/boat/truck for transport of stranding responders or animals, use of Navy property for necropsies or burial, or assistance with aerial surveys to discern the extent of a USE. The Navy may assist NMFS with the Investigations by providing one or more of the in-kind services outlined in the MOA, when available and logistically feasible and which do not negatively affect Fleet operational commitments.

7. Phase 2 Investigation – Please see # 5, Phase 1 Investigation. Results from the Phase 2 Investigation (procedures outlined in the Biomonitoring Protocols) will be categorized in one of the three ways discussed below and trigger the indicated action:

- If the results indicate that the USE was likely caused by something (such as entanglement or blunt force trauma) other than MFAS or explosive detonations authorized by the Navy's LOA, then the USE investigation will be considered complete as related to the MMPA authorization.
- If the results are inconclusive which, historically, is the most likely result (i.e., NMFS can neither conclude that the USE was likely caused by something other than acoustic trauma nor conclude that there is a high likelihood that exposure to MFAS or explosive detonations were a cause of the USE), then the USE investigation will be considered complete as related to the MMPA authorization.
- If the results of a comprehensive and detailed scientific investigation into all possible causes of the stranding event indicate that there is a high likelihood that MFAS was a cause of the USE, one of the following will occur: The Navy will be provided at least ten working days to review and provide comments on NMFS' summary and characterization of the factors involved in the USE. NMFS will consider the Navy's comments prior to finalizing any conclusions and/or deciding to take any action involving any take authorization.

8. USE Response Debrief and Evaluation – Within 2 months after a USE, NMFS and Navy staff will meet to discuss the implementation of the USE response and recommend modifications or clarifications to improve the Stranding Response Plan. These recommendations will feed into the adaptive management strategy discussed below.

9. Adaptive Management – The regulations under which the Navy's LOA (and this Stranding Response Plan) are issued will contain an adaptive management component. This gives NMFS the ability to

consider the results of the previous years' monitoring, research, and/or the results of stranding investigations when prescribing mitigation or monitoring requirements in subsequent years. In the event that NMFS concludes that there is a high likelihood that MFAS or explosive detonations were a cause of a USE, NMFS will review the analysis of the environmental and operational circumstances surrounding the USE. In subsequent NMFS LOAs, based on this review and through the adaptive management component of the regulations, NMFS may require the mitigation measures or Stranding Response Plan be modified or supplemented if the new data suggest that modifications would either have a reasonable likelihood of reducing the chance of future USEs resulting from a similar confluence of events or would increase the effectiveness of the stranding investigations. Further based on this review and the adaptive management component of the regulations, NMFS may modify or add to the existing monitoring requirements if the data suggest that the addition of a particular measure would likely fill a specifically important data or management gap. Additionally, the USE Debrief and Evaluation discussed above (in combination with adaptive management) will allow NMFS and the Navy to further refine the Stranding Response Plan for maximum effectiveness.

Communication

Effective communication is critical to the successful implementation of this Stranding Response Plan. Very specific protocols for communication, including identification of the Navy personnel authorized to implement a shutdown and the NMFS personnel authorized to advise the Navy of the need to implement shutdown procedures (NMFS Protected Resources HQ – senior administrators) and the associated phone trees, etc. (to be included in the document entitled "TMAA Stranding Communication Protocols") will be finalized at a subsequent date, and updated yearly (or more frequently, as appropriate).

The Stranding Response Plan is dependent upon advance notice to NMFS (HQ and Alaska Regional Office) of the planned upcoming MTE. NMFS and the Navy will develop a mechanism (that conforms with operational security requirements) wherein the Navy can provide NMFS with necessary advance notification of MTEs.

NMFS will keep information about planned MTEs in a confidential manner and will transmit information to NMFS personnel responding to USEs to the minimum necessary to accomplish the NMFS mission under this plan.

Supplemental Documents in Development

GOA Stranding Communication Protocol

This document, which is currently in development, will include all of the communication protocols (phone trees, etc.) and associated contact information required for NMFS and the Navy to carry out the actions outlined in this Stranding Response Plan. This document is currently being developed by NMFS and when completed, will be updated yearly (or more frequently, as appropriate).

Biomonitoring Protocols for GOA

This NMFS document (which is currently in a draft form, but will be finalized in 2010) will contain protocols for the procedures that are necessary for NMFS staff to implement this Stranding Plan including:

- Qualifications necessary for individuals to implement certain parts of the Stranding Plan, such as: identifying a USE, identifying a Code 2 animal, or conducting a Phase 1 or 2 Investigation
- A protocol for the stranding responders that outlines the actions to take in the event of a USE during MTEs
- Protocols for the investigators that describe in detail the procedures implemented for conducting the Phase 1 and Phase 2 Investigations

Memorandum of Agreement

This document (or other mechanism consistent with federal fiscal law requirements and all other applicable laws), which will be finalized in 2010, will establish whereby the Navy can assist with stranding investigations, when feasible. This document will include a comprehensive list of the specific ways the Navy could provide this assistance.

5.2.1.6 Alternative Mitigation Measures Considered but Eliminated

As described in Section 3.9 and Appendix D, the vast majority of estimated sound exposures of marine mammals in the GOA during proposed active sonar activities would not cause injury. Potential acoustic effects on marine mammals would be reduced by the mitigation measures described previously. Therefore, through this EIS and associated regulatory documents. the National Marine Fisheries Service (NMFS) and the Navy have concluded the Proposed Action and mitigation measures would achieve the least practical adverse impact on species or stocks of marine mammals.

Based on NMFS' preliminary determinations reached in the development of the proposed rule associated with the Gulf of Alaska, the Navy anticipates that NMFS will determine that the Final EIS/OEIS adequately analyzes the training activities in the Gulf of Alaska. NMFS is anticipated to adopt the GOA Final EIS/OEIS to support the proposed issuance of the MMPA incidental take regulations, the 2009 LOA, and future LOAs as appropriate. As mentioned above, NMFS must also prescribe regulations that set forth the means of effecting the least practicable adverse impact on affected species or stocks and their habitat (i.e., mitigation measures). The Navy's Final EIS/OEIS will include a suite of proposed mitigation measures, a discussion of mitigation measures that were considered by the Navy and NMFS, but eliminated, and an indication that additional mitigation measures (either not discussed in the Final EIS/OEIS or measures considered but eliminated in the Final EIS/OEIS) may be required by NMFS/Navy Final Rule adaptive management process. As will be indicated in the Final EIS/OEIS, all alternatives include implementation of mitigation measures, and the analysis of mitigation alternatives will be specifically presented in this chapter of the Final EIS/OEIS.

In making a determination of "least practicable adverse impact," NMFS considers the following factors relative to one another: (1) the manner in which, and the degree to which, the successful implementation of the measure is expected to minimize adverse impacts to marine mammals; (2) the proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and (3) the practicability of the measure for Navy implementation, which includes consideration of personnel safety, practicality of implementation, and the impact on the effectiveness of the military readiness activity. Accordingly, the following additional mitigation measures were analyzed and eliminated from further consideration:

Seasonal and/or Geographic Limitations:

Benefit to Marine Mammals/Effectiveness of Measure

In previous documents NMFS has indicated that seasonal or geographic limitations are a direct and effective means of reducing adverse impacts to marine mammals. By reducing the overlap in time and space of the known concentrations of marine mammals and the acoustic footprint associated with the thresholds for the different types of take (either at all times and places where animals are concentrated, or times and places where they are concentrated for specifically important behaviors [such as reproduction or feeding]), the amount of take can be reduced.

However, the concept of geographical and seasonal (or temporal) limitations is inconsistent with the Title 10 responsibilities of Department of Defense to assure a fully trained and ready military force in regards to training activities in the GOA. Such restrictions would not be appropriate in the GOA. The training area locations utilized in the GOA were very carefully chosen by planners based on training requirements and the ability of ships, aircraft, and submarines to operate safely. Moving the training activities to alternative locations would impact the effectiveness of the training and has no known benefit.

It is important that any measures are used carefully at times and places where their effects are relatively well known. For example, if there is credible evidence that concentrations of marine mammals are known to be high at a specific place or during a specific time of the year, or that certain areas are selectively used for important life functions like breeding or feeding (such as the high densities of humpback whales in the main Hawaiian Islands, or North Atlantic right whale critical habitat on the east coast), then these types of seasonal or geographic exclusions or limitations can be effective. However, if marine mammals are only known to prefer certain types of areas (as opposed to specific areas) for certain functions (such as beaked whales use of seamounts or marine mammal use of productive areas like fronts), which means that they may or may not be present at any specific time, it may be less effective to require avoidance or limited use of that type of area all of the time.

In the GOA, for the purposes of this EIS/OEIS, the Navy has no plans to conduct sonar training, and only very minimal underwater explosive training, in the Inshore Area where the Southern Resident killer whale critical habitat is located. The Navy will abide by the standard 3,000-ft aquatic and aerial restrictions designated for Stellar Sea Lion critical habitat on the coast.

Practicability of the Measure

Generally speaking, and specifically discussed in Chapter 2 of the EIS/OEIS, the Navy needs to have the flexibility to operate at any time or place to meet their training needs pursuant to Title 10. The Navy needs to be able to train in the largest variety of physical (bathymetry, etc.), environmental, and operational (within vicinity of different assets, such as airfields, instrumented ranges, homeports, etc.) parameters in order to be properly prepared. Additionally, Navy training, planning and implementation needs to be adaptable in order to accommodate the need of the Navy to respond to world events and the ever-changing strategic focus of the U.S. The Navy has always expressed a need to maintain the flexibility to train in an area if necessary for national security, and any measures imposed by NMFS need to account for this reality.

Aside from the general reasons of impracticability cited above, below are some of the specific reasons that certain specific types of seasonal and geographic restrictions or limitations are impracticable for the Navy.

Coastal restrictions (such as 25 nm from 200-m isobath) - Littoral waterspace is where potential enemies will operate. The littoral waterspace is also the most challenging area to operate due to a diverse acoustic environment. In real world situations, it is highly likely the Navy would be working in these types of areas. It is not realistic to refrain from training in the areas that are the most challenging and operationally important. Areas where ASW events are scheduled to occur are carefully chosen to provide for the safety of events and to allow for the realistic development of the training scenario including the ability of the exercise participants to develop, maintain, and demonstrate proficiency in all areas of warfare simultaneously. Limiting the training event to a few areas would have an adverse impact on the effectiveness of the training by limiting the ability to conduct other critical warfare areas including, but not limited to, the ability of the Strike Group to defend itself from threats on the surface and in the air while carrying out air strikes and/or amphibious assaults. In those locations where amphibious landing events occur, coastal restrictions would decouple ASW training and Amphibious training, which are critically important to be conducted together due to the high risk to forces during actual Amphibious operations. Furthermore, training activities using integrated warfare components require large areas of the littorals and open ocean for realistic and safe training.

Sea Mounts and Canyons- Submarine tracking is a long and complicated tactical procedure. Seamounts are often used by submarines to hide or mask their presence, requiring the need to train in this complex ocean environment. This is precisely the type of area needed by the Navy to train. Sea mounts and canyons impact the way sound travels in water as well as the Navy's ability to search and track submarines. If the Navy does not train near sea mounts and canyons and understand how these features affect their ability to search and track a submarine, they will be unable to do so when faced with an actual threat. Exercise locations are carefully chosen based on training requirements and the ability of ships, aircraft, and submarines to operate safely. Given the strategic training needs, restricting active sonar operation around seamounts and canyons in the TMAA is not practicable. This discussion considers the impracticability of avoiding all seamounts and canyons. While it may be somewhat less impracticable to avoid a subset of specific seamounts or canyons, marine mammal use of these areas is ephemeral and varies based on many changing factors, which would make it difficult to justify requiring the avoidance of any particular features since doing so may or may not benefit marine mammals at any particular time.

Fronts and other Major Oceanographic Features – NMFS has determined that the impracticability to the Navy of avoiding these features outweighs the potential conservation gain. Though many species may congregate near fronts and other major oceanographic features, these areas may be both large and transitory, so restricting access to these features to avoid animals that may congregate in a small subset of the total areas is not practicable. Additionally, limiting sonar use in the vicinity of these types of features would disrupt training for the reasons described above for sea mounts and canyons.

Use of Dedicated or Independent Marine Mammal Observers (MMOs) to Implement Mitigation:

Benefit to Marine Mammals/Effectiveness of Measure

Navy lookouts are specifically trained to detect anything (living or inanimate) that is in the vicinity of, visible from, or approaching the vessel. The safety of the personnel on board and of the vessel depends on their performance. While they receive training that is intended to expose them to the different species of marine mammals they might see and the behaviors they might potentially observe, they would certainly not be expected to differentiate between species or identify the significance of a behavior as effectively as an independent MMO. However, identification to species and understanding of marine mammal behavior is not necessary for mitigation implementation – for that, a lookout must simply detect a marine mammal and estimate its distance (e.g., within 1000 yds, 500 yds, or 200 yds) to the vessel. Though dedicated and independent MMOs are critical to implement a Monitoring Plan, Navy lookouts performing their normal duties are expected to be effective at detecting marine mammals for mitigation implementation.

Practicability of the Measure

Following are several reasons for why using third-party observers from air or surface platforms, in addition to or instead of the existing Navy-trained lookouts is not practicable.

- The use of third-party observers could compromise security due to the requirement to provide advance notification of specific times/locations of Navy platforms.
- Reliance on the availability of third-party personnel would also impact training flexibility, thus adversely affecting training effectiveness. The presence of other aircraft in the vicinity of naval exercises would raise safety concerns for both the commercial observers and naval aircraft.
- Use of Navy observers is the most effective means to ensure quick and effective implementation of mitigation measures if marine species are spotted. A critical skill set of effective Navy training is communication. Navy lookouts are trained to act swiftly and decisively to ensure that appropriate actions are taken.
- Security clearance issues would have to be overcome to allow non-Navy observers onboard exercise platforms.

- Some training events will span one or more 24-hour period(s), with operations underway continuously in that timeframe. It is not feasible to maintain non-Navy surveillance of these operations, given the number of non-Navy observers that would be required onboard.
- Surface ships with active mid-frequency sonar have limited berthing capacity. Exercise planning includes careful consideration of this limited capacity in the placement of exercise controllers, data collection personnel, and Afloat Training Group personnel on ships involved in the exercise. Inclusion of non-Navy observers onboard these ships would require that in some cases there would be no additional berthing space for essential Navy personnel required to fully evaluate and efficiently use the training opportunity to accomplish the exercise objectives.
- Aerial surveying during an event raises safety issues with multiple, slow civilian aircraft operating in the same airspace as military aircraft engaged in combat training activities. In addition, most of the training events take place far from land, limiting both the time available for civilian aircraft to be in the exercise area and presenting a concern should aircraft mechanical problems arise.
- Scheduling civilian vessels or aircraft to coincide with training events would impact training effectiveness, since exercise event timetables cannot be precisely fixed and are instead based on the free-flow development of tactical situations. Waiting for civilian aircraft or vessels to complete surveys, refuel, or be on station would slow the progress of the exercise and impact the effectiveness of the military readiness activity.
- Multiple events may occur simultaneously in areas at opposite ends of the TMAA and continue for multiple days at a time. There are not enough qualified third-party personnel to accomplish the monitoring task.

Use of Additional Detection Methods to Implement Mitigation (Shutdown Zones):

Benefit to Marine Mammals/Effectiveness of Measure

Lookouts stationed on surface vessels are currently the primary component of the Navy's marine mammal detection capabilities, with some opportunistic assistance from aerial or passive acoustic platforms when such assets are participating in a given exercise. The use of additional detection methods, such as those listed in Section 5.2.1.2, for the implementation of mitigation might further minimize the Level A and Level B of marine mammals. Specifically, passive and active acoustic methods may detect animals that were below the surface (for passive acoustic detection, the animals would have to be vocalizing to be detected, but for active acoustic detection they would not – the HFM3 system utilized by LFA sonar vessels effectively detects marine mammals to within 1 km of the sonar source).

In order for additional marine mammal detection methods to assist in the implementation of mitigation (shutdown and powerdown), they must be able to localize, or identify where the marine mammal is in relation to the sound source of concern (since shutdown and powerdown mitigation is triggered by the distance from the sound source), and transmit the applicable data to the commanding officer in real time (i.e., quickly so that the sonar source can be turned down or shut off right away or the explosive detonation can be delayed). A limited number of techniques based on the real-time participation of additional observers (such as additional aerial platforms) can achieve this, while many passive acoustic methods cannot. The section below contains information that speaks both to the practicality of implementation of some methods as well as the effectiveness.

Practicability of the Measure

Radars - While Navy radars are used to detect objects at or near the water surface, radars are not specifically designed to search for and identify marine mammals. For example, when an object is detected by radar, the operators cannot definitively discern that it is a whale. During a demonstration project at

Pacific Missile Range Facility (PMRF) in Hawaii, radar systems were only capable of detecting whales under very controlled circumstances and when these whales were already visually spotted by lookouts/watchstanders. Enhancing radar systems to detect marine mammals requires additional resources to schedule, plan and execute Navy limited objective experiments (LOEs) and RDT&E events. The Navy is currently reviewing opportunities to pursue enhancing radar systems and other developmental methods such as laser detection and ranging technology as potential mitigation for detecting marine mammals. Until funding resources and the data are available to develop enhanced systems, it is not known whether it will be technically feasible in the future to implement radar as an additional detection method.

Additional Platforms (aerial, UAV, Gliders, and Other**)** - The number of aerial and unmanned aerial vehicle (UAV) systems currently integrated into fleet training is extremely low and their availability for use in most training events is rare; therefore, shifting their use and focus from hunting submarines to locating marine mammals would be costly and negatively impact the training objectives related to these systems. If additional platforms are civilian, scheduling civilian vessels or aircraft to coincide with training events would affect training effectiveness since exercise events or timetables are not fixed and are based on a free flow development of tactical situations. Waiting for civilian aircraft or vessels to complete surveys, refuel, or be on station would slow the required progress of the training exercise. In addition, the precise location data and exercise plans provided to non-Navy assets poses logistical challenges and classification or security issues. While the Navy is currently reviewing options for additional detection methods, these additional platforms proved to be impracticable for the following reasons:

- Additional Aerial Survey Detection: Airborne assets when available already monitor for the presence of marine mammals with no reported incidents where marine mammals were overlooked during an exercise or where aerial assets were unable to perform their duties while watching for marine mammals; therefore, the allocation of additional airborne assets is not well justified. In addition, the presence of additional aircraft (not involved in the exercise) near naval exercises would present safety concerns for both commercial and naval observers because ASW training exercises are dynamic, can last several hours or days, and cover large areas of ocean several miles from land.
- UAV Detection: Currently and in the foreseeable five-year period of the requested authorization, these assets are extremely limited and are rarely if ever available and, therefore, impractical and expensive.
- Gliders Detection: Gliders are not currently capable of providing real time data and, therefore, are not an effective detection method for use in mitigation implementation.

Active Sonar - As previously noted, the Navy is actively engaged in acoustic monitoring research involving a variety of methodologies; however, none of the methodologies have been developed to the point where they could be used as a mitigation tool for MFAS or HFAS. At this time, the active sonar and adjunct systems listed below proved to be impracticable for the following reasons:

- Use of multiple systems (meaning the MFAS used for the exercise plus any additional active system used for marine mammal detection) operating simultaneously increases the likelihood that a submarine may be detected under conditions where it is attempting to mask its presence before activating sonar, resulting in an impact to the effectiveness of the military readiness activity. Additionally, interference may occur when certain active sonar systems (such as HFM3) are activated concurrently with MFAS.
- HFM3 is an adjunct system used by LFA because the hulls of those platforms can be modified and travel can occur at slow speeds. MFAS combatants are not equipped with HFM3 systems and it is impractical to install such a system on MFAS combatants.

The Navy will continue to coordinate acoustic monitoring and detection research specific to the proposed use of active sonar. As technology and methodologies become available, their applicability and viability will be evaluated for potential future incorporation.

Additional Passive Acoustic Monitoring - To provide a specialized localization capability (distance, direction, etc.), most of the systems (Sonobuoys, SQQ89, Bottom-Mounted Sensors) would require significant modifications. The Navy is working to develop or enhance systems with distance measuring capabilities. Until these capabilities are available, exercise participants can use these systems to aid in marine mammal detection, but not solely to implement mitigation measures. Although passive contact on marine mammals only indicates the presence, not the range (distance and direction), the information on any passive acoustic detections is disseminated real time to allow lookouts to focus their visual search for marine mammals.

The Navy is improving the capabilities to use range instrumentation to aid in the passive acoustic detection of marine mammals. At the Southern California Offshore ASW Range (SOAR) in the SOCAL Range Complex, development of effective passive acoustic detection as part of the instrumented range is progressing fairly rapidly. Passive acoustic monitoring has the potential to significantly improve the ability to detect marine mammal presence within SOAR. The Navy sponsored Marine Mammal Monitoring on Navy Ranges (M3R) program has developed hardware and software that leverages the SOAR sensors to detect and localize marine mammal vocalizations. Localization is possible when the same signal is detected, precisely time-tagged, and associated on at least three sensors. Prototype M3R systems have been installed on both the AUTEC (Bahamas) and SOAR ranges.

The M3R system is capable of monitoring all the range hydrophones in real-time. The Navy is refining the M3R system by developing tools to display detected transient signals including marine mammal vocalizations and localizations. The tools operate in real-time and are being used in a series of tests to document marine mammal species, their vocalizations, and their distribution on the SOAR range. In addition, they are being used to collect and analyze opportunistic data at AUTEC, and as part of the on-going Behavioral Response Study (BRS) there.

Reliable automated methods are needed for detection and classification of marine mammal calls to allow range hydrophones to be used for routine marine mammal monitoring in SOAR. The performance of these hydrophones must be quantified. The calls of many baleen whale species are stereotyped and well known. Identification of stereotyped mysticete calls within SOAR has been accomplished using automatic detectors. However, the full range of mysticete call types that are expected within SOAR is not known (e.g. sei whales). Odontocete call identification is more difficult owing to their call complexity. Calls of some odontocetes, such as sperm whales, killer whales, and porpoises, are easily distinguishable. For most species, however, the variation in and among call types is a topic of current research. Likewise, pinniped call types are complex and more data are needed to develop automatic detectors and classifiers to allow automated identification for pinniped species within SOAR. The Navy continues to develop this technology.

At SOAR the large number of species and high animal density combined with imprecise acoustic localization makes the efficacy of such monitoring for use for mitigation implementation during real-time operations questionable.

Prior to implementation of real-time passive acoustic monitoring for use in mitigation, the species present and their distribution should be established. A system must be implemented on range and Detection, Classification, and Localization (DCL) algorithms specific to these species must be developed and tests with visual observers must be conducted to verify their performance. The Navy continues to work on this, and such systems are not yet available for consideration as required mitigation.

Infrared technology – As a complement to existing methods, use of the Infrared (IR) band for marine mammal detection and location has some obvious benefits if proved viable, including the ability to operate infrared at night, as well as the ability to establish automated detections procedures which might well reduce the factor of human fatigue that affects observer-based methods. The Navy has committed to a program of research, development, and testing of IR-based technologies for detection of marine mammals in the wild.

The Navy program will have two main thrusts. NAVAIR will continue to pursue operational tests of their airborne monitoring and mitigation program for marine species using net-centric Intelligence, Surveillance, and Reconnaissance (ISR) systems. The proposed system uses a radar detect and track cueing sensor for a turreted airborne Electro-Optic/Infrared/Multi-spectral imaging sensor. If fully funded for prototyping and demonstration, this program would evaluate the efficacy for marine mammal detection of a large, high-powered system designed, tested, and deployed for other purposes, and operates beyond the domain of research Science and Technology.

At the same time, the Office of Naval Research (ONR) will take the lead in pursuing a longer-range, research S&T program to evaluate new concepts for IR detection that may ultimately lead to an operationally viable technique(s). The focus of the ONR effort will be on comparatively small, low-power systems that might be deployable on small, robot aircraft known as Unmanned Aerial Vehicles (UAVs) as well as operating in a ship-based mode. Either option might allow the inclusion of standard video for confirmation of mammal detections during the day. The UAV option might allow for multiple passages of an area of interest at low altitude to confirm mammal detections and identification.

ONR will continue to support this effort for at least several years, with the potential for sustained support, though the future breadth of this program will depend on the outcome of early efforts. The system is not considered practicable to require for implementation at this time.

Avoidance of Federal and State Marine Protected Areas:

Benefit to Marine Mammals/Effectiveness of Measure

Pursuant to the MMPA, NMFS makes decisions regarding required mitigation based on biological information pertaining to the potential impacts of an activity on marine mammals and their habitat (and the practicability of the measure), not management designations intended for the broad protection of various other marine resources.

As mentioned previously, no known areas of specific importance to marine mammals (that would benefit from a training restriction, i.e., not counting pinniped haulouts where the animals are not in the water the majority of the time) are present within these designated areas. Therefore, limiting activity in these areas would be of questionable value to marine mammals.

Practicability of the Measure

As discussed above, these measures would not offer any additional benefit to marine mammals. Additionally, the impracticability of seasonal and geographic restrictions and limitations, which applies to this measure, is discussed above.

Suspension of MFAS Training at Night, or During Low Visibility or Surface Duct:

Benefit to Marine Mammals/Effectiveness of Measure

The Navy is capable of ***effectively monitoring*** a 1000-yd safety zone using night vision goggles and passive acoustic monitoring (infrared cameras are sometimes used as an extra tool for detection, when available, but have not been shown to show a significant enhancement of current capabilities). Night vision goggles are always available to all vessel and aircrews as needed and passive acoustic monitoring is always in use. As mentioned previously, the estimated zone in which TTS may be incurred is within about 140 m of the sound source (830 m for harbor seals), and the estimated zone for injury is within 10 m of the sonar dome. The powerdown and shutdown zones are at 1000, 500, and 200 yds. The Navy is expected to be able to effectively implement the necessary mitigation measures during nighttime and times of lower visibility.

Because of the limited visibility beyond 1000 yards, Navy personnel could potentially detect fewer animals early (outside of the 1000 yds), as they are approaching to within 1000 yd, which could result in a slightly delayed powerdown or shutdown as compared to when operations are conducted in full daylight. However, any such potential delays would be at the outer edge of the safety zone and would not result in an animal being exposed to received sound levels associated with TTS or injury. So, suspension of MFAS during times of lower visibility may slightly reduce the exposures of marine mammals to levels associated with behavioral harassment, but would not reduce the number of marine mammals exposed to sound levels associated with TTS or injury.

Regarding surface ducts, their presence is based on water conditions in the exercise areas, is not uniform, and can change over a period of a few hours as the effects of environmental conditions such as wind, sunlight, cloud cover, and tide changes alter surface duct conditions. Across a typical exercise area, the determination of “significant surface ducting” is continually changing, and this mitigation measures cannot be accurately implemented. Furthermore, surface ducting alone does not necessarily increase the risk of MFA sonar impacts to marine mammals. While surface ducting causes sound to travel farther before losing intensity, simple spherical and cylindrical spreading losses result in a received level of no more than 175 dB rms at approximately 1,100 yards (assuming the nominal source of 235 dB rms), even in significant surface ducting conditions.

Practicability of the Measure

ASW training using MFAS is required year round in all environments, to include nighttime and low visibility conditions or conditions that realistically portray bathymetric features where adversary submarine threats (i.e., extremely quite diesel electric or nuclear powered) can hide and present significant detection challenges. Unlike an aerial dogfight, which is over in minutes or even seconds, ASW is a cat and mouse game that requires large teams of personnel working in shifts around the clock (24-hours) typically over multiple days to complete an ASW scenario. ASW can take a significant amount of time to develop the tactical picture (i.e., understanding of the battle space such as area searched or unsearched, identifying false contacts, and water conditions). Reducing or securing power at night or in low visibility conditions would affect a Commander’s ability to develop the tactical picture as well as not provide the needed training realism. If there is an artificial break in the exercise by reducing power or suspending MFAS use, the flow of the exercise is lost and several hours of training will have been wasted. Both lost time and training differently than what would be needed in combat diminish training effectiveness.

MFAS training at night is vital because differences between daytime and nighttime affect the detection capabilities of MFAS systems. Ambient noise levels are higher at night because many species use the nighttime period for foraging and movement. Temperature layers, which affect sound propagation, move up and down in the water column from day to night. Consequently, personnel must train during all hours of the day to ensure they identify and respond to changing environmental conditions. An ASW team trained solely during the day cannot be sent on deployment and be expected to fight at night because they would not identify and respond to the changing conditions.

Finally, as a matter of safety and international law, Navy vessels are required to use all means available in restricted visibility, including MFAS and positioning of additional lookouts, to provide heightened vigilance to avoid collision. The *International Navigation Rules of the Road* considers periods of fog, mist, falling snow, heavy rainstorm, sandstorms, or any similar events as "restricted visibility." In restricted visibility, all mariners, including Navy vessel crews, are required to maintain proper lookout by sight and hearing as well as "by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision." Prohibiting or limiting vessels from using sensors like MFAS during periods of restricted visibility violates international navigational rules, increases navigational risk, and jeopardizes the safety of the vessel and crew.

Surface ducting occurs when water conditions (e.g., temperature layers, lack of wave action) result in sound energy emitted at or near the surface to be refracted back up to the surface, then reflected from the surface only to be refracted back up to the surface so that relatively little sound energy penetrates to the depths that otherwise would be expected. This increases active detection ranges in a narrow layer near the surface, but decreases active sonar detection below the thermocline, a phenomenon that submarines have long exploited. Significant surface ducts are conditions under which ASW training must occur to ensure Sailors learn to identify these conditions, how they alter the abilities of MFA sonar systems, and how to deal with the resulting effects on MFA sonar capabilities. To be effective, the complexity of ASW requires the most realistic training possible. Reducing power in significant surface ducting conditions undermines training realism, and is, therefore, impracticable.

Delayed Restart of MFAS after Shutdown or Powerdown:

Benefit to Marine Mammals/Effectiveness of Measure

NMFS' assessment indicates that expanding the delay (until sonar can be restarted after a shutdown due to a marine mammal sighting) for deep-diving species adds minimal protective value for the following reasons:

- The ability of an animal to dive longer than the required shutdown time does not mean that it will always do so. Therefore, the additional delay would only potentially add value in instances when animals had remained under water for longer than the shutdown time required.
- Navy vessels typically move at 10-12 knots (5-6 m/sec) when operating active sonar and potentially much faster when not. Fish et al. (2006) measured speeds of 7 species of odontocetes and found that they ranged from 1.4–7.30 m/sec. Even if a vessel was moving at the slower typical speed associated with active sonar use, an animal would need to be swimming near sustained maximum speed for an hour in the direction of the vessel's course to stay within the safety zone of the vessel (i.e., to be in danger of being exposed to levels of sonar associated with injury or TTS).
- Additionally, the times when marine mammals are deep-diving (i.e., the times when they are under the water for longer periods of time) are the same times that a large portion of their motion is in the vertical direction, which means that they are far less likely to keep pace with a horizontally moving vessel.
- Given that, the animal would need to have stayed in the immediate vicinity of the sound source for an hour and considering the maximum area that both the vessel and the animal could cover in an hour, it is improbable that this would randomly occur. Moreover, considering that many animals have been shown to avoid both acoustic sources and ships without acoustic sources, it is improbable that a deep-diving cetacean (as opposed to a dolphin that might bow ride) would choose to remain in the immediate vicinity of the source. It is unlikely that a single cetacean would remain in the safety zone of a Navy sound source for more than 30 minutes.
- Last, in many cases, the lookouts are not able to differentiate species to the degree that would be necessary to implement this measure. Plus, Navy operators have indicated that increasing the

number of mitigation decisions that need to be made based on biological information is more difficult for the lookouts (because it is not their area of expertise).

Practicability of the Measure

When there is an artificial break in the exercise (such as a shutdown) the flow of the exercise is lost and several hours of training may be wasted, depending on where the Navy was in the exercise. An increase in the delay of MFAS use that occurs during an exercise will likely further negatively affect the effectiveness of the military readiness training because it will be harder to regain the flow of the exercise the longer the equipment and personnel are on hold. Moreover, lengthening a delay in training necessitates a continuation of the expenditure of resources (operation of all of the equipment and personnel), while not making progress towards the accomplishment of the mission (training completion).

Halting of MFAS Use in the Event of a Marine Mammal Injury or Death (and Stranding) until Cause is Determined:

Benefit to Marine Mammals/Effectiveness of Measure

Only in a very small portion of incidents (such as when a ship strikes a whale and personnel realize it immediately) is the cause of marine mammal injury or death immediately known. Halting MFAS use in the event of a marine mammal stranding may have only a very limited immediate benefit to marine mammals if animals have stranded and are still in the water and are within a certain distance of a Navy sound source(s) (not to imply that the Navy source would be assumed to have caused the event), i.e., it is physically possible for them to be exposed to received levels of sound that could potentially result in an additional adverse effects. In this case, cessation of sonar may alleviate additional stress to an animal that is already in a compromised physical state. However, if stranded animals are dead or on the beach, the benefit of a cessation of sonar does not exist as neither dead nor beached animals can benefit from it. The Navy only plans to conduct approximately 678 hours of hull-mounted MFAS activity annually in the TMAA. The Navy will be required (by the MMPA authorization) to notify NMFS immediately if an injured, stranded, or dead marine mammal is found during or shortly after, and in the vicinity of, any Navy training exercise utilizing MFAS, HFAS, or underwater explosive detonations taking place within the TMAA.

Practicability of the Measure

Investigations into the causes of stranding events often take months or years and the most probable outcome is that a definitive determination of cause is not made. Despite the fact that the Navy has been conducting thousands of hours of sonar, each, in southern California, the Pacific Northwest, around Hawaii, and off the east coast of the U.S. for multiple years, NMFS and the Navy have concluded that only 5 strandings worldwide (and not in the areas mentioned) can be associated with MFAS use. It is impracticable to halt the use of MFAS while the cause of a stranding is determined.

Ramp Up of Sonar Source Prior to Full Power Operation:

Benefit to Marine Mammals/Effectiveness of Measure

Based on the evidence that some marine mammals avoid sound sources, such as vessels, seismic sources, or MFAS (Richardson et al. 1995, Southall et al. 2007, and DoN 2008), the theory behind the ramp-up is that animals would move away from a sound source that was ramped up starting at low energy, which would result in the animals not being suddenly exposed to a more alarming, or potentially injurious sound. Compton et al. (2007) noted that this response has not been empirically demonstrated, that the effectiveness of the measure would likely vary between species and circumstances, and that the effectiveness of the measure should be the focus of further research (i.e., controlled exposure experiments). The implicit assumption is that animals would have an avoidance response to the low power sonar and would move away from the sound and exercise area; however, there is no data to indicate this assumption is correct. The Navy is currently gathering data and assessing it regarding the potential usefulness of this procedure as a mitigation measure. With seismic surveys, which have relatively large safety zones compared to MFAS (and for which NMFS estimates that injury can occur at greater distances from the source than MFAS), NMFS utilizes ramp-up as a cautious mitigation measure to reduce Level B harassment and help ensure that Level A harassment does not occur.

Practicability of the Measure

Ramp-up procedures are not a viable alternative for MFA sonar training events as the ramp-up would alert opponents to the participants' presence, thus undermining training realism and effectiveness of the military readiness activity. When a MFA sonar ship turns its sonar on, area submarines are alerted to its presence. A submarine can hear an active sonar transmission farther away than the surface ship can hear the echo of its sonar off the submarine. Ideally, the surface ship will detect the submarine in time to attack the submarine before the submarine can attack one of the ships of the Strike Group (noting, of course, that attacks during training events are not actual attacks). If the MFA sonar ship starts out at a low power and gradually ramps up, it will give time for the submarine to take evasive action, hide, or close in for an attack before the MFA sonar is at a high enough power level to detect the submarine. Additionally, using these procedures would not allow the Navy to conduct realistic training, or "train as they fight," thus adversely impacting the effectiveness of the military readiness activity. Ramp up would constitute additional unnecessary sound introduced into the marine environment, in and of itself constituting harassment and this measure does not account for the movement of the ASW participants over the period of time when ramp up would be implemented.

Enlargement or Modification of Powerdown/Shutdown Zones of Hull-mounted Sonar:

Benefit to Marine Mammals/Effectiveness of Measure

The current power down and shut down zones are based on scientific investigations specific to MFA sonar for a representative group of marine mammals. They are based on the source level, frequency, and sound propagation characteristics of MFA sonar. The zones are designed to preclude direct physiological effect from exposure to MFA sonar. Specifically, the current power-downs at 500 yards and 1,000 yards, as well as the 200 yard shut-down, were developed to minimize exposing marine mammals to sound levels that could cause TTS and PTS. The underlying received levels of sound that were used to determine the appropriate safety zone distances are based on: for TTS - empirical information gathered on the levels at which the onset of noise-induced loss in the hearing sensitivity of captive cetaceans occurs, and, for PTS – extrapolations from the cetacean TTS data that incorporate TTS growth data from terrestrial animals. NMFS has determined that these measures effectively accomplish this.

Enlargement of the powerdown or shutdown zones would primarily result in the further reduction of the maximum received level that the detected animal might be exposed to, which could potentially mean that an animal expected to respond in a manner NMFS would classify as level B harassment could potentially either respond in a less severe manner or maybe not respond at all. This could be more important at an important time or place or in the presence of species or age-classes of concern (such as beaked whales). NMFS has received varying recommendations regarding the potential size of an expanded powerdown or shutdown zone, including 2 km, 4 km, or the 154 dB isopleth. As noted below, the ability of the lookouts to effectively monitor the safety zone decreases as the distance to the edge of the zone increases and the area that it is necessary to monitor increases by a factor of 4 as the distance to the edge doubles.

A review of the Navy's post-exercise reports shows lookouts have not reported any observed response of marine mammals at any distance.

Practicability of the Measure

The outer safety zone the Navy has developed (1000 yd) is also based on a lookout's ability to realistically maintain situational awareness over a large area of the ocean, including the ability to detect marine mammals at that distance during most conditions at sea. Requirements to implement procedures when marine mammals are present well beyond 1,000 yards dictate that lookouts sight marine mammals at distances that, in reality, are not always possible. These increased distances also significantly expand the area that must be monitored to implement these procedures. For instance, if a power down zone increases from 1,000 to 4,000 yards, the area that must be monitored increases sixteen-fold. Increases in safety zones are not based in science, provide limited benefit to marine mammals and severely impact realistic ASW training by increasing the number of times that a ship would have to shut down active sonar, impacting realistic training, and depriving ships of valuable submarine contact time. Commanders participating in training designed for locating, tracking, and attacking a hostile submarine could lose awareness of the tactical situation through increased stopping and starting of MFA sonar leading to significant exercise event disruption. Increased shutdowns could allow a submarine to take advantage of the lapses of active sonar, and position itself for a simulated attack, artificially changing the reality of the training activity. Given the operational training needs, increasing the size of the safety range is generally impracticable.

Expansion of Exclusion Area Delineated for Use with Explosive Detonations:

Benefit to Marine Mammals/Effectiveness of Measure

As described previously, the current designated exclusion zones for three exercise types (SINKEX, BOMBEX, and MISSILEX) are not large enough to prevent TTS should one of the largest explosives (MK-82 or Harpoon) detonate while the animal is at some distance outside of the exclusion zone. If the exclusion zone were enlarged, the Navy could theoretically reduce the number of TTS takes that might occur – however, anticipated takes by TTS are already very low, and the exclusion zones are more than large enough to avoid injury from all charges.

Practicability of the Measure

As mentioned above, SINKEXs have associated range clearance procedures that cover a circle with a radius of either 2 nm (though the exclusion zone is only 1 nm), 1,645 m, or 914 m. Enlarging these circles to encompass the TTS isopleths for these exercise means doubling the radius of the exclusion zones (or more), which would mean that an area 4 times the size would need to be monitored. Generally speaking, the Navy could do this in one of two ways: they could either use the same amount of resources to monitor the area that is 4 times larger, which could potentially result in less focus on the center area that is more critical (because more severe effects are expected closer to the source where the received level would be louder), or they could maintain the same level of coverage by increasing the resources used for monitoring by four times (or more), which is not practicable considering the limited anticipated protective value of the measure.

Monitoring of Explosive Exclusion Area During Exercises:

Benefit to Marine Mammals/Effectiveness of Measure

The Navy's SINKEX and BOMBEX measures currently require that the Navy survey a safety zone prior to an exercise, and then during the exercise when feasible. Additionally, passive acoustic means are used to detect marine mammals during the exercise. Continuous monitoring during an explosive exercise could potentially decrease the number of animals exposed to energy or pressure levels associated with take. However, one could assume that animals would continue to avoid the area to some degree if continuous explosions were occurring in the areas.

Of note, aside from SINKEXs, training events involving explosives are generally completed in a short amount of time. For smaller detonations such as those involving underwater demolitions training, the area is observed to ensure all the charges detonated and that they did so in the manner intended; however, it is not possible to have visual contact 100 percent of the time for all explosive in-water events. The Navy must clear all people from the explosive zone of influence prior to an in-water explosive event for the safety of personnel and assets. If there is an extended break between clearance procedures and the timing of the explosive event, clearance procedures are repeated.

Practicability of the Measure

There are potentially serious safety concerns associated with monitoring an area where explosions will occur and the Navy must take those into consideration when determining when monitoring during an exercise is feasible. While the Navy's measures allow for some monitoring during explosive exercises, it is not practicable to do all of the time.

Using MFA and HFA Sonar with Output Levels as Low as Possible Consistent with Mission Requirements or Using Active Sonar Only When Necessary:

Operators of sonar equipment are trained to be aware of the environmental variables affecting sound propagation. In this regard, the sonar equipment power levels are always set consistent with mission requirements. Active sonar is only used when required by the mission since it has the potential to alert opposing forces to the sonar platform's presence. The Navy remains committed to using passive sonar and all other available sensors in concert with active sonar to the maximum extent practicable consistent with mission requirements.

Scaling Down Training to Meet Core Aims:

As with each Navy range complex, the primary mission of the ATA is to provide a realistic training environment for naval forces to ensure that they have the capabilities and high state of readiness required to accomplish assigned missions. Modern war and security operations are complex. Modern weaponry has brought both unprecedented opportunity and innumerable challenges to the Navy. Smart weapons, used properly, are very accurate and actually allow the military Services to accomplish their missions with greater precision and far less destruction than in past conflicts. But these modern smart weapons are very complex to use. U.S. military personnel must train regularly with them to understand their capabilities, limitations, and operation. Modern military actions require teamwork between hundreds or thousands of people, and their various equipment, vehicles, ships, and aircraft, all working individually and as a coordinated unit to achieve success. These teams must be prepared to conduct activities in multiple warfare areas simultaneously in an integrated and effective manner. Navy training addresses all aspects of the team, from the individual to joint and coalition teamwork. Training events are identified and planned because they are necessary to develop and maintain critical skills and proficiency in many warfare areas. Exercise planners and Commanding Officers are obligated to ensure they maximize the use of time, personnel and equipment during training. The level of training expressed in the Proposed Action and alternatives is essential to achieving the primary mission of the ATA.

Limiting the Active Sonar Event Locations:

Areas where events are scheduled to occur are carefully chosen to provide for the safety of events and to allow for the realistic development of the training scenario including the ability of the exercise participants to develop, maintain, and demonstrate proficiency in all areas of warfare simultaneously. Limiting the training event to a few areas would have an adverse impact to the effectiveness of the training by limiting the ability to conduct other critical warfare areas including, but not limited to, the ability of Navy ships to defend themselves from threats on the surface and in the air while carrying out other activities. Limiting the exercise areas would concentrate all active sonar use, resulting in unnecessarily prolonged and intensive sound levels rather than the more transient exposures predicted by the current planning that makes use of multiple exercise areas. Furthermore, exercises using integrated warfare components require large areas of the littorals and open ocean for realistic and safe training.

Implementing Vessel Speed Reduction:

Vessels engaged in training use extreme caution and operate at a slow, safe speed consistent with mission and safety. Ships and submarines need to be able to react to changing tactical situations in training as they would in actual combat. Placing arbitrary speed restrictions would not allow them to properly react to these situations. Training differently than that which would be needed in an actual combat scenario would decrease training effectiveness and reduce the crew's abilities.

The majority of the ships participating in training activities in the TMAA have a number of advantages for avoiding ship strikes as compared to most commercial merchant vessels. These include the following: (1) Navy ships have their bridges positioned forward, offering good visibility ahead of the bow; (2) Crew size is much larger than that of merchant ships, allowing for more potential observers on the bridge; (3) Dedicated lookouts are posted during a training activity scanning the ocean for anything detectable in the water; anything detected is reported to the Officer of the Deck; (4) Navy lookouts receive extensive training including Marine Species Awareness Training designed to provide marine species detection cues and information necessary to detect marine mammals; and (5) Navy ships are generally much more maneuverable than commercial merchant ships.

Restricting the Use of MFA Sonar During ASW Training Events While Conducting Transits Between Islands (i.e., Choke-points):

This restriction is not applicable to training in the TMAA. A chokepoint is a strategic strait or canal. Although there are over 200 major straits around the world, only a handful are considered to be strategic "chokepoints," such as the Strait of Gibraltar, Panama Canal, Strait of Magellan, Strait of Malacca, Bosporus and Dardanelles, Strait of Hormuz, Suez Canal, and Bab el Mandeb. While chokepoints are relatively few in number, significant quantities of international commerce and naval shipping move through these chokepoints, making them strategically important to the United States because a single quiet diesel submarine can position itself in the chokepoint and effectively block access beyond that point. The primary similarity of these chokepoints is lengthy shorelines that restrict maneuverability. The longer and more narrow the passage, the more likely the chokepoint creates an area of restricted egress for marine mammals. However these features are not present in the areas of the TMAA in which the Navy plans to conduct sonar training.

Adopting Mitigation Measures of Foreign Nation Navies:

The Navy typically operates in a Strike Group configuration where the group focuses its efforts on conducting air strikes and/or amphibious operations ashore. This requires that the Navy train to what it calls "integrated warfare" meaning that Strike Groups must conduct many different warfare areas simultaneously. These include the ability to defend itself from attacks from submarines, mines, ships, aircraft and missiles. Other nations do not possess the same integrated warfare capabilities as the United States. As a result, many foreign nations' measures are focused solely on reducing what they perceive to be impacts involving ASW. They are not required to locate training areas and position naval forces for the simultaneous and integrated warfare elements that the Navy conducts. As a result, many nations are willing to move training to areas where they believe marine mammals may not exist and do not train in the same bathymetric and littoral environments.

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6 OTHER CONSIDERATIONS REQUIRED BY THE NATIONAL ENVIRONMENTAL POLICY ACT

6.1 CONSISTENCY WITH OTHER FEDERAL, STATE, AND LOCAL PLANS, POLICIES, AND REGULATIONS

Based on an evaluation with respect to consistency with statutory obligations, the Department of the Navy's alternatives, including the Proposed Action, for the Gulf of Alaska Navy Training Activities (GOA NTA) Draft Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS), hereby referred to as Draft EIS/OEIS, does not conflict with the objectives or requirements of federal, state, regional, or local plans, policies, or legal requirements. Table 6-1 provides a summary of environmental compliance requirements that may apply.

Table 6-1: Summary of Environmental Compliance for the Proposed Action

Plans, Policies, and Controls	Responsible Agency	Status of Compliance
National Environmental Policy Act (NEPA) of 1969 (42 United States Code [U.S.C] §§ 4321 et seq.) Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations [C.F.R.] §§ 1500-1508) Navy Procedures for Implementing NEPA (32 C.F.R. § 775)	Navy	Navy training activities that occur within the United States (U.S.). Air Force (Air Force) inland Special Use Airspace (SUA) and the U.S. Army (Army) training lands are analyzed under previous NEPA documentation (the *Alaska Military Operations Areas EIS* [USAF 1995], *Improvements to Military Training Routes in Alaska Environmental Assessment* [USAF 2007], *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* [Army 1999], and the *Transformation of U.S. Army Alaska FEIS* [Army 2004]). These documents are incorporated by reference. Public participation and review is being conducted in compliance with NEPA.
Executive Order (EO) 12114, 32 C.F.R. 187, Environmental Effects Abroad of Major Federal Actions	Navy	This EIS/OEIS has been prepared in accordance with EO 12114 as implemented by 32 C.F.R. 187, which requires environmental consideration for actions that may affect the environment outside of U.S. territorial waters within the U.S. Exclusive Economic Zone (EEZ) and on the high seas.
Federal Water Pollution Control Act (Clean Water Act [CWA]) (33 U.S.C. §§ 1344 et seq.)	U.S. Environmental Protection Agency (USEPA)	No permits are required under the CWA Sections 401, 402, or 404 (b) (1), since the activities in GOA occur outside 12nm and the proposed action does not involve construction.
Rivers and Harbors Act (33 U.S.C.§§ 401 et seq.)	U.S. Army Corps of Engineers	No permit is required under the Rivers and Harbors Act as no construction in navigable waterways is proposed.
Coastal Zone Management Act (CZMA) (16 C.F.R. §§ 1451 et seq.)	Alaska Department of Natural Resources	The Navy is preparing a Coastal Consistency Determination (CCD) for compliance with the CZMA. See Section 6.1.1, below, for discussion of Navy activities and compliance with the CZMA.

Table 6-1: Summary of Environmental Compliance for the Proposed Action (continued)

Plans, Policies, and Controls	Responsible Agency	Status of Compliance
Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §§ 1801-1802)	National Marine Fisheries Service (NMFS)	The Proposed Action would only have localized and temporary impacts to Essential Fish Habitat (EFH) and managed species. Therefore, no consultation with NMFS is required.
Endangered Species Act (ESA) (16 U.S.C. §§ 1531 et seq.)	U.S. Fish and Wildlife Service (USFWS) NMFS	The EIS/OEIS analyzes potential effects to species listed under the ESA. In accordance with ESA requirements, the Navy will complete consultation under Section 7 of the ESA with NMFS and USFWS on the potential that implementation of the Proposed Action may affect threatened and endangered listed species. Informal consultation for listed marine birds will be conducted with USFWS. Consultation for listed marine species, including mammals, turtles, and fish, will be conducted with NMFS. Upon concluding Section 7 consultation, the Navy will adhere to any provisions of the Biological Opinion (BO).
Marine Mammal Protection Act (MMPA) (16 U.S.C. §§ 1431 et seq.)	NMFS	The MMPA governs activities with the potential to harm, disturb, or otherwise "harass" marine mammals. As a result of acoustic effects associated with mid-frequency active sonar use and underwater detonations of explosives, implementation of the alternatives including the Proposed Action may result in potential Level A (harm) or Level B (disturbance) harassment to marine mammals. Therefore, the Navy has submitted an application for a Letter Of Authorization (LOA) from NMFS to permit takes of marine mammals.
The Sikes Act of 1960 (16 U.S.C. §§ 670a-670o, as amended by the Sikes Act Improvement Act of 1997, Pub. L. No. 105-85)	Navy	No Navy installations are a part of the Proposed Action. Therefore, no trigger exists for Sikes Act compliance.
National Historic Preservation Act (NHPA) (16 U.S.C. §§ 470 et seq.)	Navy	The Navy has determined that the Proposed Action would have no adverse effects on cultural and historic resources within the Temporary Maritime Activities Area (TMAA). This conclusion will be reviewed and agreed upon by the Alaska State Historic Preservation Office (SHPO) and affected Alaska Native tribes.

Table 6-1: Summary of Environmental Compliance for the Proposed Action (continued)

Plans, Policies, and Controls	Responsible Agency	Status of Compliance
EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	Navy	The Proposed Action would not result in any disproportionately high adverse human health or environmental effects on minority or low-income populations.
EO 13045, Protection of Children from Environmental Health Risks and Safety Risks	Navy	The Proposed Action would not result in environmental health and safety risks to children.
Alaska Native Claims Settlement Act of 1971 (ANCSA) (43 U.S.C. §§ 1601-1624)	Navy	No lands in Alaska subject to aboriginal claims exist within the TMAA. Therefore, there is no requirement for action by the Navy under the ANSCA.
EO 13089, Coral Reef Protection	Navy	No resources that are governed by this EO exist within the TMAA. Therefore, mitigation of effects will not be necessary for the protection of resources under EO 13089.
Migratory Bird Treaty Act (MBTA) (16 U.S.C. §§ 703-712)	USFWS	A review of the actions under the implementation of the alternatives presented (including the Proposed Action) shows that there would not be a significant adverse effect on a migratory bird population. Therefore, under 50 CFR § 21.15, there is no need to confer with USFWS regarding MBTA species.

6.1.1 Coastal Zone Management Act Compliance

The CZMA of 1972 (16 U.S.C. Section [§] 1451) encourages coastal states to be proactive in managing coastal zone uses and resources. The CZMA established a voluntary coastal planning program; participating states submit a Coastal Management Plan (CMP) to the National Oceanographic and Atmospheric Administration (NOAA) Office of Ocean and Coastal Resource Management (OCRM) for approval. Under CZMA, federal actions are required to be consistent, to the maximum extent practicable, with the enforceable policies of approved CMPs.

CZMA defines the coastal zone (16 U.S.C. § 1453) as extending, "to the outer limit of State title and ownership under the Submerged Lands Act." The coastal zone extends inland only to the extent necessary to control the shoreline. Excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of, or which is held in trust by, the federal government (16 U.S.C. § 1453). Accordingly, federal military lands are not within the coastal zone. In the state of Alaska, CZMA coastal boundaries are determined by each individual Coastal Resource District pursuant to 11 Alaska Administrative Code (AAC) 114.220.

The State of Alaska has an approved CMP, Alaska Coastal Management Program (ACMP), which is found at Alaska Statutes Annotated (AS) Title 46 Chapter 40. The ACMP received federal approval from the NOAA in 1979. The ACMP provides stewardship for Alaska's rich and diverse coastal resources to ensure a healthy and vibrant Alaskan coast that efficiently sustains long-term economic and environmental productivity. The Alaska Department of Natural Resources (ADNR) is the state's designated coastal management agency and is responsible for reviewing projects for consistency with the

CMP and issuing coastal management decisions under the provisions of 11 AAC Code Chapters 110 and 112. Specific statewide standards for review under the ACMP are found at 11 AAC Chapter 112.

The CZMA federal consistency determination process includes a review of the Proposed Action to determine whether it has potential direct or indirect effects on coastal zone resources or uses under the provisions of the CMP. An in-depth examination of any such effects, and a determination on whether those effects are consistent to the maximum extent practicable with the state's enforceable policies, is then conducted by the action proponent. Specific standards of the ACMP that appear applicable to proposed training activities occurring in the TMAA are 11 AAC Chapter 112 Sections 280 ("Transportation Routes and Facilities"), 300 ("Habitats"), 310 ("Air, Land, and Water Quality), and 320 ("Historic, Prehistoric, and Archeological Resources").

For the activities covered in this Draft EIS/OEIS, the Navy will ensure compliance with the CZMA through coordination with the ADNR.

6.2 Relationship Between Short-Term Use of Man's Environment and Maintenance and Enhancement of Long-Term Productivity

NEPA requires an analysis of the relationship between a project's short-term impacts on the environment and the effects that these impacts may have on the maintenance and enhancement of the long-term productivity of the affected environment. Impacts that narrow the range of beneficial uses of the environment are of particular concern. This means that choosing one option may reduce future flexibility in pursuing other options, or that committing a resource to a certain use may often eliminate the possibility for other uses of that resource.

The Proposed Action would result in both short- and long-term environmental effects. However, the Proposed Action would not be expected to result in any impacts that would reduce environmental productivity, permanently narrow the range of beneficial uses of the environment, or pose long-term risks to health, safety, or the general welfare of the public. The Navy is committed to sustainable training area management, including co-use of all the training areas of the Alaska Training Area (ATA) with the general public and commercial interests to the extent practicable, consistent with accomplishment of the Navy mission and in compliance with applicable law. This commitment to co-use will enhance the long-term productivity of the training areas throughout the ATA.

6.3 Irreversible or Irretrievable Commitment of Resources

NEPA requires that environmental analysis include identification of "any irreversible and irretrievable commitments of resources which would be involved in the Proposed Action should it be implemented." [NEPA Sec. 102 (2)(C)(v), 42 U.S.C. § 4332]. Irreversible and irretrievable resource commitments are related to the use of nonrenewable resources and the effects that the uses of these resources have on future generations. Irreversible effects primarily result from the use or destruction of a specific resource (e.g., energy or minerals) that cannot be replaced within a reasonable time frame. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the action (e.g., the disturbance of a cultural site).

For the alternatives including the Proposed Action, most resource commitments are neither irreversible nor irretrievable. Most impacts are short-term and temporary or, if long lasting, are negligible. No habitat associated with threatened or endangered species would be lost as result of implementation of the Proposed Action. Since there would be no building or facility construction, the consumption of materials typically associated with such construction (e.g., concrete, metal, sand, fuel) would not occur. Energy typically associated with construction activities would not be expended and irreversibly lost.

Implementation of the Proposed Action would require fuels used by aircraft, ships, and ground-based vehicles. Since fixed- and rotary-wing flight and ship activities could increase, relative total fuel use would increase. Therefore, total fuel consumption would increase and this nonrenewable resource would be considered irreversibly lost.

6.4 Energy Requirements and Conservation Potential of Alternatives and Mitigation Measures

Increased training activities in the ATA would result in an increase in energy demand over the No Action Alternative. This would result in an increase in fossil fuel consumption, mainly from aircraft, vessels, ground equipment, and power supply. Although the required electricity demands of increased intensity of land use would be met by the existing electrical generation infrastructure at the ATA, the alternatives would result in a net cumulative negative impact on the energy supply.

Energy requirements would be subject to any established energy conservation practices at each facility. No additional power generation capacity would be required for any of the activities. The use of energy sources has been minimized wherever possible without compromising safety or training activities. No additional conservation measures related to direct energy consumption by the proposed activities are identified.

6.5 Natural or Depletable Resource Requirements and Conservation Potential of Various Alternatives and Mitigation Measures

Resources that will be permanently and continually consumed by project implementation include water, electricity, natural gas, and fossil fuels; however, the amount and rate of consumption of these resources would not result in significant environmental impacts or the unnecessary, inefficient, or wasteful use of resources. Nuclear-powered vessels would be a benefit as they decrease use of fossil fuels. Pollution prevention is an important component of mitigation of the alternative’s adverse impacts. To the extent practicable, pollution prevention considerations are included.

Sustainable range management practices are in place that protect and conserve natural and cultural resources; and preservation of access to training areas for current and future training requirements, while addressing potential encroachments that threaten to impact range and training area capabilities.

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6 OTHER CONSIDERATIONS

No References in this section.

7 LIST OF PREPARERS

No References in this section.

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9 DISTRIBUTION LIST

Following is a list of public officials, government agencies, Native American Tribes and Nations, organizations, and individuals who attended the public scoping meetings, provided comments during the scoping process, or have been identified by the Navy to be on the distribution list for the Gulf of Alaska Navy Training Activities Draft Environmental Impact Statement/Overseas Environmental Impact Statement (DEIS/OEIS).

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- Washington D.C. headquarters*
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- Office of Protected Resources
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Alaska Department of Environmental Conservation

Alaska Department of Transportation & Public Facilities

Alaska Office of History and Archaeology

Regulatory Commission of Alaska

Alaska Department of Military and Veterans Affairs

Native American Tribes and Nations*

Kaguyak Village

Lesnoi Village

Native Village of Afognak

Native Village of Chenega

Native Village of Eyak

Native Village of Old Harbor

Native Village of Ouzinkie

Native Village of Port Graham

Native Village of Port Lions

Native Village of Tatitlek

Shoonaq Tribe of Kodiak

Yakutat Tlingit Tribe

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U.S. Senator
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U.S. Senator
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Alaska State Senator
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AK District 38

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Hon. Richard Foster,
AK District 39

Alaska State Representative
Hon. Reggie Joule,
AK District 40

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Hon. Luke Hopkins
Mayor

Kenai Peninsula Borough
Hon. David R. Carey
Mayor

Kodiak Island Borough
Hon. Jerome M. Selby
Mayor

Matanuska-Susitna Borough
Hon. Talis Colberg
Mayor

Municipality of Anchorage
Hon. Dan Sullivan
Mayor

City of Cordova
Hon. Timothy L. Joyce
Mayor

City/Borough of Juneau
Hon. Bruce Botelho
Mayor

__Individuals__

Tom Anderson
Cordova, AK

Claudia Anderson
Kodiak, AK

Brad Barr
Kodiak, AK

Wendy Beck
Kodiak, AK

Robert Berceli
Cordova, AK

Allison Bidlack
Cordova, AK

Cheryl Boehlan
Kodiak, AK

Richard Brenner
Cordova, AK

Bruce Cain
Cordova, AK

Mark Cammrys
Cordova, AK

Madelene Caselli
Palmer, AK

Al Clayton
Anchorage, AK

Taral Clayton
Anchorage, AK

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Susan Glinton
Nassau, Bahamas

Lavonne Heacock
Rhododendron, OR

Pat Heitman
Kodiak, AK

Carolyn Heitman*
Kodiak, AK

Leona Heitsch
Bourbon, MI

Pat Holmes
Kodiak, AK

Deb Jaros
Kodiak, AK

Joanna Kappele
Chicago, IL

Lee Keller
Seward, AK

Kimberly Kopanuk
Anchorage, AK

Robert Kopchak
Cordova, AK

Aldone Kowenta
Kodiak, AK

Kurt Krieter
Palmer, AK

Alexis Kwachka
Kodiak, AK

Dave Lacey
Fairbanks, AK

Ann Mallard
Fairbanks, AK

Craig Matkin
Homer, AK

Irene Miramontes
Nassau, Bahamas

Maria Nasif
Tuscon, AZ

Susan Payne
Kodiak, AK

Geneneiva Pearson
Kodiak, AK

Susan Peehl
Cold Springs, NY

Barbara Sachau
Florham Park, NJ

Mike Sirofchruk
Kodiak, AK

Ralph Sirofchruk
Kodiak, AK

Michael Sirofchuck
Kodiak, AK

Erin Starr-Hollow
Kodiak, AK

Joan Stempniak
Homer, AK

Dany Stihl
Kodiak, AK

Delores Stokes
Kodiak, AK

John F. Thomas
Cordova, AK

Kip Thomet
Kodiak, AK

Hans Tscherich
Cordova, AK

Keith Van den Broek
Cordova, AK

Barbara Volpe
Kodiak, AK

Elise Wolf
Fritz Creek, AK

Appendix A

Notice of Intent

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Inquiries regarding field Service Record Books/Officer Qualification Records of current members should be addressed to the Commanding Officer of the Marine Corps unit to which they are attached.

Official mailing addresses are published in the Standard Navy Distribution List that is available at *http://doni.daps.dla.mil/sndl.aspx*.

Requests should contain the member's full name, Social Security Number (SSN) (and/or enlisted or officer service number), rank/rate, approximate dates of service, address, and signature of the requester. Transfer or Discharge (DD Form 214), discharge certificate, driver's license, or other data sufficient to ensure that the member is the subject of the record.

Current members (active and reserve) and former members may visit any of the above activities for review of records. Proof of identification will be required and may consist of an individual's active, reserve, or retired identification card, Armed Forces Report of.

RECORD ACCESS PROCEDURES:

Individuals seeking access to records about themselves contained in this system of records should address written requests to the following officials:

Inquiries regarding permanent Official Military Personnel File records of all active duty and reserve members, former members discharged, deceased, or retired after 31 December 1997 should be addressed to the Commandant of the Marine Corps (Code MMSB), Headquarters, U.S. Marine Corps, 2008 Elliot Road, Quantico, VA 22134–5030.

Inquiries regarding field Service Record Books/Officer Qualification Records of reserve members serving in the Individual Ready Reserve should be addressed to the Commanding General, Marine Corps Mobilization Command, 15303 Andrews Road, Kansas City, MO 64147–1207.

Inquiries regarding Official Military Personnel File records of former members discharged, deceased, or retired before 1 January 1998 should be addressed to the Director, National Personnel Records Center, Military Personnel Records, 9700 Page Avenue, St. Louis, MO 63132–5100.

Veterans and relatives of deceased veterans may obtain information on how to obtain copies of records from the National Personnel Records Center Web site at *http://www.archives.gov/st-louis/military-personnel/index.html*.

Inquiries regarding field Service Record Books/Officer Qualification Records of current members should be addressed to the Commanding Officer of the Marine Corps unit to which they are attached.

Official mailing addresses are published in the Standard Navy Distribution List that is available at *http://doni.daps.dla.mil/sndl.aspx*.

Requests should contain the member's full name, Social Security Number (SSN) (and/or enlisted or officer service number), rank/rate, approximate dates of service, address, and signature of the requester.

Current members (active and reserve) and former members may visit any of the above activities for review of records. Proof of identification will be required and may consist of an individual's active, reserve, or retired identification card, Armed Forces Report of Transfer or Discharge (DD Form 214), discharge certificate, driver's license, or other data sufficient to ensure that the member is the subject of the record.

CONTESTING RECORD PROCEDURES:

The USMC rules for contesting contents and appealing initial agency determinations are published in Secretary of the Navy Instruction 5211.5; Marine Corps Order P5211.2; 32 CFR part 701; or may be obtained from the system manager.

RECORD SOURCE CATEGORIES:

Staff agencies and subdivisions of Headquarters, U.S. Marine Corps; Marine Corps commands and organizations; other agencies of federal, state, and local government; medical reports; correspondence from financial and other commercial enterprises; correspondence and records of educational institutions; correspondence of private citizens addressed directly to the Marine Corps or via the U.S. Congress and other agencies; investigations to determine suitability for enlistment, security clearances, and special assignments; investigations related to disciplinary proceedings; and the individual of the record.

EXEMPTIONS CLAIMED FOR THE SYSTEM:

None.

[FR Doc. E8–5349 Filed 3–14–08; 8:45 am]

BILLING CODE 5001–06–P

DEPARTMENT OF DEFENSE

Department of the Navy

Notice of Intent To Prepare an Environmental Impact Statement and Overseas Environmental Impact Statement for Navy Training Activities in the Gulf of Alaska

AGENCY: Department of the Navy, DoD.

ACTION: Notice.

SUMMARY: Pursuant to section 102(2)(c) of the National Environmental Policy Act of 1969 (NEPA) as implemented by the Council on Environmental Quality regulations (40 CFR Parts 1500–1508), and Executive Order 12114 (Environmental Effects Abroad of Major Federal Actions), the Department of the Navy (Navy) announces its intent to prepare an Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) to evaluate the potential environmental effects of conducting Navy training in and around the Gulf of Alaska (GOA), including participation in large-scale Joint exercises, to support Fleet training exercise requirements. The Navy will invite the U.S. Fish and Wildlife Service and National Marine Fisheries Service to be cooperating agencies in preparation of this EIS/OEIS.

DATES AND ADDRESSES: Three public scoping meetings will be held to receive oral and/or written comments on environmental concerns that should be addressed in the EIS/OEIS. Each of the three scoping meetings will consist of an informal, open house session with information stations staffed by Navy representatives. The public scoping meetings will be held at the following dates, times, and locations:

1. Tuesday, April 1, 2008, 6 p.m. to 9 p.m., at Kodiak Best Western, 236 W. Rezanof Drive, Kodiak, AK 99615,
2. Wednesday, April 2, 2008, 6 p.m. to 9 p.m., at Kincaid Outdoor Center, North Assembly Room, 9401 W. Raspberry Road, Anchorage, AK 99502,
3. Thursday, April 3, 2008, 6 p.m. to 9 p.m., at Mt. Eccles Elementary School, 200 Adams Street, Cordova, AK 99574.

Details of the meeting locations and times will be announced in local newspapers. Additional information concerning meeting times will be available on the EIS/OEIS Web page located at: *http://www.GulfofAlaskaNavyEIS.com*.

FOR FURTHER INFORMATION CONTACT: Mrs. Amy Burt, Naval Facilities Engineering Command, Northwest, 1101 Tautog Circle Suite 203, Silverdale, Washington 98315–1101, Attn: GOA Navy Training Activities EIS/OEIS Project Manager,

Code EV1.AB, telephone number: 360–396–0924.

SUPPLEMENTARY INFORMATION: The proposed EIS/OEIS analyzes potential environmental effects of Navy training activities that will take place in and around the Gulf of Alaska and those aircraft events that originate in the maritime exercise area (MEA) and extend over established inland Alaska military operating areas. Navy training activities primarily take place in, or originate from, the MEA. The MEA provides approximately 42,000 nm^2 (144,056 km^2) of air and surface/subsurface ocean operating area and overlying airspace.

The MEA is a polygon that is oriented from northwest to southeast, approximately 300 nm in length by 150 nm in width, situated south of Prince William Sound and east of Kodiak Island, Alaska. The EIS/OEIS study area includes Gulf of Alaska ocean area within approximately 200 km from the MEA and the waters within this boundary up to the coastline. Military operations also occur over established land-based Military Operating Areas maintained by the Air Force in Alaska.

These Alaska training areas are used to conduct Navy training, including participating in large-scale Joint training exercises such as the annual Northern Edge exercise, involving military hardware, personnel, tactics, munitions, explosives, and electronic combat. Alaska is an ideal location to support naval and joint operational readiness by providing the maritime component to a ''geographically realistic'' range for U.S. Pacific Command (PACOM) and U.S. Northern Command (NORTHCOM) scenario-based training.

The purpose of the Proposed Action is to: (1) Support PACOM and NORTHCOM training requirements; (2) achieve and maintain Fleet readiness using these Alaska training areas to support and conduct current, emerging, and future training activities; (3) accommodate new training requirements associated with the introduction of new weapons and systems to the Fleet; and (4) support civilian authorities in homeland defense training exercises.

The need for the Proposed Action is to: (1) Maintain current levels of military readiness; (2) accommodate future increases in training activities to support Fleet exercise requirements in the Alaska training areas; (3) support the acquisition and implementation into the Fleet of advanced military technology; and (4) maintain the long-term viability of the Alaska training areas as a Navy training area while protecting human health and the environment, and enhancing the quality and the capabilities of the training area, including safety.

The No Action Alternative is the continuation of current training levels, with one carrier strike group per exercise, to exclude the use of mid-frequency active sonar (MFAS). Alternative 1 consists of an increase in the number of training activities from baseline levels, to include the use of MFAS, plus training associated with the introduction of new weapon systems, vessels, and aircraft into the Fleet. Alternative 2 consists of all elements of Alternative 1, plus the addition of a second summertime carrier strike group exercise each year, to include the use of MFAS.

Environmental issues that will be addressed in the EIS/OEIS include but are not limited to the following: Air quality; airspace; biological resources, including threatened and endangered species; cultural resources; geology and soils; hazardous materials and waste; health and safety; noise; socioeconomics; transportation and water resources.

The Navy is initiating the scoping process to identify community concerns and local issues that will be addressed in the EIS/OEIS. Federal, state, and local agencies, Alaska Native Federally-Recognized Tribes, the public, and interested persons are encouraged to provide oral and/or written comments to the Navy to identify specific environmental issues or topics of environmental concern that the commenter believes the Navy should consider. All comments, written or provided orally at the scoping meetings, will receive the same consideration during EIS/OEIS preparation.

Written comments on the scope of the EIS/OEIS should be postmarked no later than April 30, 2008. Comments may be mailed to: Mrs. Amy Burt, Naval Facilities Engineering Command, Northwest, 1101 Tautog Circle, Suite 203, Silverdale, Washington 98315–1101, Attn: GOA Navy Training Activities EIS/OEIS Project Manager, Code EV1.AB. Comments can also be submitted via the EIS/OEIS Web page located at *http://www.GulfofAlaskaNavyEIS.com.*

Dated: March 11, 2008.

T.M. Cruz,

Lieutenant, Judge Advocate General's Corps, U.S. Navy, Federal Register Liaison Officer.

[FR Doc. E8–5316 Filed 3–14–08; 8:45 am]

BILLING CODE 3810–FF–P

DEPARTMENT OF ENERGY

Agency Information Collection Extension

AGENCY: U.S. Department of Energy.

ACTION: Notice and Request for Comments.

SUMMARY: The Department of Energy (DOE), pursuant to the Paperwork Reduction Act of 1995, intends to extend for three years, an information collection package with the Office of Management and Budget (OMB) concerning *Collection of Human Resource information from major DOE contractors for contract management, administration, and cost control.* Comments are invited on:

(a) Whether the extended collection of information is necessary for the proper performance of the functions of the agency, including whether the information shall have practical utility;

(b) The accuracy of the agency's estimate of the burden of the proposed collection of information, including the validity of the methodology and assumptions used;

(c) Ways to enhance the quality, utility, and clarity of the information to be collected; and

(d) Ways to minimize the burden of the collection of information on respondents, including through the use of automated collection techniques or other forms of information technology.

DATES: Comments regarding this proposed information collection must be received on or before May 16, 2008. If you anticipate difficulty in submitting comments within that period, contact the person listed below as soon as possible.

ADDRESSES: Written comments may be sent to: Robert M. Myers, U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585–1615, 202–287–1584, or by fax at 202–287–1656 or by e-mail at *robert.myers@hq.doe.gov.*

FOR FURTHER INFORMATION CONTACT: Requests for additional information or copies of the information collection instrument and instructions should be directed to Robert Myers at the address listed above.

SUPPLEMENTARY INFORMATION: This package contains:

(1) *OMB No.* 1910–0600;

(2) *Package Title:* Industrial Relations;

(3) *Type of Review:* Renewal;

(4) *Purpose:* This information is required for management oversight for the Department of Energy's Facilities Management Contractors and to ensure that the programmatic and

Appendix B

Cooperating Agency Correspondence

TABLE OF CONTENTS

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, DC 20350-2000

IN REPLY REFER TO

5090
Ser N456E/8U158107
31 March 2008

Dr. James W. Balsiger
Assistant Administrator, Acting
National Oceanic and Atmospheric
Administration (NOAA) Fisheries
1315 East West Highway
Silver Spring, MD 20910

Dear Dr. Balsiger:

In accordance with the National Environmental Policy Act (NEPA) and Executive Order 12114, the Department of the Navy (Navy) is preparing an Environmental Impact Statement/ Overseas Environmental Impact Statement (EIS/OEIS) to evaluate potential environmental effects of conducting Navy training in and around the Gulf of Alaska (GOA). In order to adequately evaluate the potential environmental effects of the proposed action, Navy and the National Marine Fisheries Service need to work together on acoustic effects to marine species protected under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act. To assist in this effort and in accordance with 40 CFR Part 1501 and the Council on Environmental Quality Cooperating Agency guidance issued on January 30, 2002, Navy requests NMFS serve as a cooperating agency for the development of the GOA EIS/OEIS.

The No Action Alternative is the continuation of training activities associated with large-scale joint training events in the GOA. Two action alternatives are proposed to accomplish the proposed action. Alternative (1) consists of an increase in the number of training activities from levels described in the No Action Alternative, along with force structure changes associated with the introduction of new weapon systems, vessels, and aircraft into the Fleet. Alternative (2) consists of all elements of Alternative (1) plus the addition of a second summertime carrier strike group exercise in the GOA each year.

The purpose of the proposed action is to:

- Support U.S. Pacific Command (PACOM) and U.S. Northern Command (NORTHCOM) training requirements;

- Achieve and maintain Fleet readiness using the GOA to support and conduct current, emerging, and future training activities;
- Accommodate new training requirements associated with the introduction of new weapons and systems to the Fleet; and
- Support civilian authorities in homeland defense training exercises.

The EIS/OEIS will address reasonably foreseeable activities in the particular geographical areas affected by the No Action Alternative and action alternatives. This EIS/OEIS will analyze the effects of sound in the water on marine mammals in the areas of the GOA where activities occur. In addition, other environmental resource areas that will be addressed as applicable in the EIS/OEIS include, but are not limited to: air quality; airspace; biological resources, including threatened and endangered species; cultural resources; geology and soils; hazardous materials and waste; health and safety; noise; socioeconomics; transportation; and water resources.

As the lead agency, the Navy will be responsible for preparing the EIS/OEIS which includes, but is not limited to the following:

- Gathering all necessary background information and preparing the EIS/OEIS and all necessary permit applications associated with acoustic issues on the GOA study area.
- Working with NMFS personnel to determine the method of estimating potential effects to protected marine species, including threatened and endangered species.
- Determining the scope of the EIS/OEIS, including the alternatives evaluated.
- Circulating the appropriate NEPA documentation to the general public and any other interested parties.
- Scheduling and supervising meetings held in support of the NEPA process and compiling any comments received.
- Maintaining an administrative record and responding to any Freedom of Information Act requests relating to the EIS/OEIS.

As a cooperating agency, the Navy requests NMFS support the Navy in the following manner:

- Providing timely comments after the Agency Information Meeting (which will be held at the onset of the EIS/OEIS process) and on working drafts of the EIS/OEIS documents. The Navy requests that comments on draft EIS/OEIS documents be provided within 30 calendar days.

- Responding to Navy requests for information in a timely manner.

- Coordinating, to the maximum extent practicable, any public comment periods that are necessary in the MMPA permitting process with the Navy's NEPA public comment periods.

- Participating, as necessary, in meetings hosted by the Navy for discussion of EIS/OEIS-related issues.

- Adhering to the overall schedule as set forth by the Navy.

- Providing a formal, written response to this request.

The Navy views this agreement as important to the successful completion of the NEPA process for the GOA EIS/OEIS. It is the Navy's goal to complete the analysis as expeditiously as possible, while using best scientific information available. NOAA Fisheries assistance will be invaluable in that endeavor.

My point of contact for this action is Ms. Karen M. Foskey, (703) 602-2859, email: Karen.Foskey@navy.mil.

Sincerely,

L. RICE
Read Admiral, U.S. Navy
Director, Environmental Readiness
Division (OPNAV N45)

Copy to:
Deputy Assistant Secretary of the Navy (Environment)
Office of Assistant General Counsel (Installation & Environment)

Commander, U.S. Pacific Fleet (N01CE, N7)
Commander, U.S. Fleet Forces Command (N73, N77)
Commander, Naval Installations Command (N45)
Commander, Navy Region Northwest (N40)
Commander, Naval Facilities Engineering Command, Northwest (N45)

DEPARTMENT OF THE NAVY
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR. HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N01CE1/0379
4 Apr 08

Mr. Tom Melius
Regional Director
U.S. Fish & Wildlife Service – Alaska Region
1011 East Tudor Road
Anchorage, Alaska 99503

Dear Mr. Melius:

SUBJECT: GULF OF ALASKA ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT FOR NAVY TRAINING ACTIVITIES

In accordance with the Council on Environmental Quality regulations implementing the National Environmental Policy Act, the Department of the Navy (Navy) requests that the U.S. Fish & Wildlife Service serve as a cooperating agency for the development of the Gulf of Alaska (GOA) Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS).

This EIS/OEIS will evaluate several alternatives based on intensity and frequency of training within an identified geographic area.

The proposed action will allow the Navy to:

- Maintain baseline training activities at current levels;
- Increase training activities from current levels to support future Fleet exercise requirements;
- Accommodate new training requirements associated with the introduction of new weapons and systems to the Fleet; and
- Support civilian authorities in homeland defense training exercises.

The EIS/OEIS will address reasonably foreseeable activities in the particular geographical areas affected by the alternatives and analyze the potential effects of additional training activities. Areas of analysis will the potential effects of sound in the water on marine mammals in the areas of the GOA where training activities occur. Other environmental resource areas that will be addressed include, but are not limited to: air quality; airspace; biological resources, including threatened and endangered species; historic and cultural resources; water resources; geology; hazardous materials and waste; health and safety; noise; socioeconomics; transportation; fishing; and recreation.

As the lead agency, the Navy will prepare the EIS/OEIS that includes but is not limited to the following:

- Gathering all necessary background information and preparing the EIS/OEIS.

  Working with U.S. Fish & Wildlife Service personnel to evaluate potential impacts of changes and enhancements on wildlife refuges, critical habitat, and wildlife resources including threatened and endangered species.

- Identifying the scope of the EIS/OEIS, including the alternatives evaluated.

- Circulating the appropriate NEPA documentation to the general public and any other interested parties.

- Scheduling and supervising meetings held in support of the NEPA process, and compiling any comments received.

- Maintaining an administrative record and responding to any Freedom of Information Act requests relating to the EIS/OEIS.

As a cooperating agency, the Navy requests the U.S. Fish & Wildlife Service support the Navy by:

  Providing timely comments throughout the EIS process, to include, on working drafts of the EIS/OEIS documents. The Navy requests that comments on draft EIS/OEIS documents be provided within 30 calendar days.

- Responding to Navy requests for information. Timely U.S. Fish & Wildlife Service input will be critical to meeting our planned schedule.

SUBJECT: GULF OF ALASKA ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT FOR NAVY TRAINING ACTIVITIES

- Participating, as necessary, in meetings hosted by the Navy for discussion of EIS/OEIS related issues including the preparation of the draft EIS/OEIS and responses to comments.

- Adhering to the overall schedule as set forth by the Navy.

The Navy views your participation as a cooperating agency important to the successful completion of the NEPA process for the Gulf of Alaska EIS/OEIS. It is the Navy's goal to complete the analysis as expeditiously as possible, while using best scientific information available. USFWS assistance will be invaluable in that endeavor.

Navy's timelines for the completion of this EIS/OEIS are aggressive. The schedule calls for the draft EIS/OEIS and public Hearings in Mid 2009, release of the final EIS/OEIS in early 2010 and a record of decision in Mid 2010.

My point of contact for this action is Ms. Carolyn L. Winters, (360) 315-5092, email: carolyn.winters@navy.mil.

Sincerely,

J. P. RIOS
Captain, U.S. Navy
Deputy Fleet Civil Engineer
By direction

Copy to:
Chief of Naval Operations (N45)
Commander, U.S. Fleet Forces Command (N73, N77)
Commander, U.S. Pacific Fleet (N7)
Commander, Naval Installations Command (N45)
Commander, Navy Region Northwest (N4, N40)
Commander, Naval Facilities Engineering Command, Northwest (EV1)

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, DC 20350-2000

IN REPLY REFER TO

5090
Ser N456M/8U158134
21 April 2008

Mr. P. Michael Payne
Division Chief
Permits, Conservation, and Education Division
National Marine Fisheries Service (NMFS)
National Oceanic and Atmospheric Administration
B-SSMC3, Room 13821
1315 East-West Highway
Silver Springs, MD 20910

Dear Mr. Payne:

The Commander, U.S. Pacific Fleet (CPF) is preparing an Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) to assess the potential environmental impacts associated with Navy training in the Gulf of Alaska (GOA). Specifically, the Proposed Action is to continue and increase training activities in the GOA. A collection of actions will be evaluated within the EIS/OEIS.

The No Action Alternative is the continuation of training activities associated with large-scale Joint training events in the GOA. Two action alternatives are proposed to accomplish the Proposed Action. Alternative 1 consists of an increase in the number of training activities from levels described in the No Action Alternative, along with force structure changes associated with the introduction of new weapon systems, vessels, and aircraft into the Fleet. Alternative 2 consists of all elements of Alternative 1 plus the addition of a second summertime carrier strike group exercise in the GOA each year.

The purpose of the Proposed Action is to:

- Support U.S. Pacific Command (PACOM) and U.S. Northern Command (NORTHCOM) training requirements;
- Support Joint Task Force 519 (JTF-519) training requirements;

- Achieve and maintain Fleet readiness using the GOA to support and conduct current, emerging, and future training activities;
- Accommodate new training requirements associated with the introduction of new weapons and systems to the Fleet; and
- Support civilian authorities in homeland defense training exercises.

More specific descriptions of the alternatives are included in enclosure (1).

Conduct of these activities will likely result in acoustic exposure of marine mammals listed under the Marine Mammal Protection Act (MMPA) from mid-frequency active sonar (MFAS) and impulsive sources, and likely requires a Letter of Authorization (LOA). As such, the Navy will be submitting an LOA request to your office in the coming months for these activities. It is expected that species for which an LOA is sought will include species listed under the Endangered Species Act.

As applicant for a Letter of Authorization, the Navy requests your office initiate early consultation procedures with the Endangered Species Division, in accordance with Section 7(a)(3) of the Endangered Species Act and its implementing regulation at 50 CFR §402.11. In accordance with these regulations, the attached Preliminary Draft Description of the Proposed Action and Alternatives for the GOA Navy Training Activities EIS/OEIS serves as the Navy's definitive proposal outlining the action (Enclosure 1). As previously stated, the effects of the proposed action for purposes of the MMPA permit will be from exposure to acoustic energy from MFAS and impulsive sources. The level of magnitude of these effects is still being modeled, and will be included in the Navy's request for an LOA.

Title 10, Section 5062 of the United States Code requires the Navy to be "organized, trained, and equipped primarily for prompt and sustained combat incident to operations at sea." The current and emerging training activities in the GOA will be used to meet this legal requirement. Thus, in accordance with 50 CFR §402.11(b), this letter serves as the Navy's statement that it intends to implement the proposal should an MMPA Letter of Authorization be obtained from your office.

We appreciate your continued support in helping us to meet our Section 7 responsibilities. My point of contact for this matter is Ms. Elizabeth Phelps, 703-604-5420 or Elizabeth.Phelps@navy.mil.

Sincerely,

R. E. Tickle

Ronald Tickle
Head, Operational Environmental Readiness and Planning Branch
Environmental Readiness Division
(OPNAV N45)

Enclosure:
(1) DRAFT - Gulf of Alaska Navy Training Activities EIS/OEIS Description of Proposed Action and Alternatives (Dated March 2008)

Copy to:
Chief of Naval Operations (N43)
Commander, U.S. Fleet Forces Command (N73, N77)
Commander, U.S. Pacific Fleet (N01CE, N3, N7)
Commander, Naval Installations Command (N45)
Commander, Navy Region Northwest (N40)
Commander, Naval Facilities Engineering Command, Northwest (N45)

From:	Frances_Mann@fws.gov
To:	Burt, Amy E CIV NAVFAC NW, EV1;
cc:	Ann_Rappoport@fws.gov; Frances_Mann@fws.gov;
Subject:	FWS declines to be cooperators on EIS for Gulf of Alaska
Date:	Monday, September 08, 2008 16:21:55

Dear Ms. Burt:

Thank you for your April 4, 2008, request for the U.S. Fish and Wildlife Service to be a cooperating agency in your preparation of an Environmental Impact Statement (EIS) for navy training exercises in the Gulf of Alaska. I regret that we must decline this opportunity due to staffing and timing constraints of other Service priorities. Nevertheless, we are concerned about potential effects of the proposed activities on Service trust resources in this area and surrounding areas where there could be secondary and indirect effects. Consequently we expect to maintain our status as a commenting agency throughout your National Environmental Policy Act process for this potential action. In that regard, we will involve pertinent Service programs and expect to work with your staff as the EIS is developed.

For further coordination and comments on this project, please contact Ann Rappoport or me (contact information provide below).

Thank you.

Frances

Ann Rappoport, Field Supervisor
907-271-2787
Ann_rappoport@fws.gov <mailto:Ann_rappoport@fws.gov>

Frances Mann, Branch Chief, Conservation Planning Assistance
907-271-3053
Frances_mann@fws.gov <mailto:Frances_mann@fws.gov>

Address for both Ann and Fran:

Anchorage Fish and Wildlife Field Office
605 W. 4th Ave., Rm. G61
Anchorage, AK 99501

Appendix C

Cultural Resources Correspondence

TABLE OF CONTENTS

HEADQUARTERS
ALASKAN COMMAND (ALCOM)
ELMENDORF AIR FORCE BASE, ALASKA 99506

MAR 31 2008

Lieutenant General Douglas M. Fraser
Commander, Alaskan Command
10471 20th Street, Suite 139D
Elmendorf AFB, AK 99506-2200

Ms. Phyllis Amado
Kaguyak Village
P.O. Box 5078
Akhiok, AK 99615

Dear Ms. Amado

The purpose of this letter is to inform your Tribal Council of anticipated U.S. Navy training activities in the Gulf of Alaska (GOA) in future years (Enclosure 1). The Navy is preparing an Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) for Navy training activities in the GOA.

The majority of Navy training activities in Alaska and the GOA would occur in the GOA temporary Maritime Exercise Area, or MEA (Enclosure 2). This area includes 42,146 square nautical miles (144,560 km^2) of surface and subsurface ocean operating area and overlying airspace. The GOA MEA serves as the principal training venue for annual exercises, which can involve forces from the U.S. Navy, U.S. Air Force, U.S. Army, and U.S. Coast Guard. The air and sea components of the GOA MEA provide the space and resources needed to realistically train Service men and women to achieve and maintain U.S. Pacific Fleet readiness. The Navy's Proposed Action is a step toward ensuring the continued vitality of this essential training opportunity.

As global defense technology advances, it is necessary for the Navy to enhance its training capabilities. Therefore, the Navy is proposing to support current, emerging, and future training activities in the GOA as necessary to achieve and sustain military readiness, including:

- Maintain current levels of military readiness by training in Alaska and the GOA;
- Accommodate future increases in training activities from current levels as necessary to support Fleet exercise requirements;
- Accommodate training requirements associated with force structure changes; and
- Support civilian authorities in homeland defense training exercises.

Additional information on this project can be found by visiting www.GulfofAlaskaNavyEIS.com.

A preliminary evaluation indicates that potential protected tribal resources (seals and sea lions) may be affected, but not adversely (no changes in numbers or permanent changes in distribution), by Navy training activities occurring in the MEA. Although my staff believes your hunting areas are outside the boundaries of the MEA, your tribe is one of the closest Federally-Recognized Tribes to the MEA. Therefore, I am notifying you of this action and seeking your input.

Pursuant to our American Indian/Alaska Native policy, I ask you to consider whether this proposal will significantly affect any of Kaguyak Village's tribal rights or protected tribal resources. I would appreciate a reply by May 30, 2008, with your analysis. If yes, please specify which tribal right(s) or protected tribal resource(s) will be affected and how it (they) will be significantly affected. If you reply by indicating an effect to a right or resource, we invite you to consult with us on a Government-to-Government basis as a way to discuss issues before we move forward with further environmental analysis and public comment.

We look forward to working with you to address any concerns you may have on this project. Please feel free to contact my Native Affairs/Natural Resources Advisor, Dr. Jerome Montague, at (907) 552-2769 or jerome.montague@elmendorf.af.mil if you have any questions.

Sincerely

COL, USA, Chief of Staff
DOUGLAS M. FRASER
Lieutenant General, USAF
Commander

2 Enclosures:
1. GOA Navy Training Activities EIS/OEIS Exercise Description
2. GOA Navy Training Activities EIS/OEIS Areas Map

GULF OF ALASKA NAVY TRAINING ACTIVITIES ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT

EXERCISE DESCRIPTION

1.1 Overview

The Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) analyzes potential environmental effects of Navy training activities that will take place during Navy training activities in and around the Gulf of Alaska (GOA). The Navy training activities covered in the EIS/OEIS include those that take place in the temporary maritime exercise area (MEA) within the GOA and those exercise events that originate in the MEA and extend over inland Alaska training areas. This document summarizes the contents of the EIS/OEIS. The areas involved within the Gulf of Alaska and the air military operating areas and land ranges in Alaska will be referred to as the Alaska training areas. The GOA temporary MEA includes 42,146 nm^2 (144,560 km^2) of surface and subsurface ocean operating area and overlying airspace.

Navy training activities within the Alaska Training Areas will consist of the following sea and land exercises. These exercises will involve Navy assets and will include participation by other services in joint exercises. Possible activities include: Command and Control (C2), Special Warfare Operations (SPECWAROPS), Personnel Recovery (PR), Deck Landing Qualifications (DLQ), Close Air Support (CAS), Defense Counter Air (DCA), Air Interdiction of Maritime Targets (AIMT), Air to Air Exercises, Air to Surface Exercises, Underway Replenishments (UNREP), Aircraft Operations Support (AIROPS), Submarine Operations (SUBOPS), and Anti-Submarine Warfare Exercises (ASW). Navy training will include the use of tactical mid-frequency active sonar.

Navy training activities in the state of Alaska and the Gulf of Alaska will occur during two separate summer season (April-October) events, for approximately 16 hours per day over a three-week period for each event.

1.2 Participants and Assets

Participants in the Navy training activities in Alaska and the GOA will include personnel and assets from the U.S. Navy, Army, Air Force, Marine Corps, Coast Guard, other federal and local agencies, and various civilian contracted vessels. Typical Naval forces participants will include a U.S. Navy Carrier Strike Group (CSG) with one nuclear-powered aircraft carrier (CVN), one guided missile cruiser (CG), three guided missile destroyers (DDGs), one guided missile Frigate (FFG), one Navy fleet oiler, one nuclear-powered attack submarine (SSN), and 12-15 contracted fishing vessels, for a total of 18-21 surface vessels. Approximately 150-200 aircraft will typically support Navy training activities in the Alaska training areas, including participation by other armed forces assets.

1.3 Training Activities to be conducted in the Alaska Training Areas

Participating aircraft could be stationed at Elmendorf Air Force Base (AFB), Anchorage; Eielson AFB, 23 miles (37 km) south of Fairbanks; Kulis Air National Guard Base, Anchorage; Fort Wainwright, Fairbanks, and on the aircraft carrier. The activities of these aircraft will be described by the term 'sortie.' A sortie is defined as a single operation by one aircraft, which uses a range or operating area. A single aircraft sortie is one complete flight (i.e., one takeoff and one final landing). The exercises planned to take place within the GOA and the MEA are described in the following sections.

1.3.1 Anti-Air Warfare (AAW) Training

Anti-Air Warfare addresses combat operations by air and surface forces against hostile aircraft.

Air Combat Maneuvers (ACM): ACM includes basic flight maneuvers where aircraft engage in offensive and defensive maneuvering against each other. During an ACM engagement, no ordnance is fired. These maneuvers typically involve two (2) aircraft; however, based upon the training requirement, ACM exercises may involve over a dozen aircraft. However, for purposes of this study, ACM includes other aircraft activities conducted routinely in preparation for more advanced training flights such as ACM. These other activities include in-flight refueling, basic familiarization training, and formation flying.

Air Defense Exercise (ADEX): ADEX is an exercise to train ships and aircraft assets in coordination and tactics for defense of the CSG or other Naval forces from airborne threats.

Surface to Air Missile Exercise (SAMEX): During a SAMEX, surface ships engage threat missiles and aircraft with missiles with the goal of disabling or destroying the threat. The exercise lasts about two hours.

Surface-to-Air Gunnery Exercise (GUNEX S-A): During a GUNEX S-A, a ship's gun crews engage threat aircraft or missile targets with their guns with the goal of disabling or destroying the threat. The exercise lasts about two hours which normally includes several non-firing tracking runs followed by one or more the firing runs.

A typical scenario involving a DDG or FFG with 20 mm Close-in-Weapon System (CIWS) is similar, except the ships involved engage the simulated threat aircraft or missile with the CIWS. CIWS equipped ships can expend between 900 to 1400 rounds per mount per firing run for a total of up to five runs during the typical two hour exercise. The actual number of rounds expended during this exercise is dependent on the ship class, the CIWS model installed, and the available ammunition allowance.

Air to Air Missile Exercise (AAMEX): During an AAMEX, aircraft attack a simulated threat target aircraft with air-to-air missiles with the goal of destroying the target. Air-to-air missiles are fired from aircraft against aerial targets to provide aircrews with experience using aircraft missile firing systems and training on air-to-air combat tactics.

1.3.2 Antisubmarine Warfare (ASW) Training

An ASW training activity provides crews of submarines, ships, aircraft, and helicopters with experience in locating, tracking, and attacking submarines or submarine-like mobile underwater targets. ASW tasks include responding rapidly and decisively to enemy submarine contacts; employing sensors and weapons to neutralize the target, and providing commanders with a common tactical picture of what the battlefield resembles undersea. During ASW training, a target submarine is searched for using active and passive sonar. ASW aircraft, including both helicopters and fixed-wing, use a combination of passive and active sonobuoys. Helicopters may also use active dipping sonar when hovering. Weapons and signaling devices such as inert, air-dropped torpedo shapes, and smoke markers may also be used.

1.3.3 Anti-Surface Warfare (ASUW) Training

Anti-surface Warfare addresses combat (or interdiction) operations by air, surface, or submarine against hostile surface ships and boats.

Visit, Board, Search and Seizure/Vessels of Interest (VBSS/VOI): VBSS/VOI missions are the principal type of maritime interdiction operations used by naval forces. Highly trained teams of armed personnel, wearing body armor, flotation devices, and communications gear are deployed by small Zodiac boats or helicopters to board and inspect ships and vessels suspected of carrying contraband. Once aboard, the team takes control of the bridge, crew, and engineering plant, and inspects the ship's papers and its cargo.

Air-to-Surface Missile Exercise (A-S MISSILEX): A-S MISSILEX involves fixed winged aircraft and helicopter crews launching missiles at surface maritime targets, day and night, with the goal of destroying or disabling enemy ships or boats. The platform fitted with the expendable target could be a stationary barge or a remote controlled speed boat. The majority of exercises involve the use of captive carry (inert, no release) training missiles; the aircraft perform all detection, tracking, and targeting requirements without actually releasing a missile.

Air-to-Surface Bombing Exercise (A-S BOMBEX): During an A-S BOMBEX, maritime patrol aircraft (MPA) or F/A-18 delivers bombs against surface maritime targets, with the goal of destroying or disabling enemy ships or boats. Exercises at night will normally be done with captive carry (no drop) weapons because of safety considerations. Laser designators from aircraft are used to illuminate certified targets for use with lasers when using laser guided weapons. The majority of unit level exercises involve the use of inert training bombs; the aircraft perform all detection, tracking, and targeting requirements without actually releasing a bomb.

Air-to-Surface Gunnery Exercise (A-S GUNEX): Strike fighter aircraft and helicopter crews, including embarked Naval Special Warfare personnel, use guns to attack surface maritime targets, day or night, with the goal of destroying or disabling enemy ships, boats, or floating or near-surface mines.

Surface-to-Surface Gunnery Exercise (S-S GUNEX): These exercises train surface ship crews in high-speed surface engagement procedures against mobile (towed or self-propelled) seaborne targets. Both live and inert training rounds are used against the targets. The training consists of the pre-attack phase, including locating, identifying, and tracking the threat vessel, and the attack phase in which the weapon is launched and flies to the target. In a live-fire event, aircraft would conduct a surveillance flight to ensure that the range is clear of non-participating ships and that no marine mammals are present.

Maritime Interdiction (MI): MI is a coordinated defensive pre-planned attack against multiple sea-borne and air targets using airborne and surface assets with the objective of delivering a decisive blow to enemy forces. These exercises typically involve all the assets of the CSG and joint forces in an attempt to neutralize the threat.

Sea Surface Control (SSC): SSC exercises involve aircraft performing reconnaissance of the surrounding sea area. Airborne assets investigate surface contacts of interest and attempt to identify, via onboard sensors or cameras, the type, course, speed, name, and other pertinent data about the ship of interest.

1.3.4 Electronic Combat (EC) Training

Electronic Combat (EC): EC exercises are conducted to prevent or reduce the effective use of enemy electronic equipment and ensure the continued use of friendly electronic equipment, including command and control capabilities. During these exercises, aircraft, surface ships, and submarines attempt to control critical portions of the electromagnetic spectrum used by threat radars, communications equipment, and electronic detection equipment to degrade or deny the enemy's ability to defend its forces from attack and/or recognize an emerging threat early enough to take the necessary defensive actions.

Chaff Exercise (CHAFFEX): Ships, fixed-winged aircraft, and helicopters deploy chaff to disrupt threat targeting and missile guidance radars and to defend against an attack. Chaff is a radar reflector material made of thin, narrow, metallic strips cut in various lengths to elicit frequency responses, which deceive enemy radars. Chaff training is the most common exercise used for training both ships and aircraft.

Counter Targeting: A Counter Targeting exercise is a coordinated, defensive activity utilizing surface and air assets, that attempts to use jamming and chaff to show a false force presentation to inbound surface-to-surface platforms.

1.3.5 Naval Special Warfare (NSW) Training

Insertion/Extraction: Personnel approach or depart an objective area using various transportation methods depending on the tactical situation. These exercises train forces to insert and extract personnel and equipment day or night. NSW personnel conduct insertion/extraction exercises using helicopters, rubber boats, and other equipment.

1.3.6 Strike Warfare Training

Strike Warfare addresses combat (or interdiction) operations by air and surface forces against hostile land based forces and assets. Strike exercises occur on the land and air training ranges as identified in the Alaska Military Operations Areas EIS (USAF., 1995, 1997) and are covered in separate environmental analyses.

Air-to-Ground Bombing Exercise (BOMBEX): Air-to-ground bombing exercises consist of fixed-wing strike fighter aircraft that deliver bombs and rockets against land targets, day or night, with the goal of destroying or disabling enemy vehicles, infrastructure, and personnel. Typically, a flight of two to four aircraft will depart the aircraft carrier and fly inland at high altitude (greater than 30,000 ft). Exercises at night will normally be done with captive carry (no drop) weapons because of safety considerations. Laser designators from the aircraft dropping the bomb, a support aircraft, or ground support personnel are used to illuminate certified targets for use with lasers when using laser guided weapons. The average time for this exercise is about one hour.

Personnel Recovery (PR): PR is the umbrella term for activities that are focused on the task of recovering captured, missing, or isolated personnel from harm's way. PR exercises train rescue forces personnel on the tasks needed to recover distressed personnel during war or military operations other than war. PR exercises will include insertion of a survivor into the water or on land ranges and rescue activities to recover the survivor by helicopter. In a hostile environment, this exercise becomes a Combat Search and Rescue (CSAR) mission. The exercise can include reconnaissance aircraft to find the downed aircrew, helicopters to conduct the rescue, and in a hostile situation, fighter aircraft to perform CAS to protect both the downed aircrews and the rescue helicopters.

1.3.7 Other Training

Deck Landing Qualifications (DLQs): These exercises provide training for helicopter crews to land on ships underway at sea. DLQs performed in the GOA will be done by aircrews from the U.S. Air Force, U.S. Army, and U.S. Coast Guard, who do not normally perform DLQs. These participants will use this venue to practice helicopter DLQs onboard naval vessels. The activity takes place in both day and night, and could involve more than one helicopter over a period of several hours. The crew that is receiving the training will typically depart from a shore facility and fly to sea and make an approach and landing aboard the ship.

Defense Support of Civil Authorities (DSCA): DSCA exercises provide training for Navy forces in responding to a request for emergency support in response to a request for military support. The purpose is to train CSG forces in providing assistance and relief to a civilian population. The basic elements of the training are to provide logistics support, communications, and civil relations associated with a civilian requirement.

Joint Logistics Over-The-Shore (JLOTS): Naval Beach Group units provide support during amphibious assaults and with Maritime Preposition Force units to load and unload ships without the benefit of deep draft-capable, fixed port facilities in friendly or undefended territory. Essentially, these units create and operate facilities ashore where no facilities exist, and bring equipment and supplies from ships at sea to ashore staging points for use by forces ashore. This type of exercise is called Logistics Over-the-Shore and is composed of several types of activities depending on what has to be done to unload the ships.

Non-combatant Evacuation Operation (NEO): NEO training practices the evacuation of American citizens from a country or region in which their safety cannot be assured such as during a revolution or coup. The essential elements of a NEO exercise include establishing and securing a marshalling area for evacuees, moving evacuees to the marshalling area, accounting for evacuees, and moving evacuees from the marshalling area to a safe haven, often on ships at-sea. A NEO requires rapid planning, ingress with appropriate transportation, location, identification and securing of evacuees, and egress to a secure location.

1.4 Analysis of Potential Impacts to Marine Mammals and Fish in the GOA

The Navy will conduct an analysis of direct and indirect impacts to marine mammals, including cetaceans and pinnipeds, and fish during the training activities described above that could take place as a part of Navy training activities in Alaska and the GOA. As results of that analysis are finalized, that information will be explained through the NEPA process.

Further, the Navy must comply with the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA) and the Navy will seek to obtain the appropriate permits and authorizations under these federal laws from National Oceanic and Atmospheric Agency (NOAA) Headquarters and from the Alaska Regional Office of the U.S. Fish and Wildlife Service (USFWS).

Figure 1. Navy Training Areas in Alaska and the Gulf of Alaska

Ms. Phyllis Amado
Kaguyak Village
P.O. Box 5078
Akhiok, AK 99615

Dr. Gordon Pullar
Lesnoi Village
P.O. Box 9009
Kodiak, AK 99615

Mr. Robert Henrichs
Native Village of Eyak
P.O. Box 1388
Cordova, AK 99574

Mr. Patrick Norman
Native Village of Port Graham
P.O. Box 5510
Port Graham, AK 99603

Ms. Sue Johnson
Native Village of Tatitlek
P.O. Box 171
Tatitlek, AK 99677

Mr. Conrad Peterson
Village of Old Harbor
P.O. Box 62
Old Harbor, AK 99643

Ms. Nancy Nelson
~~Dr. Gordon Pullar~~ Afognak Island
~~Lesnoi Village~~
~~P.O. Box 9009~~ Kodiak Island
~~Kodiak, AK 99615~~

Mr. Pete Kompkoff
Native Village of Chenega
P.O. Box 8079
Chenega Bay, AK 99574

Mr. Alex Ambrosia
Native Village of Ouzinkie
P.O. Box 130
Ouzinke, AK 99644

Mr. Ivan Lukin
Native Village of Port Lions
P.O. Box 69
Port Lions, AK 99550

Mr. Christopher Helms
Shoonaq Tribe of Kodiak
312 West Marine Way
Kodiak, AK 99615

Advisory
Council On
Historic
Preservation

The Old Post Office Building
1100 Pennsylvania Avenue, NW #809
Washington, DC 20004

Reply to: 730 Simms Street #401
Golden, Colorado 80401

May 17, 1994

G. Virgil Hanson, Major, USAF
Chief, Environmental Management
HQ Eleventh Air Force (PACAF)
11 AF/LGV
5800 G. Street, Suite 203
Elmendorf Air Force Base, AK 99506-2150

REF: No Adverse Effect determination for the reconstruction of Military Operations Areas in Alaska

Dear Major Hanson:

We have reviewed the documentation regarding your no adverse effect determination for the above referenced undertaking. Under procedures set forth in 36 CFR Section 800.5(d)(2), the Council does not object to the finding of no adverse effect. This letter evidences that the requirements of Section 106 of the National Historic Preservation Act and the Council's regulations have been met for this project. It should be retained with all supporting documentation in your agency's environmental or project file.

If you have any questions or require the further assistance of the Council, please contact the Western Office at (303) 231-5320.

Sincerely,

Claudia Nissley
Director, Western Office
of Review

received
May 27, 1994

RECEIVED
MAY 26 1994

HQ ELEVENTH AIR FORCE (PACAF)
ELMENDORF AFB AK 99506-2150

12 April 1994

11 AF/LGV
5800 G Street Suite 203
Elmendorf AFB AK 99506-2150

Ms Claudia Nissley
Western Office of Project Review
Advisory Council on Historic Preservation
730 Simms Street Room 401
Golden CO 80401

Dear Ms Nissley

In accordance with the provisions of Title 36 CFR 800.5(d)(1)(i), this letter notifies the Advisory Council on Historic Preservation (Council) of the consultation between the Pacific Air Forces, Eleventh Air Force, and the Alaska State Historic Preservation Officer (SHPO) regarding the Air Force Proposal to Restructure Military Operations Areas in Alaska (Proposal) and associated Determination of No Adverse Effect to Cultural Resources (Determination).

Consultation regarding potential effects to cultural resources included meetings with the SHPO and other agencies. The following documents are enclosed for your information and records:

a) Eleventh Air Force Preliminary Determination of No Adverse Effect to Cultural Resources and request for SHPO concurrence with Determination (Letter of 4 Feb 94 [Attachment 1])

b) SHPO concurrence with determination (Letter of 28 Feb 94 [Atch 2]).

c) The Final Determination of No Adverse Effect to Cultural Resources (Atch 3) which includes a brief description of the undertaking; a brief summary of the historic properties subject to effect; and a brief explanation of why the undertaking will have no adverse effect on the historic properties involved.

d) Map showing the Proposal Areas within the State of Alaska (Atch 4).

The Determination and associated correspondences will be published and available for public inspection in the *Draft* Environmental Impact Statement (EIS). The Draft EIS is presently scheduled to be published on or before 2 September 1994.

If there are any questions, please contact Mr James W. Hostman, 11 AF/LGV, at 907-552-4151.

G. VIRGIL HANSON, Major, USAF
Chief, Environmental Management

Attachments:
1. Spectrum Letter of 4 Feb 94
2. Final Determination of No Adverse Effect
3. SHPO Concurrence letter, 28 Feb 94
4. Map of Proposed Action

Environmental Impact Statement
for
Improvements to Military Operations Areas
in Alaska

DETERMINATION OF NO ADVERSE EFFECT TO CULTURAL RESOURCES

Pursuant to Section 106 of the National Historic Preservation Act of 1966 (16 USC 470), and according to the regulations governing Section 106, 36 CFR Part 800 "Protection of Historic Properties," a determination is made of No Adverse Effect to cultural resources due to the implementation of the Pacific Air Forces' Proposal for Improvements to Military Operations Areas in Alaska (Proposal).

1. **Description of the undertaking.**

The undertaking consists of a proposal to restructure Military Operations Area (MOA) airspace in Alaska. *Please see Description of the Proposed Action and Alternatives (DOPAA) for a complete description of the Proposal.* The following items have been consolidated from the Proposal because of their relevancy to the subject Determination:

a) The Proposal is limited to structuring (location, dimensions, etc.) and Air Force use of MOA airspace. There would be no ground disturbance associated with the Proposal (i.e., no construction of new buildings or facilities, or alteration of existing buildings or facilities).
b) Supersonic activity would not occur below 5,000 feet AGL within any of the MOAs.
c) Intentional flare deployment would not occur below 2,000 feet AGL, an altitude designated to allow complete flare burnout prior to contact with the ground or vegetation.

2. **Description of historic properties that may be affected by the undertaking.**

Due to the extensive area affected by the Proposal, it would be infeasible to identify all historic properties in the Region of Influence. It is reasonable to conclude that the MOAs as described would overlay lands that contain a number of historic properties (cultural resources) already listed in or eligible for the Register of National Historic Places (Register). Such properties or resources may include surface and subsurface prehistoric sites; above-ground historic structures such as sod, log, and frame buildings and Cold War Era sites; and historic and prehistoric trails, including the Iditarod National Historic Trail. To date, there have been no traditional Native use sites identified.

3. **Description of the efforts used to identify historic properties.**

The range and extent of cultural resources that might be affected by the Proposal were determined through preliminary consultation with the State Historic Preservation Officer

(SHPO) (September 8, 1993); agency, local government, and public scoping meetings for the Environmental Impact Statement; review of agencies' resource management and cultural resource management plans; and review of various literature that describes Alaska's cultural resources.

4. How and why the Criteria of Adverse Effect were found inapplicable.

a) There would be no direct physical destruction, damage, or alteration to any part of a property. The possibility for indirect damage is considered to be remote. It can be speculated that indirect damage such as window breakage or structural damage from sonic booms or noise vibration could occur. However, low-altitude [(below 5,000 feet above ground level (AGL)] supersonic flight would not occur under any Proposal alternatives, therefore minimizing the possibility for such damage. Air Force Regulation 60-16 also prohibits military aircraft from flying below 500 feet (AGL) over structures. It is highly improbable that a fire would be started by a flare and subsequently damage or destroy historic properties. Intentional deployment of flares would not occur below 2,000 thousand feet, an altitude designated to allow complete flare burnout prior to contact with the ground or vegetation.
b) There would be no isolation of a property from its setting or alteration of the character of the property's setting where that character contributes to the property's qualifications for the Register.
c) There would be introduction of audible and visual elements. However, these intrusions would be transitory in nature and would only momentarily alter the natural setting of a property or properties. Such temporary alteration of the environment would not harm the integrity of the resource setting.
d) Implementation of this Proposal or its alternatives would not result in the neglect of any properties, and therefore would not contribute to the deterioration or destruction of any properties;
e) There would be no transfer, sale, or lease of any properties involved with this Proposal or any alternatives.

5. Views of the SHPO, other agencies, governments, and the public and a description of the means employed to solicit these views.

a) Views of the SHPO, other agencies, governments, and the public indicated a broad, general concern for cultural resources. However, no specific cultural resource or historic property was identified that was considered to be threatened by implementation of the Proposed Action or Alternatives. It was the preliminary conclusion of scoping that the Proposal was unlikely to have significant adverse effects to cultural resources.

b) Pursuant to the National Environmental Policy Act (40 CFR 1501.7), views were solicited during the Environmental Impact Statement scoping process. Scoping meetings were held to inform agencies and the public of the Proposal and to solicit input and identify concerns. Federal and state agency scoping meetings were held with the Alaska Departments of

Natural Resources, Fish and Game, and Community and Regional Affairs; and the United States Fish and Wildlife Service, National Park Service, Bureau of Land Management, and Bureau of Indian Affairs. Public scoping meetings were held in fourteen communities, and public input was solicited through a mail-out brochure and survey form. Meetings were also held with local governments, public interest organizations, and other groups, including the Alaska Congressional delegation, Tanana Chiefs Conference, and the Fairbanks North Star Borough. Additionally, the SHPO was consulted separately to discuss the possible effects that might occur to cultural resources due to the Proposed Action or Alternatives.

Conclusion.

As outlined above, it is not anticipated that implementation of any alternative of the proposal to restructure military operations areas in Alaska would change in any way the characteristics that qualify properties in the Region of Influence for inclusion in the Register. The undertaking would not diminish the integrity of such characteristics. Therefore, this Determination of No Adverse Effect is made.

This Determination has been made final upon receipt of concurrence from the SHPO (see attached letter, February 28, 1994). If for any reason the nature of the Proposal changes during the regular course of the Environmental Impact Statement process, further consultation with the SHPO and with the public and other agencies will occur.

STATE OF ALASKA

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF PARKS AND OUTDOOR RECREATION
Office of History and Archaeology

WALTER J. HICKEL, GOVERNOR

3601 C STREET, Suite 1278
ANCHORAGE, ALASKA 99503
PHONE: (907) 762-2622

MAILING ADDRESS:
P.O. Box 107001
ANCHORAGE, ALASKA 99510-7001

February 28, 1994

received
1 Mar 94

File No.: 3130-1R USAF

Subject: Improvements to Military Operations Areas in Alaska/EIS

Karen McKibbin, Project Manager
Spectrum Sciences & Software, Inc.
1007 W. 3rd Ave., Suite 301
Anchorage, AK 99501

Dear Ms. McKibbin;

Thank you for your letter and determination of effect for the referenced project. We concur with your finding that the undertaking will have no adverse effect on properties listed on or eligible for inclusion in the National Register of Historic Places.

The Advisory Council on Historic Preservation should be notified of this consultation pursuant to 36 CFR 800.5(d)(1)(i). Please contact Tim Smith at 762-2625 if there are any questions or if we can be of further assistance.

Sincerely,

Judith E. Bittner
State Historic Preservation Officer

JEB:tas

SPECTRUM
SCIENCES & SOFTWARE, INC.

received

February 4, 1994

Ms. Judith Bittner
Alaska State Historic Preservation Officer
Office of History and Archaeology
Division of Parks & Outdoor Recreation
Department of Natural Resources
P.O. Box 107001
Anchorage, AK 99510

Subject: Request for Concurrence with Determination of No Adverse Effect with Regard to the Air Force Military Operations Area Airspace Proposal

Dear Ms. Bittner:

Spectrum Sciences and Software, Inc., has been contracted by the U.S. Air Force to prepare an Environmental Impact Statement (EIS) for an action proposed by Headquarters, Pacific Air Forces, to be conducted in Alaska under the auspices of 11th Air Force. Susan Means and I (of Spectrum) met with you and Mr. Tim Smith on September 8, 1993, to discuss the potential effects of this proposal with regard to cultural resources.

Enclosed is a detailed description of the Proposed Action and Alternatives (Proposal). The heart of the Proposal is the conversion in Alaska of temporary Miliary Operations Area (MOA) airspace to permanent MOA airspace. The Proposal does not include any construction or other ground-disturbing activities (i.e., there would be no change to the existing ground activities at any of the ranges or bases). Please note the addition of Alternative B which would affect an area in vicinity of Tok, Alaska. This alternative has been added since our September meeting.

Also enclosed please find a Preliminary Determination of No Adverse Effect, per Section 106 of the National Historic Preservation Act, to Alaska's cultural resources due to the activities described in the Proposal. This letter requests your concurrence with the Determination. Unless the scope of the Proposal changes during the course of the EIS process, and per Section 106 of the National Historic Preservation Act, your concurrence will be considered final and no further analysis of the potential effects to cultural resources by the Proposal will be undertaken. In the event of change of scope or a response of nonconcurrence, consultation will continue. Please advise me if the Air Force should notify the Advisory Council on Historic Preservation of this determination.

All correspondence associated with this consultation will be included in the Administrative Record of the EIS. The Draft EIS is scheduled for release on September 2, 1994. In order to include in the Draft EIS this determination and your concurrence therewith (or resolution of non-concurrence with this determination, if necessary), receipt of your response is requested no later than April 1, 1994. If you have any questions regarding the proposed

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(907) 276-4408
FAX (907) 276-4453

535-A East Braddock Rd.,
Alexandria, VA 22314
(703) 684-2905
FAX (703) 684-2908

action or alternatives, or regarding this request, please feel free to contact me at (907) 276-4408. Your response may be directed to me at Spectrum's Anchorage office address, given below.

Sincerely,

Karen McKibbin

Karen McKibbin
Spectrum Sciences and Software, Inc.

Enclosures
Draft Description of the Proposed Action and Alternatives
Preliminary Determination of No Adverse Effect

cc: Major G. Virgil Hanson, 11AF/LGV
Mr. William Ham, Spectrum
Captain Buddy Briesmaster, AFCEE/ESEM

2

Environmental Impact Statement
for
Improvements to Military Operations Areas
in Alaska

PRELIMINARY DETERMINATION OF NO ADVERSE EFFECT TO CULTURAL RESOURCES

Pursuant to Section 106 of the National Historic Preservation Act of 1966 (16 USC 470), and according to the regulations governing Section 106, 36 CFR Part 800 "Protection of Historic Properties," a preliminary determination is made of No Adverse Effect to cultural resources due to the implementation of the Pacific Air Forces' Proposal for Improvements to Military Operations Areas in Alaska (Proposal).

1. **Description of the undertaking.**

The undertaking consists of a proposal to restructure Military Operations Area (MOA) airspace in Alaska. *Please see attached Description of the Proposed Action and Alternatives (DOPAA) for a complete description of the Proposal.* The following items have been consolidated from the Proposal because of their relevancy to the subject Determination:

a) The Proposal is limited to structuring (location, dimensions, etc.) and Air Force use of MOA airspace. There would be no ground disturbance associated with the Proposal (i.e., no construction of new buildings or facilities, or alteration of existing buildings or facilities).
b) Supersonic activity would not occur below 5,000 feet AGL within any of the MOAs.
c) Intentional flare deployment would not occur below 2,000 feet AGL, an altitude designated to allow complete flare burnout prior to contact with the ground or vegetation.

2. **Description of historic properties that may be affected by the undertaking.**

Due to the extensive area affected by the Proposal, it would be infeasible to identify all historic properties in the Region of Influence. It is reasonable to conclude that the MOAs as described would overlay lands that contain a number of historic properties (cultural resources) already listed in or eligible for the Register of National Historic Places (Register). Such properties or resources may include surface and subsurface prehistoric sites; above-ground historic structures such as sod, log, and frame buildings and Cold War Era sites; and historic and prehistoric trails, including the Iditarod National Historic Trail. To date, there have been no traditional Native use sites identified.

3. Description of the efforts used to identify historic properties.

The range and extent of cultural resources that might be affected by the Proposal were determined through preliminary consultation with the State Historic Preservation Officer (SHPO) (September 8, 1993); agency, local government, and public scoping meetings for the Environmental Impact Statement; review of agencies' resource management and cultural resource management plans; and review of various literature that describes Alaska's cultural resources.

4. How and why the Criteria of Adverse Effect were found inapplicable.

a) There would be no direct physical destruction, damage, or alteration to any part of a property. The possibility for indirect damage is considered to be remote. It can be speculated that indirect damage such as window breakage or structural damage from sonic booms or noise vibration could occur. However, low-altitude [(below 5,000 feet above ground level (AGL)] supersonic flight would not occur under any Proposal alternatives, therefore minimizing the possibility for such damage. Air Force Regulation 60-16 also prohibits military aircraft from flying below 500 feet (AGL) over structures. It is highly improbable that a fire would be started by a flare and subsequently damage or destroy historic properties. Intentional deployment of flares would not occur below 2,000 thousand feet, an altitude designated to allow complete flare burnout prior to contact with the ground or vegetation.

b) There would be no isolation of a property from its setting or alteration of the character of the property's setting where that character contributes to the property's qualifications for the Register.

c) There would be introduction of audible and visual elements. However, these intrusions would be transitory in nature and would only momentarily alter the natural setting of a property or properties. Such temporary alteration of the noise environment would not harm the integrity of the resource setting.

d) Implementation of this Proposal or its alternatives would not result in the neglect of any properties, and therefore would not contribute to the deterioration or destruction of any properties;

e) There is no transfer, sale, or lease of any properties involved with this Proposal or any alternatives.

5. Views of the SHPO, other agencies, governments, and the public and a description of the means employed to solicit these views.

a) Views of the SHPO, other agencies, governments, and the public indicated a broad, general concern for cultural resources. However, no specific cultural resource or historic property was identified that was considered to be threatened by implementation of the

Proposed Action or Alternatives. It was the preliminary conclusion of scoping that the Proposal was unlikely to have significant adverse effects to cultural resources.

b) Pursuant to the National Environmental Policy Act (40 CFR 1501.7), views were solicited during the Environmental Impact Statement scoping process. Scoping meetings were held to inform agencies and the public of the Proposal and to solicit input and identify concerns. Federal and state agency scoping meetings were held with the Alaska Departments of Natural Resources, Fish and Game, and Community and Regional Affairs; and the United States Fish and Wildlife Service, National Park Service, Bureau of Land Management, and Bureau of Indian Affairs. Public scoping meetings were held in fourteen communities, and public input was solicited through a mail-out brochure and survey form. Meetings were also held with local governments, public interest organizations, and other groups, including the Alaska Congressional delegation, Tanana Chiefs Conference, and the Fairbanks North Star Borough. Additionally, the SHPO was consulted in a separate meeting to discuss the possible effects that might occur to cultural resources due to the Proposed Action or Alternatives.

Conclusion.

As outlined above, it is not anticipated that implementation of any alternative of the proposal to restructure military operations areas in Alaska would change in any way the characteristics that qualify properties in the Region of Influence for inclusion in the Register. The undertaking would not diminish the integrity of such characteristics. Therefore, this Preliminary Determination of No Adverse Effect is made.

This Preliminary Determination will be made final upon receipt of concurrence from the SHPO. If the SHPO does not concur with this finding, consultation with the SHPO will continue until resolution is achieved. If for any reason the nature of the Proposal changes during the regular course of the Environmental Impact Statement process, further consultation with the SHPO and with the public and other agencies would occur.

Appendix D

Marine Mammal Modeling

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D MARINE MAMMAL MODELING

D.1 BACKGROUND AND OVERVIEW

All marine mammals are protected under the Marine Mammal Protection Act (MMPA). The MMPA prohibits, with certain exceptions, the unauthorized take of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S.

The Endangered Species Act of 1973 (ESA) provides for the conservation of species that are endangered or threatened throughout all or a significant portion of their range, and the conservation of their ecosystems. A "species" is considered endangered if it is in danger of extinction throughout all or a significant portion of its range. A species is considered threatened if it is likely to become an endangered species within the foreseeable future. There are marine mammals, already protected under MMPA, listed as either endangered or threatened under ESA, and afforded special protections.

Actions involving sound in the water include the potential to harass marine animals in the surrounding waters. Demonstration of compliance with MMPA and the ESA, using best available science, has been assessed using criteria and thresholds accepted or negotiated, and described here.

Sections of the MMPA (16 United States Code [U.S.C.] 1361 et seq.) direct the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity, other than commercial fishing, within a specified geographical region.

Authorization for incidental takings may be granted if the National Marine Fisheries Service (NMFS) finds that the taking will have no more than a negligible impact on the species or stock(s), will not have an immitigable adverse impact on the availability of the species or stock(s) for subsistence uses, and that the permissible methods of taking, and requirements pertaining to the mitigation, monitoring and reporting of such taking are set forth.

NMFS has defined negligible impact in 50 Code of Federal Regulations (CFR) 216.103 as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.

Subsection 101(a)(5)(D) of the MMPA established an expedited process by which citizens of the United States can apply for an authorization to incidentally take small numbers of marine mammals by harassment. The National Defense Authorization Act of 2004 (NDAA) (Public Law 108-136) removed the small numbers limitation and amended the definition of "harassment" as it applies to a military readiness activity to read as follows:

> (i) *any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild [Level A Harassment]; or*
>
> (ii) *any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered [Level B Harassment].*

The primary potential impact to marine mammals from underwater acoustics is Level B harassment from exposure to various sources of sound in the water including sonar and explosives. The criteria for modeling impacts from these sources are detailed in the following sections.

D.1.1 Acoustic Sound Sources

The amount of Threshold Shift depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward 1997). For intermittent sounds, less Threshold Shift will occur than from a continuous exposure with the same energy (some recovery will occur between exposures) (Kryter et al., 1966; Ward 1997). The magnitude of Threshold Shift normally decreases with the amount of time post-exposure (Miller 1974).

Permanent Threshold Shift (PTS) is non-recoverable and results from the destruction of tissues within the auditory system. PTS therefore qualifies as an injury and is classified as Level A harassment under the MMPA. The smallest amount of PTS (onset- PTS) is taken to be the indicator for the smallest degree of injury that can be measured. The acoustic exposure associated with onset-PTS is used to define the outer limit of the Level A exposure zone.

If the TS eventually returns to zero (the threshold returns to the pre-exposure value), the TS is a Temporary Threshold Shift (TTS). TTS is, from recent rulings (NOAA 2001; 2002a), considered to result from the temporary, non-injurious distortion of hearing-related tissues. The smallest measurable amount of TTS (onset-TTS) is taken as the best indicator for slight temporary sensory impairment. Because it is considered non-injurious, the acoustic exposure associated with onset-TTS is used to define the outer limit of the portion of the Level B exposure zone attributable to physiological effects. This follows from the concept that hearing loss potentially affects an animal's ability to react normally to the sounds around it. Therefore, the potential for TTS is considered as Level B harassment caused by physiological effects on the auditory system.

The exposure threshold established for onset-TTS is 195 dB re $1\mu Pa^2$-s. This result is supported by the short-duration tone data of Finneran et al. (2002, 2005) and the long-duration sound data from Nachtigall et al., (2003). Together, these data demonstrate that TTS in small odontocetes is correlated with the received EL and that onset-TTS exposures are fit well by an equal-energy line passing through 195 dB re $1\mu Pa^2$-s. Absent any additional data for other species and being that it is likely that small odontocetes are more sensitive to the mid-frequency active/high-frequency active frequency levels of concern, this threshold is used for analysis for all cetacea.

The PTS thresholds established for use in this analysis are based on a 20 dB increase in exposure EL over that required for onset-TTS. The 20 dB value is based on estimates from terrestrial mammal data of PTS occurring at 40 dB or more of TS, and on TS growth occurring at a rate of 1.6 dB/dB increase in exposure EL. This is conservative because: (1) 40 dB of TS is actually an upper limit for TTS used to approximate onset-PTS, and (2) the 1.6 dB/dB growth rate is the highest observed in the data from Ward et al. (1958, 1959). Using this estimation method (20 dB increase from onset-TTS) for analysis, the PTS threshold for cetacea is 215 dB re $1\mu Pa^2$-s.

Unlike cetaceans, the TTS and PTS thresholds used for pinnipeds vary with species. Otariids have thresholds of 206 dB re $1\mu Pa^2$-s for TTS and 226 dB re $1\mu Pa^2$-s for PTS. Northern elephant seals are similar to otariids (TTS = 204 dB re $1\mu Pa^2$-s, PTS = 224 dB re $1\mu Pa^2$-s) but are lower for harbor seals (TTS = 183 dB re $1\mu Pa^2$-s, PTS = 203 dB re $1\mu Pa^2$-s). A certain proportion of marine mammals is expected to experience behavioral disturbance at different received sound pressure levels and are counted as Level B harassment takes. The details of this theory and calculation are described in the Risk Function section. Table D-1 summarizes the threshold levels for analysis of non-explosive sound sources used during Navy training activities in the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA).

Table D-1 - Non-Explosive Sound Source Threshold Levels

Physiological Effects			
Animal	**Criteria**	**Threshold (re 1μPa^2-s)**	**MMPA Effect**
Cetacean	TTS PTS	195 215	Level B Harassment Level A Harassment
Pinnipeds			
Northern Elephant Seal	TTS PTS	204 224	Level B Harassment Level A Harassment
Steller Sea Lion	TTS PTS	206 226	Level B Harassment Level A Harassment
Northern Fur Seal	TTS PTS	206 226	Level B Harassment Level A Harassment

D.1.2 Explosives

For underwater explosions resulting from use of live ordnance in the TMAA, in the absence of any mitigation or monitoring measures, there is a very small chance that a marine mammal could be injured or killed when exposed to the energy generated from an explosive force. Analysis of sound and pressure impacts from underwater explosions is based on criteria and thresholds initially presented in U.S. Navy Environmental Impact Statements for ship shock trials of the Seawolf submarine and the Winston Churchill (DDG 81), and subsequently adopted by NMFS.

Non-lethal injurious impacts (Level A Harassment) are defined in those documents as tympanic membrane (TM) rupture and the onset of slight lung injury. The threshold for Level A Harassment corresponds to a 50-percent rate of TM rupture, which can be stated in terms of an energy flux density (EFD) value of 205 dB re 1μPa^2-s. TM rupture is well-correlated with permanent hearing impairment. Ketten (1998) indicates a 30-percent incidence of permanent threshold shift (PTS) at the same threshold.

The criteria for onset of slight lung injury were established using partial impulse because the impulse of an underwater blast wave was the parameter that governed damage during a study using mammals, not peak pressure or energy (Yelverton, 1981). Goertner (1982) determined a way to calculate impulse values for injury at greater depths, known as the Goertner “modified” impulse pressure. Those values are valid only near the surface because as hydrostatic pressure increases with depth, organs like the lung, filled with air, compress. Therefore the “modified” impulse pressure thresholds vary from the shallow depth starting point as a function of depth.

The shallow depth starting points for calculation of the “modified” impulse pressures are mass-dependent values derived from empirical data for underwater blast injury (Yelverton, 1981). During the calculations, the lowest impulse and body mass for which slight, and then extensive, lung injury found during a previous study (Yelverton et al, 1973) were used to determine the positive impulse that may cause lung injury. The Goertner model is sensitive to mammal weight such that smaller masses have lower thresholds for positive impulse so injury and harassment will be predicted at greater distances from the source for them. Impulse thresholds of 13.0 and 31.0 psi-msec, found to cause slight and extensive injury in a dolphin calf, were used as thresholds in the analysis contained in this document.

Level B (behavior response) Harassment includes temporary (auditory) threshold shift (TTS), a slight, recoverable loss of hearing sensitivity. One criterion used for TTS, the total energy flux density of the sound, is a threshold of 182 dB re 1µPa^2-s maximum EFD level in any 1/3-octave band above 100 Hz for toothed whales (e.g., dolphins). A second criterion, a maximum allowable peak pressure of 23 psi, has recently been established by NMFS to provide a more conservative range for TTS when the explosive or animal approaches the sea surface, in which case explosive energy is reduced, but the peak pressure is not. NMFS applies the more conservative of these two.

For multiple successive explosions (MSE) occurring underwater, the acoustic criterion for non-TTS behavioral disturbance is used to account for behavioral effects significant enough to be judged as harassment, but occurring at lower sound energy levels than those that may cause TTS. The non-TTS threshold is derived following the approach of the Churchill Final Environmental Impact Statement (FEIS) for the energy-based TTS threshold. The research on pure-tone exposures reported in Schlundt et al. (2000) and Finneran and Schlundt (2004) provided a threshold of 192 dB re 1µPa^2-s as the lowest TTS value. This value for pure-tone exposures is modified for explosives by (a) interpreting it as an energy metric, (b) reducing it by 10 dB to account for the time constant of the mammal ear, and (c) measuring the energy in 1/3 octave bands, the natural filter band of the ear. The resulting TTS threshold for explosives is 182 dB re 1µPa^2-s in any 1/3 octave band. As reported by Schlundt et al. (2000) and Finneran and Schlundt (2004), instances of altered behavior in the pure-tone research generally began five dB lower than those causing TTS. The non-TTS threshold is therefore derived by subtracting 5 dB from the 182 dB re 1µPa^2-s in any 1/3 octave band threshold, resulting in a 177 dB re 1µPa^2-s (EL) sub-TTS behavioral disturbance threshold for MSE. Table D-2 summarizes the threshold levels for analysis of explosives used in the GOA.

Table D-2 - Explosives Threshold Levels

Threshold Type	Threshold Level
Level A – 50% Eardrum rupture	205 dB re 1µPa^2-s
Temporary Threshold Shift (TTS) (peak 1/3 octave energy)	182 dB re 1µPa^2-s
Sub-TTS Threshold for Multiple Successive Explosions (peak 1/3 octave energy)	177 dB re 1µPa^2-s
Temporary Threshold Shift (TTS) (peak pressure)	23 psi
Level A – Slight lung injury (positive impulse)	13 psi-ms
Fatality – 1% Mortal lung injury (positive impulse)	31 psi-ms

The sound sources will be located in an area that is inhabited by species listed as threatened or endangered under the ESA (16 USC §§ 1531-1543). Operation of the sound sources, that is, transmission of acoustic signals in the water column, could potentially cause harm or harassment to listed species.

"Harm" defined under ESA regulations is "…an act which actually kills or injures…" (50 CFR 222.102) listed species. "Harassment" is an "intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (50 CFR 17.3).

If a federal agency determines that its proposed action "may affect" a listed species, it is required to consult, either formally or informally, with the appropriate regulator. There is no permit issuance under ESA, rather consultation among the cognizant federal agencies under Section 7 of the ESA. Such consultations would likely be concluded favorably, subject to requirements that the activity will not appreciably reduce the likelihood of the species' survival and recovery and impacts are minimized and mitigated.

D.2 ACOUSTIC SOURCES

The acoustic sources employed in the TMAA are categorized as either broadband (producing sound over a wide frequency band) or narrowband (producing sound over a frequency band that that is small in comparison to the center frequency). In general, the majority of acoustic energy results from narrowband sonars utilized for Anti-Submarine Warfare (ASW) activities and underwater explosions as broadband sources. This delineation of source types has a couple of implications. First, the transmission loss used to determine the impact ranges of narrowband ASW sonars can be adequately characterized by model estimates at a single frequency. Broadband explosives, on the other hand, produce significant acoustic energy across several frequency decades of bandwidth. Propagation loss is sufficiently sensitive to frequency as to require model estimates at several frequencies over such a wide band.

Second, the types of sources have different sets of harassment metrics and thresholds. Energy metrics are defined for both types. However, explosives are impulsive sources that produce a shock wave that dictates additional pressure-related metrics (peak pressure and positive impulse). Detailed descriptions of both types of sources are provided in the following subsections.

D.2.1 Acoustic Sources

Operations in the TMAA involve four (4) types of narrowband sonars, as shown in Table D-3. Harassment estimates are calculated for each source according to the manner in which it operates. For example, the SQS-53 is a hull-mounted, surface ship sonar that operates for many hours at a time, so it is useful to calculate and report SQS-53 harassments per hour of operation. The AQS-22 is a helicopter-deployed sonar, which is lowered into the water, pings a number of times, and then moves to a new location. For the AQS-22, it is useful to calculate and report harassments per dip. The SSQ-62 sonobuoy is modeled at a single depth pinging for a fixed duration, so harassments are accordingly reported per sonobuoy deployed. The following table presents the deploying platform, frequency class, and the reporting metric for each acoustic source analyzed for use in the TMAA.

Table D-3. Acoustic Sources Analyzed for use in the TMAA

Sonar	Description	Frequency Class	Harassments Reported
SQS-53	Surface ship sonar	Mid-frequency	Per hour
SSQ-62	Sonobuoy sonar	Mid-frequency	Per sonobuoy
AQS-22	Helicopter-dipping sonar	Mid-frequency	Per dip
SQS-56	Surface ship sonar	Mid-frequency	Per hour
MK-84 Range Pingers	Surface pingers	High-frequency	Per day
PUTR Transponders	Bottom pingers	Mid-frequency	Per day
MK-39 EMATT	Training target	Low frequency	Per hour
BQQ-10	Submarine sonar	Classified	Per hour
BQS-15	Submarine sonar	Classified	Per hour
SUS, MK-84	Expendable buoy	Mid-frequency	Per hour

The acoustic modeling that is necessary to support the harassment estimates for each of these sonars relies upon a generalized description of the manner of the sonar's operating modes. This description includes the following:

- "Effective" energy source level—This is the level relative to 1μPa^2-s of the integral over frequency and time of the square of the pressure and is given by the total energy level across the band of the source, scaled by the pulse length (10 $\log_{10}$ [pulse length]).

- Source depth—Depth of the source in meters.
- Nominal frequency - Typically the center band of the source emission. These are frequencies that have been reported in open literature and are used to avoid classification issues. Differences between these nominal values and actual source frequencies are small enough to be of little consequence to the output impact volumes.
- Source directivity - The source beam is modeled as the product of a horizontal beam pattern and a vertical beam pattern. Two parameters define the horizontal beam pattern:
  - Horizontal beam width—Width of the source beam (degrees) in the horizontal plane (assumed constant for all horizontal steer directions).
  - Horizontal steer direction—Direction in the horizontal in which the beam is steered relative to the direction in which the platform is heading.

  The horizontal beam is assumed to have constant level across the width of the beam with flat, 20-dB down side lobes at all other angles.

  Similarly, two parameters define the vertical beam pattern:

  - Vertical beam width - Width of the source beam (degrees) in the vertical plane measured at the 3-dB down point (assumed constant for all vertical steer directions).
  - Vertical steer direction - Direction in the vertical plane that the beam is steered relative to the horizontal (upward looking angles are positive).

  To avoid sharp transitions that a rectangular beam might introduce, the power response at vertical angle θ is

  $$\text{Power} = \max \{ \sin^2 [n(\theta_s - \theta)] / [n \sin (\theta_s - \theta)]^2,\ 0.01 \},$$

  where θ_s is the vertical beam steer direction, and $n = 2*L/\lambda$ (L = array length, λ = wavelength).

  The beamwidth of a line source is determined by n (the length of the array in half-wavelengths) as $\theta_w = 180^o/n$.

- Ping spacing - Distance between pings. For most sources this is generally just the product of the speed of advance of the platform and the repetition rate of the sonar. Animal motion is generally of no consequence as long as the source motion is greater than the speed of the animal (nominally, 3 knots). For stationary (or nearly stationary) sources, the "average" speed of the animal is used in place of the platform speed. The attendant assumption is that the animals are all moving in the same constant direction.

These parameters are defined for each of the active sound sources in Table D-4 and D-5.

Table D-4 – Source Description of Active Sources used in the TMAA

Sonar	Source Depth	Center Freq	Source Level	Emission Spacing	Vertical Directivity	Horizontal Directivity
SQS-53C	7 m	3.5 kHz	235 dB	154 m	Omni	240^o Forward-looking
SSQ-62	27 m	8 kHz	201 dB	450 m	Omni	Omni
AQS-22	27 m	4.1 kHz	217 dB	15 m	Omni	Omni
SQS-56	7 m	7.5 kHz	225 dB	129 m	Omni	90^o Forward-looking
MK-84 Range Pingers	7m, 100m	12.9 kHz	194 dB		90 Down	Omni
PUTR Transponders	1,800 m	8.8 kHz	186 dB	Variable	180 Upward	Omni
MK-39 EMATT	100 m	900 Hz	130 dB	Continuous	Omni	Omni
BQQ-10	100 m	Classified	Classified	Classified	Classified	Classified
BQS-15	50 m	Classified	Classified	Classified	Classified	Classified
SUS, MK-84	50 m	3.4 kHz	160 dB	Continuous	Omni	Omni

The following are the usage units for sonar sources in the TMAA (all modeled during the summer season):

Table D-5 – Sonar Usage Units

Sonar	2CSG	1CSG
SQS-53C	578 Hours	289 hours
SSQ-62	267 buoys	133 buoys
AQS-22	192 dips	96 dips
SQS-56	52 hours	26 hours
BQQ-10	48 hours	24 hours
BQS-15	24 hours	12 hours

D.2.2 Explosives

Explosives detonated underwater introduce loud, impulsive, broadband sounds into the marine environment. Three source parameters influence the effect of an explosive: the weight of the explosive material, the type of explosive material, and the detonation depth. The net explosive weight (or NEW) accounts for the first two parameters. The NEW of an explosive is the weight of TNT required to produce an equivalent explosive power.

The detonation depth of an explosive is particularly important due to a propagation effect known as surface-image interference. For sources located near the sea surface, a distinct interference pattern arises from the coherent sum of the two paths that differ only by a single reflection from the pressure-release surface. As the source depth and/or the source frequency decreases, these two paths increasingly, destructively interfere with each other, reaching total cancellation at the surface (barring surface-reflection scattering loss).

For the TMAA, explosive sources having detonations in the water include the following: SSQ-110 EER sonobuoys and MK-82, MK-83, MK-84, BDU-45 bombs, 5” rounds and 76 mm gunnery rounds, MK-48 torpedo, and Maverick missile. The SSQ-110 source can be detonated at several depths within the water column. For this analysis, a relatively shallow depth of 65 ft (20 m) is used to optimize the likelihood of the source being positioned in a surface duct. A source depth of two meters is used for bombs and missiles that do not strike their target. The MK-48 torpedo detonates immediately below the target's hull and a nominal depth of 50 ft (14 m) is used as its source depth in this analysis. For the gunnery rounds, a source depth of one foot is used. The NEW modeled for these sources are as follows:

- SSQ-110 Sonobuoy - 5 pounds
- MK-82 bomb - 238 pounds
- MK-83 bomb - 238 pounds
- MK-83 bomb – 574 pounds
- MK-84 bomb – 945 pounds
- 5" rounds – 9.54 pounds
- 76 mm rounds – 1.6 pounds
- MK-48 torpedo – 851 pounds
- Air-to-Ground (AGM)-65 Maverick Missile – 78.5 pounds

The harassments expected to result from these sources are computed on a per in-water explosive basis. The cumulative effect of a series of explosives can often be derived by simple addition if the detonations are spaced widely in time or space, allowing for sufficient animal movements as to ensure a different population of animals is considered for each detonation.

The cases in which simple addition of the harassment estimates may not be appropriate are addressed by the modeling of a "representative" sinking exercise (SINKEX). In a SINKEX, a decommissioned vessel is towed to a specified deep-water location and there used as a target for a variety of weapons. Although no two SINKEXs are ever the same, a representative case derived from past exercises is described in the Programmatic SINKEX Overseas Environmental Assessment (March 2006) for the Western North Atlantic. Unguided weapons are more frequently off-target and are modeled according to the statistical hit/miss ratios. Note that these hit/miss ratios are artificially low in order to demonstrate a worst-case scenario; they should not be taken as indicative of weapon or platform reliability. With one exception, it is assumed that all missiles in a SINKEX will strike the target vessel. The Maverick missile and bombs used in SINKEX were modeled as missing the target vessel approximately 33 percent of the time. For all live rounds fired in a GUNEX and an estimated 32 percent of rounds fired in SINKEX may explode in the water.

In a SINKEX, weapons are typically fired in order of decreasing range from the source with weapons fired until the target is sunk. A torpedo is used after all munitions have been expended if the target is still afloat. Since the target may sink at any time during the exercise, the actual number of weapons used can vary widely. In the representative case, however, all of the ordnances are assumed expended; this represents the worst case with maximum exposure.

The sequence of weapons firing for the representative SINKEX is described in Table D-6. Guided weapons are nearly 100% accurate and are modeled as hitting the target (that is, no underwater acoustic effect) in all but two cases: (1) the Maverick is modeled as a miss to represent the occasional miss, and (2) the MK-48 torpedo intentionally detonates in the water column immediately below the hull of the target. Unguided weapons are more frequently off-target and are modeled according to the statistical hit/miss ratios. Note that these hit/miss ratios are artificially low in order to demonstrate a worst-case scenario; they should not be taken as indicative of weapon or platform reliability.

Table D-6 – Representative SINKEX Weapons Firing Sequence

Time (Local)	Event Description
0900	Range Control Officer receives reports that the exercise area is clear of non-participant ship traffic, marine mammals, and sea turtles.
0909	Hellfire missile fired, hits target.
0915	2 HARM missiles fired, both hit target (5 minutes apart).
0930	1 Penguin missile fired, hits target.
0940	3 Maverick missiles fired, 2 hit target, 1 misses (5 minutes apart).
1145	1 SM-1 fired, hits target.
1147	1 SM-2 fired, hits target.
1205	5 Harpoon missiles fired, all hit target (1 minute apart).
1300-1335	7 live and 3 inert MK 82 bombs dropped – 7 hit target, 2 live and 1 inert miss target (4 minutes apart).
1355-1410	4 MK 83 bombs dropped – 3 hit target, 1 misses target (5 minutes apart).
1500	Surface gunfire commences – 400 5-inch rounds fired (one every 6 seconds), 280 hit target, 120 miss target.
1700	MK 48 Torpedo fired, hits, and sinks target.

D.3 ENVIRONMENTAL PROVINCES

Propagation loss ultimately determines the extent of the Zone of Influence (ZOI) for a particular source activity. In turn, propagation loss as a function of range responds to a number of environmental parameters:

- Water depth
- Sound speed variability throughout the water column
- Bottom geo-acoustic properties, and
- Surface roughness, as determined by wind speed

Due to the importance that propagation loss plays in Anti-Submarine Warfare (ASW) exercises, the Navy has, over the last four to five decades, invested heavily in measuring and modeling these environmental parameters. The result of this effort is the following collection of global databases of these environmental parameters, which are accepted as standards for Navy modeling efforts.

- Water depth - Digital Bathymetry Data Base Variable Resolution (DBDBV)
- Sound speed - Generalized Digital Environmental Model (GDEM)
- Bottom loss - Low-Frequency Bottom Loss (LFBL), Sediment Thickness Database, and High-Frequency Bottom Loss (HFBL), and
- Wind speed - U.S. Navy Marine Climatic Atlas of the World

This section provides a discussion of the relative impact of these various environmental parameters. These examples then are used as guidance for determining environmental provinces (that is, regions in which the environmental parameters are relatively homogeneous and can be represented by a single set of environmental parameters) within the TMAA.

D.3.1 Impact of Environmental Parameters

Within a typical operating area, the environmental parameter that tends to vary the most is bathymetry. It is not unusual for water depths to vary by an order of magnitude or more, resulting in significant impacts upon the ZOI calculations. Bottom loss can also vary considerably over typical operating areas but its impact upon ZOI calculations tends to be limited to waters on the continental shelf and the upper portion of the slope. Generally, the primary propagation paths in deep water, from the source to most of the ZOI volume, do not involve any interaction with bottom. In shallow water, particularly if the sound velocity profile directs all propagation paths to interact with the bottom, bottom loss variability can play a larger role.

The spatial variability of the sound speed field is generally small over operating areas of typical size. The presence of a strong oceanographic front is a noteworthy exception to this rule. To a lesser extent, variability in the depth and strength of a surface duct can be of some importance. In the mid-latitudes, seasonal variation often provides the most significant variation in the sound speed field. For this reason, both summer and winter profiles are modeled for each selected environment.

D.3.2 Environmental Provincing Methodology

The underwater acoustic environment can be quite variable over ranges in excess of ten kilometers. For ASW applications, ranges of interest are often sufficiently large as to warrant the modeling of the spatial variability of the environment. In the propagation loss calculations, each of the environmental parameters is allowed to vary (either continuously or discretely) along the path from acoustic source to receiver. In such applications, each propagation loss calculation is conditioned upon the particular locations of the source and receiver.

On the other hand, the range of interest for marine animal harassment by most Naval activities is more limited. This reduces the importance of the exact location of source and marine animal and makes the modeling required more manageable in scope.

In lieu of trying to model every environmental profile that can be encountered in an operating area, this effort utilizes a limited set of representative environments. Each environment is characterized by a fixed water depth, sound velocity profile, and bottom loss type. The operating area is then partitioned into homogeneous regions (or provinces) and the most appropriately representative environment is assigned to each. This process is aided by some initial provincing of the individual environmental parameters. The Navy-standard high-frequency bottom loss database in its native form is globally partitioned into nine classes. Low-frequency bottom loss is likewise provinced in its native form, although it is not considered in the process of selecting environmental provinces. Only the broadband sources produce acoustic energy at the frequencies of interest for low-frequency bottom loss (typically less than 1 kHz); even for those sources the low-frequency acoustic energy is secondary to the energy above 1 kHz. The Navy-standard sound velocity profiles database is also available as a provinced subset. Only the Navy-standard bathymetry database varies continuously over the world's oceans. However, even this environmental parameter is easily provinced by selecting a finite set of water depth intervals. For this analysis "octave-spaced" intervals (10, 20, 50, 100, 200, 500, 1000, 2000, and 5000 m) provide an adequate sampling of water depth dependence.

ZOI volumes are then computed using propagation loss estimates derived for the representative environments. Finally, a weighted average of the ZOI volumes is taken over all representative environments; the weighting factor is proportional to the geographic area spanned by the environmental province.

The selection of representative environments is subjective. However, the uncertainty introduced by this subjectivity can be mitigated by selecting more environments and by selecting the environments that occur most frequently over the operating area of interest.

As discussed in the previous subsection, ZOI estimates are most sensitive to water depth. Unless otherwise warranted, at least one representative environment is selected in each bathymetry province. Within a bathymetry province, additional representative environments are selected as needed to meet the following requirements.

- In shallow water (less than 1,000 meters), bottom interactions occur at shorter ranges and more frequently; thus significant variations in bottom loss need to be represented.
- Surface ducts provide an efficient propagation channel that can greatly influence ZOI estimates. Variations in the mixed layer depth need to be accounted for if the water is deep enough to support the full extent of the surface duct.

Depending upon the size and complexity of the operating area, the number of environmental provinces tends to range from 5 to 20.

D.3.3 Description of Environmental Provinces

The TMAA is approximately 92,246 square kilometers of ocean located south of Prince William Sound and east of Kodiak Island. The TMAA encompasses Warning Area W-612 and extends from the continental shelf to the deep waters of the Gulf of Alaska. The acoustic sources described in subsection D2 are deployed throughout the TMAA. This subsection describes the representative environmental provinces selected for the GOA. For all of these provinces, the average wind speed in the winter is 19 knots and in the summer 12 knots.

The GOA contains a total of 20 distinct environmental provinces. These represent various combinations of six bathymetry provinces, two Sound Velocity Profile (SVP) provinces, and four High-Frequency Bottom Loss (HFBL) classes.

The bathymetry provinces represent depths ranging from 100 meters to typical deep-water depths (slightly more than 5,000 meters). Nearly two-thirds of the Exercise Area is characterized as deep-water (depths of 2,000 meters or more). The second most prevalent water depth, covering nearly one-quarter of the Exercise Area, is representative of waters near the continental shelf break. The remaining water depths provide only small contributions (individually less than 5%) to the analysis. The distribution of the bathymetry provinces over the GOA is provided in D-7.

Table D-7 – Distribution of Bathymetry Provinces in GOA

Province Depth (m)	Frequency of Occurrence
100	4.85 %
200	22.29 %
500	4.22 %
1000	4.53 %
2000	12.67 %
5000	51.44 %

The distribution of the two sound speed provinces found in the TMAA is presented in Table D-8.

Table D-8 – Distribution of Sound Speed Provinces in GOA

SVP Province	Frequency of Occurrence
21	30.46 %
22	69.54 %

The variation in sound speed profiles associated with these two provinces is significant. This is illustrated in Figure D-1 and D-2 that display the upper 1,000 meters of the winter and summer profiles, respectively. In the winter, province 21 is a classic half-channel profile. The strong near-surface (within the upper 200 meters) gradient is the likely product of thorough mixing by strong winter winds and some fresh water sources. The winter profile for province 22 features a strong surface duct to a depth of 100 meters, also the result of thorough mixing by the winter winds. In contrast to province 21, however, the surface layer is modestly warmer. Nonetheless, both profiles are conducive to favorable sound propagation from a near-surface source.

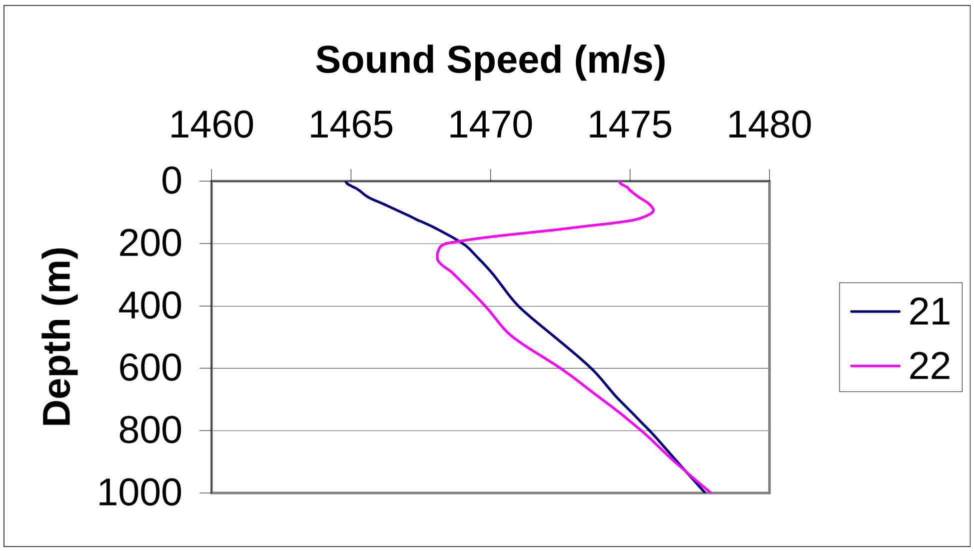

Figure D-1 – Winter SVPs in GOA

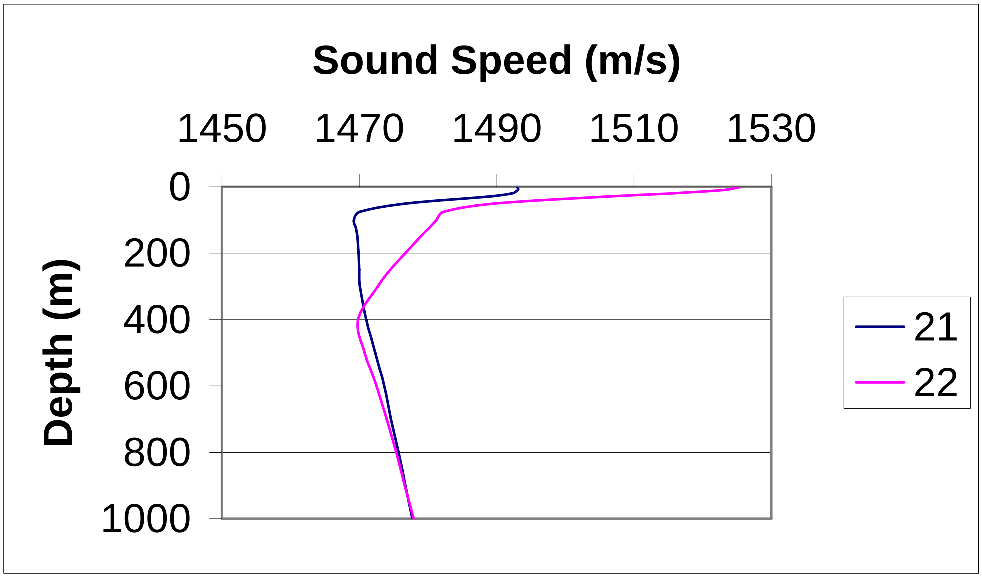

Figure D-2 – Summer SVPs in GOA

The summer profiles exhibit an even wider range of differences in the upper 200 meters (as much as 25 m/sec at the surface) with neither featuring a surface duct of significance. In the absence of surface loss considerations, both summer profiles would be less favorable than their winter counterparts for propagation from a near-surface source. However, the high wind speeds that are prevalent in the winter and the upward-refracting nature of the winter profiles appear to produce significantly higher surface scattering losses which can lead to summer being the season with the more favorable propagation.

The four HFBL classes represented in the GOA vary from low-loss bottoms (class 2, typically in shallow water) to high-loss bottoms (class 8). The four classes are fairly equally distributed as indicated in Table D-9 Distribution of High-Frequency Bottom Loss Classes in GOA. However, since two (classes 2 and 3) of the four classes are relatively low-loss, the bias in the environmental provinces will be towards low-loss bottoms.

Table D-9 – Distribution of High-Frequency Bottom Loss Classes in GOA

HFBL Class	Frequency of Occurrence
2	28.28 %
3	22.60 %
5	22.70 %
8	26.42 %

The logic for consolidating the environmental provinces focuses upon water depth, using the sound speed profile (in deep water) and the HFBL class (in shallow water) as secondary differentiating factors. The first consideration was to ensure that all six bathymetry provinces are represented. Then within each bathymetry province further partitioning of provinces proceeded as follows:

- The three shallowest bathymetry provinces are each represented by one environmental province. In each case, the bathymetry province is dominated (in some cases almost exclusively) by a single HFBL class, so that the secondary differentiating environmental parameter is of no consequence.
- The 1000-meter bathymetry province has two environmental provinces (differing in SVP province only) that occur in small, but relatively equal portions. Although they collectively

represent less than 5% of the TMAA, both are included in the analysis to ensure thoroughness. A third environmental province with a different HFBL class is not encountered enough to warrant consideration.

- The 2000-meter bathymetry province contains two environmental provinces that feature different SVP provinces. Both occur with sufficient frequency to warrant inclusion in the analysis.
- The 5000-meter bathymetry province consists of five environmental provinces. Four of these provinces are maintained for analysis; the fifth province is representative of less than one percent of the TMAA and for that reason, is excluded from consideration.

The distribution of the resulting eleven environmental provinces used in the acoustic modeling is summarized in Table D-10 and depicted in Figure D-3.

Table D-10 – Distribution of Environmental Provinces in TMAA

Environmental Province	Water Depth	SVP Province	Frequency of Occurrence
1	100 m	21	4.85 %
2	200 m	21	22.29 %
3	500 m	21	4.22 %
4	1000 m	21	2.32 %
5	1000 m	22	2.21 %
6	2000 m	21	10.61 %
7	2000 m	22	2.06 %
8	5000 m	21	22.60 %
9	5000 m	21	21.20 %
10	5000 m	22	1.51 %
11	5000 m	21	6.13 %

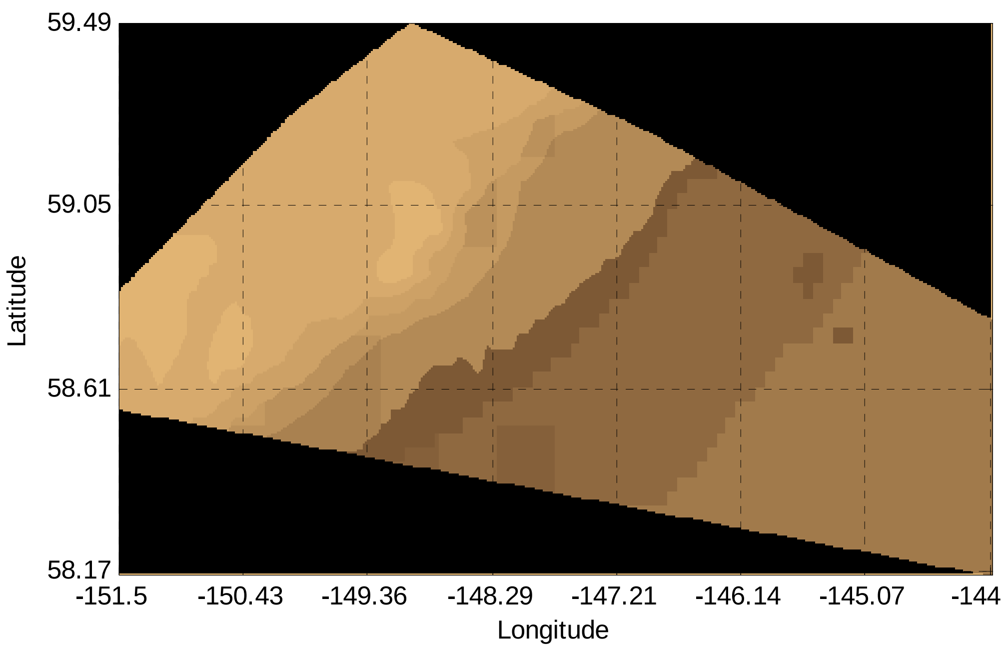

Figure D-3 – Distribution of Environmental Provinces in the TMAA

On this plot, darker-colored regions correspond to higher environmental province numbers, and hence depict deeper regions of the TMAA.

SINKEX operations are restricted to areas outside of 50 nautical miles (nm) from land and in waters deeper than 1,000 fathoms (or 1,852 meters). These limitations result not only in a smaller set of environments for analysis but also different frequencies of occurrence as indicated in Table D-11.

Table D-11 – Distribution of Environmental Provinces in the TMAA SINKEX Area

Environmental Province	Water Depth	SVP Province	Sediment Thickness	Frequency of Occurrence
1	2000 m	21	0.2 secs	7.15 %
2	5000 m	21	0.94 secs	35.55 %
3	5000 m	21	0.29 secs	9.04 %
4	5000 m	21	0.81 secs	45.93 %
5	5000 m	22	0.92 secs	1.75 %
6	5000 m	22	0.67 secs	0.58 %

D.4 IMPACT VOLUMES AND IMPACT RANGES

Many naval actions include the potential to injure or harass marine animals in the neighboring waters through noise emissions. The number of animals exposed to potential harassment in any such action is dictated by the propagation field and the characteristics of the noise source.

The impact volume associated with a particular activity is defined as the volume of water in which some acoustic metric exceeds a specified threshold. The product of this impact volume with a volumetric animal density yields the expected value of the number of animals exposed to that acoustic metric at a level that exceeds the threshold. The acoustic metric can either be an energy term (energy flux density, either in a limited frequency band or across the full band) or a pressure term (such as peak pressure or positive impulse). The thresholds associated with each of these metrics define the levels at which half of the animals exposed will experience some degree of harassment (ranging from behavioral change to mortality).

Impact volume is particularly relevant when trying to estimate the effect of repeated source emissions separated in either time or space. Impact range, which is defined as the maximum range at which a particular threshold is exceeded for a single source emission, defines the range to which marine mammal activity is monitored in order to meet mitigation requirements.

With the exception of explosive sources, the sole relevant measure of potential harm to the marine wildlife due to sonar operations is the accumulated (summed over all source emissions) energy flux density received by the animal over the duration of the activity. Harassment measures for explosive sources include energy flux density and pressure-related metrics (peak pressure and positive impulse).

Regardless of the type of source, estimating the number of animals that may be injured or otherwise harassed in a particular environment entails the following steps.

- Each source emission is modeled according to the particular operating mode of the sonar. The "effective" energy source level is computed by integrating over the bandwidth of the source, scaling by the pulse length, and adjusting for gains due to source directivity. The location of the source at the time of each emission must also be specified.

- For the relevant environmental acoustic parameters, transmission loss (TL) estimates are computed, sampling the water column over the appropriate depth and range intervals. TL data are sampled at the typical depth(s) of the source and at the nominal center frequency of the source. If the source is relatively broadband, an average over several frequency samples is required.
- The accumulated energy within the waters that the source is "operating" is sampled over a volumetric grid. At each grid point, the received energy from each source emission is modeled as the effective energy source level reduced by the appropriate propagation loss from the location of the source at the time of the emission to that grid point and summed. For the peak pressure or positive impulse, the appropriate metric is similarly modeled for each emission. The maximum value of that metric, over all emissions, is stored at each grid point.
- The impact volume for a given threshold is estimated by summing the incremental volumes represented by each grid point for which the appropriate metric exceeds that threshold.
- Finally, the number of harassments is estimated as the "product" (scalar or vector, depending upon whether an animal density depth profile is available) of the impact volume and the animal densities.

This section describes in detail the process of computing impact volumes (that is, the first four steps described above). This discussion is presented in two parts: active sonars and explosive sources. The relevant assumptions associated with this approach and the limitations that are implied are also presented. The final step, computing the number of harassments is discussed in subsection D.6.

D.4.1 Computing Impact Volumes for Active Sound Sources

This section provides a detailed description of the approach taken to compute impact volumes for active sonars. Included in this discussion are:

- Identification of the underwater propagation model used to compute transmission loss data, a listing of the source-related inputs to that model, and a description of the output parameters that are passed to the energy accumulation algorithm.
- Definitions of the parameters describing each sonar type.
- Description of the algorithms and sampling rates associated with the energy accumulation algorithm.

D.4.1.1 Transmission Loss Calculations

Transmission loss (TL) data are pre-computed for each of two seasons in each of the environmental provinces described in the previous subsection using the Gaussian Ray Bundle (GRAB) propagation loss model (Keenan, 2000). The TL output consists of a parametric description of each significant eigenray (or propagation path) from source to animal. The description of each eigenray includes the departure angle from the source (used to model the source vertical directivity later in this process), the propagation time from the source to the animal (used to make corrections to absorption loss for minor differences in frequency and to incorporate a surface-image interference correction at low frequencies), and the transmission loss suffered along the eigenray path.

The frequency and source depth TL inputs are specified in Table D-12.

Table D-12 – TL Frequency and Source Depth by Type

SONAR	FREQUENCY	SOURCE DEPTH
SQS-53	3.5 kHz	7 m
AQS-22	4.1 kHz	27 m
ASQ-62	8 kHz	27 m
SQS-56	7.5 kHz	7 m
MK-84 Range Pingers	12.9 kHz	7m, 100m
PUTR Transponders	8.8 kHz	1,800 m
MK-39 EMATT	900 Hz	100 m
BQQ-10	Classified	100 m
BQS-15	Classified	50 m
SUS, MK-84	3.4 kHz	50 m

The eigenray data for a single GRAB model run are sampled at uniform increments in range out to a maximum range for a specific "animal" (or "target" in GRAB terminology) depth. Multiple GRAB runs are made to sample the animal depth dependence. The depth and range sampling parameters are summarized in Table D-13. Note that some of the low-power sources do not require TL data to large maximum ranges.

Table D-13 – TL Depth and Range Sampling Parameters by Sonar Type

SONAR	RANGE STEP	MAXIMUM RANGE	DEPTH SAMPLING
SQS-53	10 m	200 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
AQS-22	10 m	10 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
ASQ-62	5 m	5 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
SQS-56	10 m	50 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
MK-84 Range Pingers	5 m	15 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
PUTR Transponders	5 m	15 km	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
MK-39 EMATT	5 m	1 km	1 m steps
BQQ-10	Classified	Classified	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
BQS-15	Classified	Classified	0 – 1 km in 5 m steps 1 km – Bottom in 10 m steps
SUS, MK-84	5 m	1 km	1 m steps

In a few cases, most notably the SQS-53 for levels below approximately 180 dB, TL data may be required by the energy summation algorithm at ranges greater than covered by the pre-computed GRAB data. In these cases, TL is extrapolated to the required range using a simple cylindrical spreading loss law in addition to the appropriate absorption loss. This extrapolation leads to a conservative (or under) estimate of transmission loss at the greater ranges.

Although GRAB provides the option of including the effect of source directivity in its eigenray output, this capability is not exercised. By preserving data at the eigenray level, this allows source directivity to be applied later in the process and results in fewer TL calculations.

The other important feature that storing eigenray data supports is the ability to model the effects of surface-image interference that persist over range. However, this is primarily important at frequencies lower than those associated with the sonars considered in this subsection. A detailed description of the modeling of surface-image interference is presented in the subsection on explosive sources.

D.4.1.2 Energy Summation

The summation of energy flux density over multiple pings in a range-independent environment is a trivial exercise for the most part. A volumetric grid that covers the waters in and around the area of sonar operation is initialized. The source then begins its set of pings. For the first ping, the TL from the source to each grid point is determined (summing the appropriate eigenrays after they have been modified by the vertical beam pattern), the "effective" energy source level is reduced by that TL, and the result is added to the accumulated energy flux density at that grid point. After each grid point has been updated, the accumulated energy at grid points in each depth layer is compared to the specified threshold. If the accumulated energy exceeds that threshold, then the incremental volume represented by that grid point is added to the impact volume for that depth layer. Once all grid points have been processed, the resulting sum of the incremental volumes represents the impact volume for one ping.

The source is then moved along one of the axes in the horizontal plane by the specified ping separation range and the second ping is processed in a similar fashion. Again, once all grid points have been processed, the resulting sum of the incremental volumes represents the impact volume for two pings. This procedure continues until the maximum number of pings specified has been reached.

Defining the volumetric grid over which energy is accumulated is the trickiest aspect of this procedure. The volume must be large enough to contain all volumetric cells for which the accumulated energy is likely to exceed the threshold but not so large as to make the energy accumulation computationally unmanageable.

Determining the size of the volumetric grid begins with an iterative process to determine the lateral extent to be considered. Unless otherwise noted, throughout this process the source is treated as omni-directional and the only animal depth that is considered is the TL target depth that is closest to the source depth (placing source and receiver at the same depth is generally an optimal TL geometry).

The first step is to determine the impact range (R_{max}) for a single ping. The impact range in this case is the maximum range at which the effective energy source level reduced by the transmission loss is greater than the threshold. Next, the source is moved along a straight-line track and energy flux density is accumulated at a point that has a CPA range of R_{max} at the mid-point of the source track. That total energy flux density summed over all pings is then compared to the prescribed threshold. If it is greater than the threshold (which, for the first R_{max}, it must be) then R_{max} is increased by ten percent, the accumulation process is repeated, and the total energy is again compared to the threshold. This continues until R_{max} grows large enough to ensure that the accumulated energy flux density at that lateral range is less than the threshold. The lateral range dimension of the volumetric grid is then set at twice R_{max}, with the grid centered along the source track. In the direction of advance for the source, the volumetric grid extends on the interval from [$-R_{max}$, 3 R_{max}] with the first source position located at zero in this dimension. Note that the source motion in this direction is limited to the interval [0, 2 R_{max}]. Once the source reaches 2 R_{max} in this direction, the incremental volume contributions have approximately reached their asymptotic limit and further pings add essentially the same amount. This geometry is demonstrated in Figure D-4 below.

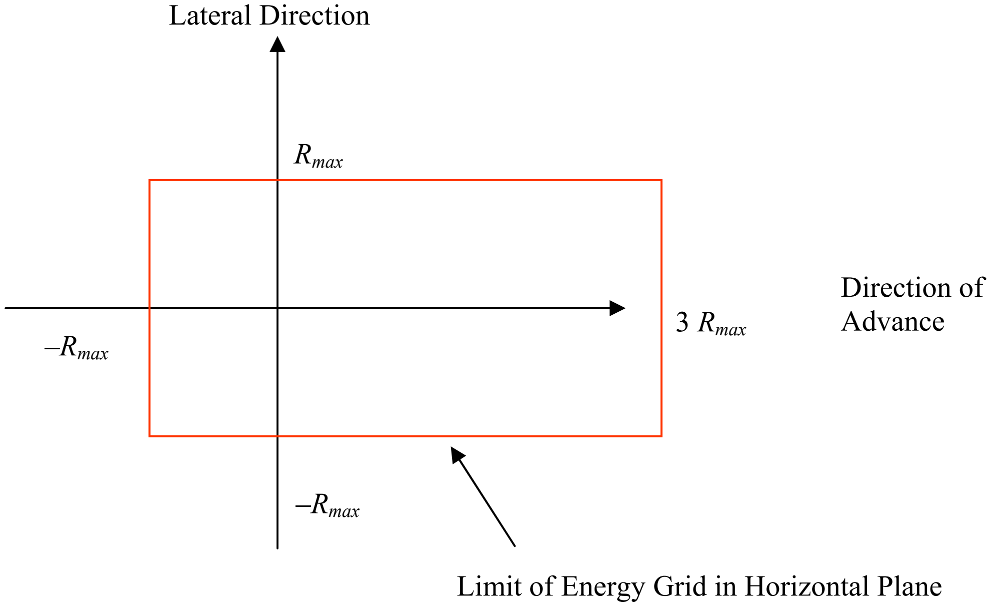

Figure D-4. Horizontal Plane of Volumetric Grid for Omni Directional Source

If the source is directive in the horizontal plane, then the lateral dimension of the grid may be reduced and the position of the source track adjusted accordingly. For example, if the main lobe of the horizontal source beam is limited to the starboard side of the source platform, then the port side of the track is reduced substantially as demonstrated in Figure D-5.

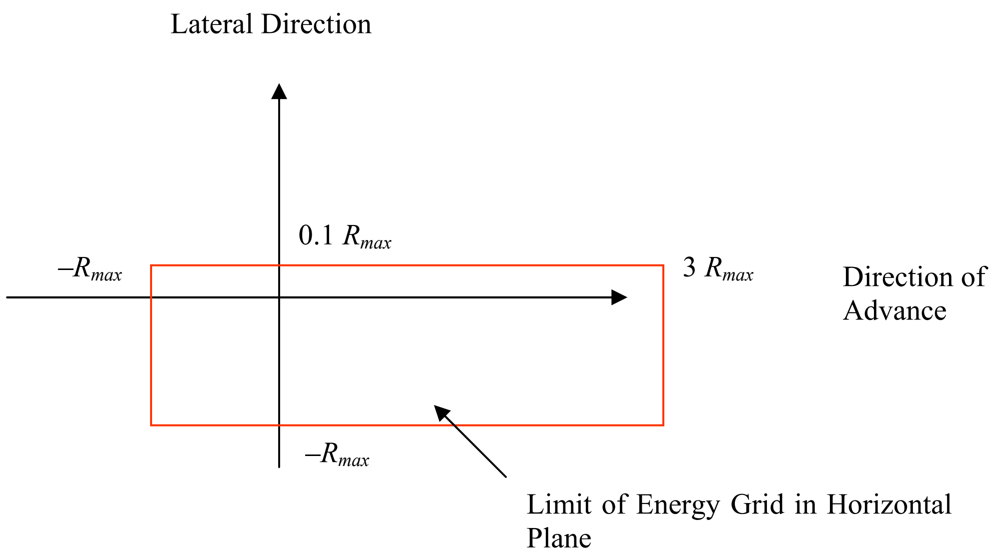

Figure D-5. Horizontal Plane of Volumetric Grid for Starboard Beam Source

Once the extent of the grid is established, the grid sampling can be defined. In both dimensions of the horizontal plane the sampling rate is approximately $R_{max}/100$. The round-off error associated with this sampling rate is roughly equivalent to the error in a numerical integration to determine the area of a circle with a radius of R_{max} with a partitioning rate of $R_{max}/100$ (approximately one percent). The depth-sampling rate of the grid is comparable to the sampling rates in the horizontal plane but discretized to match an actual TL sampling depth. The depth-sampling rate is also limited to no more than ten meters to ensure that significant TL variability over depth is captured.

D.4.1.3 Impact Volume per Hour of Source Operation

The impact volume for a source moving relative to the animal population increases with each additional ping. The rate at which the impact volume increases varies with a number of parameters but eventually approaches some asymptotic limit. Beyond that point the increase in impact volume becomes essentially linear as depicted in Figure D-6 using the SQS-53 as an example.

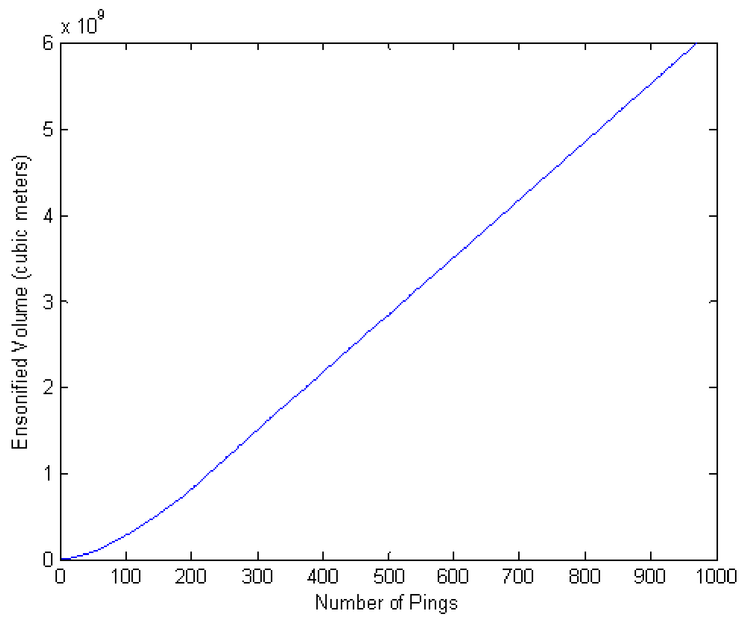

Figure D-6. SQS-53 Impact Volume by Ping

The slope of the asymptotic limit of the impact volume at a given depth is the impact volume added per ping. This number multiplied by the number of pings in an hour gives the hourly impact volume for the given depth increment. Completing this calculation for all depths in a province, for a given source, gives the hourly impact volume vector, v_n, which contains the hourly impact volumes by depth for province n. Figure D-7 provides an example of an hourly impact volume vector for a particular environment.

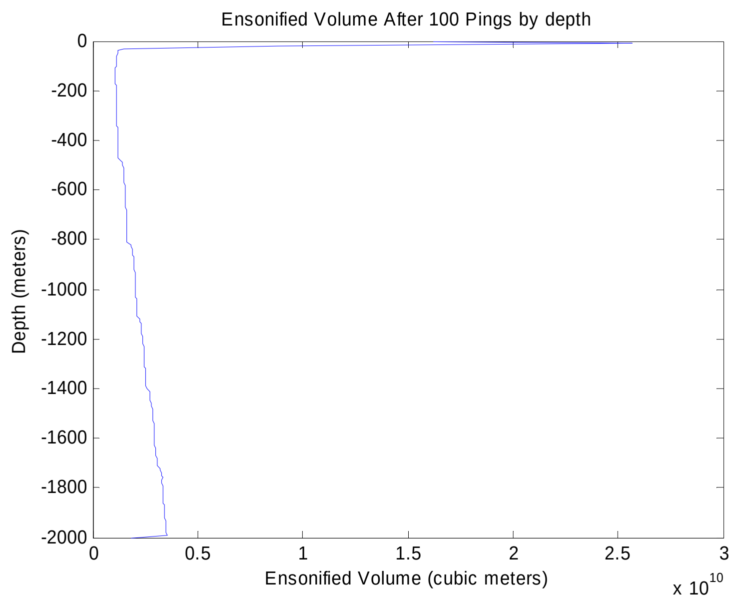

Figure D-7. Example of an Impact Volume Vector

D.4.2 Computing Impact Volumes for Explosive Sources

This section provides the details of the modeling of the explosive sources. This energy summation algorithm is similar to that used for sonars, only differing in details such as the sampling rates and source parameters. These differences are summarized in the following subsections. A more significant difference is that the explosive sources require the modeling of additional pressure metrics: (1) peak pressure, and (2) "modified" positive impulse. The modeling of each of these metrics is described in detail in the subsections of D.4.2.3.

D.4.2.1 Transmission Loss Calculations

Modeling impact volumes for explosive sources span requires the same type of TL data as needed for active sonars. However unlike active sonars, explosive ordnances and the EER source are broadband, contributing significant energy from tens of Hertz to tens of kilohertz. To accommodate the broadband nature of these sources, TL data are sampled at seven frequencies from 10 Hz to 40 kHz, spaced every two octaves.

An important propagation consideration at low frequencies is the effect of surface-image interference. As either source or target approach the surface, pairs of paths that differ by a single surface reflection set up an interference pattern that ultimately causes the two paths to cancel each other when the source or target is at the surface. A fully coherent summation of the eigenrays produces such a result but also introduces extreme fluctuations that would have to be highly sampled in range and depth, and then smoothed to give meaningful results. An alternative approach is to implement what is sometimes called a semi-coherent summation. A semi-coherent sum attempts to capture significant effects of surface-image interference (namely the reduction of the field due to destructive interference of reflected paths as the source or target approach the surface) without having to deal with the more rapid fluctuations associated with a fully coherent sum. The semi-coherent sum is formed by a random phase addition of paths that have already been multiplied by the expression:

$$\sin^2\left(\frac{4\pi f z_s z_a}{c^2 t}\right)$$

where f is the frequency, z_s is the source depth, z_a is the animal depth, c is the sound speed and t is the travel time from source to animal along the propagation path. For small arguments of the sine function this expression varies directly as the frequency and the two depths. It is this relationship that causes the propagation field to go to zero as the depths approach the surface or the frequency approaches zero.

This surface-image interference must be applied across the entire bandwidth of the explosive source. The TL field is sampled at several representative frequencies. However, the image-interference correction given above varies substantially over that frequency spacing. To avoid possible under sampling, the image-interference correction is averaged over each frequency interval.

D.4.2.2 Source Parameters

Unlike active sonars, explosive sources are defined by only two parameters: (1) net explosive weight, and (2) source detonation depth. Values for these source parameters are defined earlier in subsection D.2.2.

The effective energy source level, which is treated as a de facto input for the other sources, is instead modeled directly for SSQ-110 explosive sonobuoys and munitions. For both, the energy source level is comparable to the model used for other explosives (Arons (1954), Weston (1960), McGrath (1971), Urick (1983), Christian and Gaspin (1974)). The energy source level over a one-third octave band with a center frequency of f for a source with a net explosive weight of w pounds is given by:

$$\mathrm{ESL} = 10 \log_{10} (0.26\, f) + 10 \log_{10} (2\, p_{max}^2 / [1/\theta^2 + 4 \pi f^2]) + 197 \text{ dB}$$

where the peak pressure for the shock wave at 1 meter is defined as

$$p_{max} = 21600\, (w^{1/3} / 3.28)^{1.13} \text{ psi} \qquad \text{(A-1)}$$

and the time constant is defined as:

$$\theta = [(0.058)\, (w^{1/3})\, (3.28 / w^{1/3})^{0.22}] / 1000 \text{ msec} \qquad \text{(A-2)}$$

In contrast to munitions that are modeled as omni-directional sources, the SSQ-110 is a directed source consisting of two explosive strips that are fired simultaneously from the center of the array. Each strip generates a beam pattern with the steer direction of the main lobe determined by the burn rate. The resulting response of the entire array is a bifurcated beam for frequencies above 200 Hz, while at lower frequencies the two beams tend to merge into one.

Since very short ranges are under consideration, the loss of directivity of the array needs to be accounted for in the near field of the array. This is accomplished by modeling the sound pressure level across the field as the coherent sum of contributions of infinitesimal sources along the array that are delayed according to the burn rate. For example, for frequency f the complex pressure contribution at a depth z and horizontal range r from an infinitesimal source located at a distance z' above the center of the array is

$$p(r,z) = e^{i\phi}$$

where

$\phi = kr' + \alpha z'$, and

$\alpha = 2\pi f / c_b$

with k the acoustic wave number, c_b the burn rate of the explosive ribbon, and r' the slant range from the infinitesimal source to the field point (x,z).

Beam patterns as function of vertical angle are then sampled at various ranges out to a maximum range that is approximately L^2 / λ where L is the array length and λ is the wavelength. This maximum range is a rule-of-thumb estimate for the end of the near field (Bartberger, 1965). Finally, commensurate with the resolution of the TL samples, these beam patterns are averaged over octave bands.

A couple of sample beam patterns are provided in Figure D-8 and Figure D-9. In both cases, the beam response is sampled at various ranges from the source array to demonstrate the variability across the near field. The 80-Hz family of beam patterns presented in Figure D-8 shows the rise of a single main lobe as range increases.

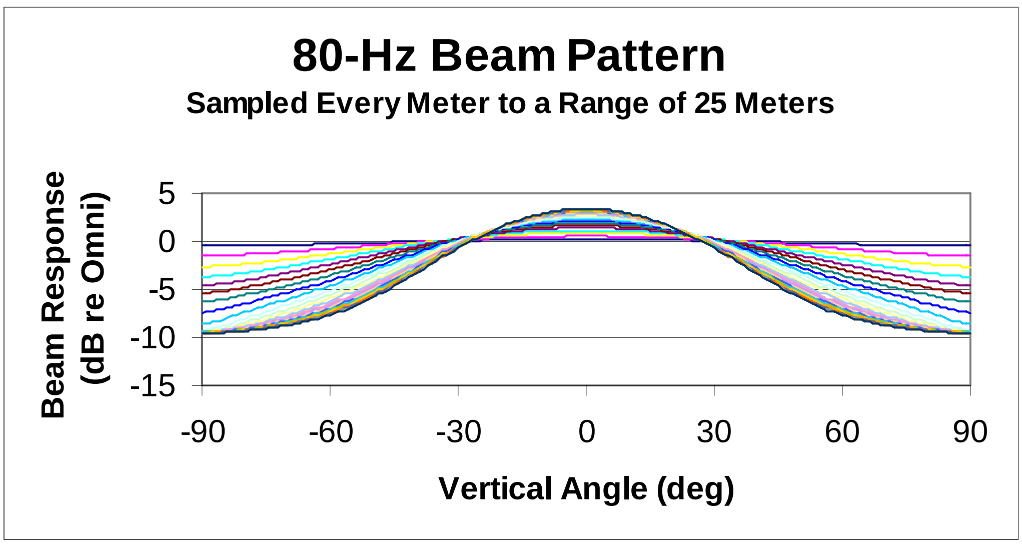

Figure D-8. 80-Hz Beam Patterns across Near Field of EER Source

On the other hand, the 1,250-Hz family of beam patterns depicted in Figure D-9 demonstrates the typical high-frequency bifurcated beam.

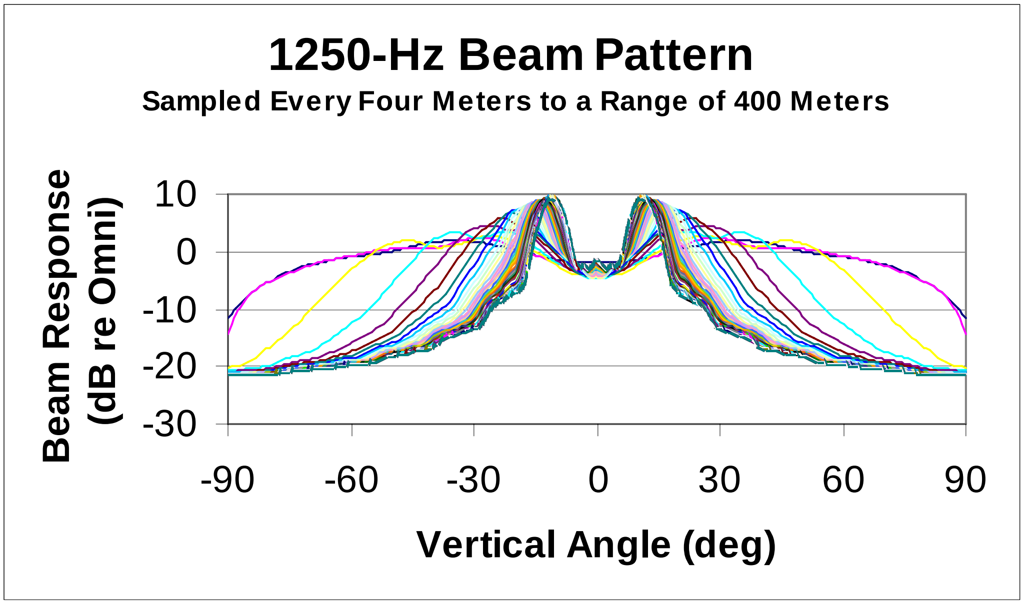

Figure D-9. 1250-Hz Beam Patterns across Near Field of SSQ-110 Source

D.4.2.3 Impact Volumes for Various Metrics

The impact of explosive sources on marine wildlife is measured by three different metrics, each with its own thresholds. The energy metric, peak one-third octave, is treated in similar fashion as the energy metric used for the active sonars, including the summation of energy if there are multiple source emissions. The other two, peak pressure and positive impulse, are not accumulated but rather the maximum levels are taken.

Peak One-Third Octave Energy Metric

The computation of impact volumes for the energy metric closely follows the approach taken to model the energy metric for the active sonars. The only significant difference is that energy flux density is sampled at several frequencies in one-third-octave bands and only the peak one-third-octave level is accumulated over time.

Peak Pressure Metric

The peak pressure metric is a simple, straightforward calculation at each range/animal depth combination. First, the transmission ratio, modified by the source level in a one-octave band and the vertical beam pattern, is averaged across frequency on an eigenray-by-eigenray basis. This averaged transmission ratio (normalized by the total broadband source level) is then compared across all eigenrays with the maximum designated as the peak arrival. Peak pressure at that range/animal depth combination is then simply the product of:

- The square root of the averaged transmission ratio of the peak arrival,
- The peak pressure at a range of 1 meter (given by equation A-1), and
- The similitude correction (given by $r^{-0.13}$, where r is the slant range along the eigenray estimated as tc with t the travel time along the dominant eigenray and c the nominal speed of sound).

If the peak pressure for a given grid point is greater than the specified threshold, then the incremental volume for the grid point is added to the impact volume for that depth layer.

"Modified" Positive Impulse Metric

The modeling of positive impulse follows the work of Goertner (Goertner, 1982). The Goertner model defines a "partial" impulse as

$$\int_0^{T_{min}} p(t)\, dt$$

where $p(t)$ is the pressure wave from the explosive as a function of time t, defined so that $p(t) = 0$ for $t < 0$. This pressure wave is modeled as

$$p(t) = p_{max}\, e^{-t/\theta}$$

where p_{max} is the peak pressure at 1 meter (see, equation B-1), and θ is the time constant defined as

$$\theta = 0.058\, w^{1/3}\, (r/w^{1/3})^{0.22} \text{ seconds}$$

with w the net explosive weight (pounds), and r the slant range between source and animal.

The upper limit of the "partial" impulse integral is

$$T_{min} = \min\, \{T_{cut}, T_{osc}\}$$

where T_{cut} is the time to cutoff and T_{osc} is a function of the animal lung oscillation period. When the upper limit is T_{cut}, the integral is the definition of positive impulse. When the upper limit is defined by T_{osc}, the integral is smaller than the positive impulse and thus is just a "partial" impulse. Switching the integral limit from T_{cut} to T_{osc} accounts for the diminished impact of the positive impulse upon the animals lungs that compress with increasing depth and leads to what is sometimes call a "modified" positive impulse metric.

The time to cutoff is modeled as the difference in travel time between the direct path and the surface-*reflected* path in an isospeed environment. At a range of r, the time to cutoff for a source depth z_s and an animal depth z_a is

$$T_{cut} = 1/c\ \{\, [r^2 + (z_a + z_s)^2]^{1/2} - [r^2 + (z_a - z_s)^2]^{1/2}\, \}$$

where c is the speed of sound.

The *animal* lung oscillation period is a function of animal mass M and depth z_a and is modeled as

$$T_{osc} = 1.17\, M^{1/3}\, (1 + z_a/33)^{-5/6}$$

where M is the animal mass (in kg) and z_a is the animal depth (in feet).

The modified positive impulse threshold is unique among the various injury and harassment metrics in that it is a function of depth and the animal weight. So instead of the user specifying the threshold, it is computed as $K\ (M/42)^{1/3}\ (1 + z_a/33)^{1/2}$. The coefficient K depends upon the level of exposure. For the onset of slight lung injury, K is 19.7; for the onset of extensive lung hemorrhaging (1% mortality), K is 47.

Although the thresholds are a function of depth and animal weight, sometimes they are summarized as their value at the sea surface for a typical dolphin calf (with an average mass of 12.2 kg). For the onset of slight lung injury, the threshold at the surface is approximately 13 psi-msec; for the onset of extensive lung hemorrhaging (1% mortality), the threshold at the surface is approximately 31 psi-msec.

As with peak pressure, the "modified" positive impulse at each grid point is compared to the derived threshold. If the impulse is greater than that threshold, then the incremental volume for the grid point is added to the impact volume for that depth layer.

D.4.2.4 Impact Volume per Explosive Detonation

The detonations of explosive sources are generally widely spaced in time and/or space. This implies that the impact volume for multiple firings can be easily derived by scaling the impact volume for a single detonation. Thus the typical impact volume vector for an explosive source is presented on a per-detonation basis.

D.4.3 Impact Volume by Region

The TMAA is described by eleven (11) environmental provinces. The hourly impact volume vector for operations involving any particular source is a linear combination of the eleven impact volume vectors with the weighting determined by the distribution of those eleven environmental provinces within the range. Unique hourly impact volume vectors for winter and summer are calculated for each type of source and each metric/threshold combination.

D.5 Risk Function: Theoretical and Practical Implementation

This section discusses the recent addition of a risk function response "threshold" to acoustic effects analysis procedure. This approach includes two parts, a metric, and a function to map exposure level under the metric to probability of harassment for acoustic sources. What these two parts mean, how they affect exposure calculations, and how they are implemented are the objects of discussion.

D.5.1 Thresholds and Metrics

The term "thresholds" is broadly used to refer to both thresholds and metrics. The difference, and the distinct roles of each in effects analyses, will be the foundation for understanding the dose-response approach, putting it in perspective, and showing that, conceptually, it is similar to past approaches.

Sound is a pressure wave, so at a certain point in space, sound is simply rapidly changing pressure. Pressure at a point is a function of time. Define $p(t)$ as pressure (in micropascals) at a given point at time t (in seconds); this function is called a "time series." Figure D-10 gives the time series of the first "hallelujah" in Handel's Hallelujah Chorus.

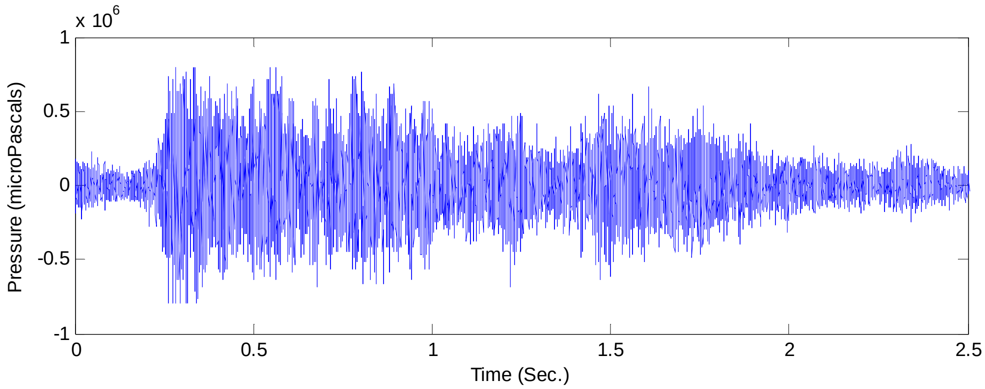

Figure D-10. Time Series

The time-series of a source can be different at different places. Therefore, sound, or pressure, is not only a function of time, but also of location. Let the function $p(t)$, then be expanded to $p(t;x,y,z)$ and denote the time series at point (x,y,z) in space. Thus, the series in Figure D-10 $p(t)$ is for a given point (x,y,z). At a different point in space, it would be different.

Assume that the location of the source is (0,0,0) and this series is recorded at (0,10,-4). The time series above would be p(t;0,10,-4) for $0<t<2.5$.

As in Figure D-10, pressure can be positive or negative, but acoustic power, which is proportional to the square of the pressure, is always positive, this makes integration meaningful. Figure D-11 is $p^2(t;0,10,-4)$.

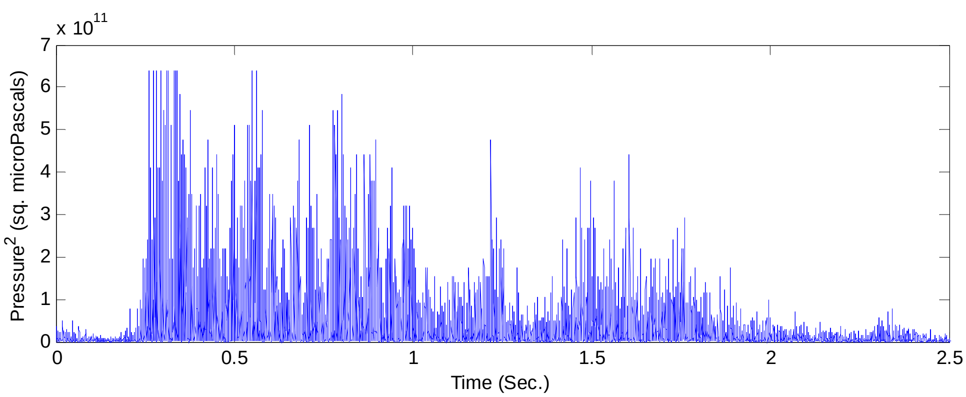

Figure D-11. Time Series Squared

The metric chosen to evaluate the sound field at the end of this first "hallelujah" determines how the time series is summarized from thousands of points, as in Figure D-10, to a single value for each point (x,y,z) in the space. The metric essentially "boils down" the four dimensional $p(t,x,y,z)$ into a three dimensional function $m(x,y,z)$ by dealing with time. There is more than one way to summarize the time component, so there is more than one metric.

D.5.2 Maximum Sound Pressure Level

Because of the large dynamic range of the acoustic power, it is generally represented on a logarithmic scale using sound pressure levels (SPLs). SPL is actually the ratio of acoustic power and density (power/unit area = $\frac{p^2}{Z}$ where Z = ρc is the acoustic impedance). This ratio is presented on a logarithmic scale relative to a reference pressure level, and is defined as:

$$SPL = 10\log_{10}\left(\frac{p^2}{p_{ref}^2}\right) = 20\log_{10}\left(abs\left(\frac{p}{p_{ref}}\right)\right)$$

(Note that SPL is defined in dB re a reference pressure, even though it comes from a ratio of powers.)

One way to characterize the power of the time series $p(t;x,y,z)$ with a single number over the 2.5 seconds is to only report the maximum SPL value of the function over time or,

$SPL_{\max} = \max\{10\log_{10}(p^2(t,x,y,z))\}$ (relative to a reference pressure of 1 μPa^2-s) for 0<t<2.5

The $SPL_{\max}$ for this snippet of the Hallelujah Chorus is $10\log_{10}(6.4\times10^{11}\,\mu Pa^2/1\mu Pa^2) = 118\,dB$ re 1 μPa^2-s and occurs at 0.2606 seconds, as shown in Figure D-12.

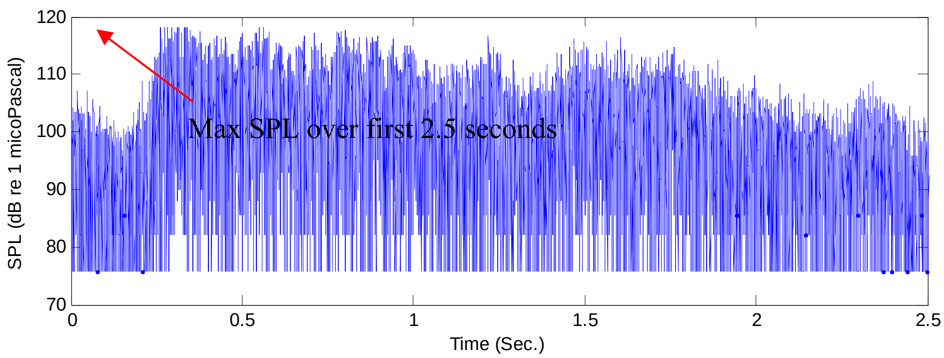

Figure D-12. Max SPL of Time Series Squared

D.5.3 Integration

$SPL_{\max}$ is not necessarily influenced by the duration of the sound (2.5 seconds in this case). Integrating the function over time gives the EFD, which accounts for this duration. A simple integration of $p^2(t;x,y,z)$ over t is common and is proportional to the EFD at (*x,y,z*). Because we will again be dealing in levels (logarithms of ratios), we neglect the impedance and simply measure the square of the pressure:

$Energy = \int_0^T p^2(t,x,y,z)dt$, where T is the maximum time of interest in this case 2.5.

The energy for this snippet of the Hallelujah Chorus is $8.47 \times 10^{10}\ \mu Pa^2 \cdot s$. This would more commonly be reported as an energy level (EL):

$$EL = 10\log_{10}\left(\frac{\int_0^T p^2(t,x,y,z)dt}{1.0\mu Pa^2 s} \right) = \text{ 109.3 dB re } 1\mu\text{Pa}^2\text{-s}$$

Energy is sometimes called "equal energy" because if *p*(*t*) is a constant function and the duration is doubled, the effect is the same as doubling the signal amplitude (*y* value). Thus, the duration and the signal have an "equal" influence on the energy metric.

Mathematically we have

$$\int_0^{2T} p(t)^2\,dt = 2\int_0^T p(t)^2\,dt = \int_0^T 2p(t)^2\,dt$$

or a doubling in duration equals a doubling in energy equals a doubling in signal.

Sometimes, the integration metrics are referred to as having a "3 dB exchange rate" because if the duration is doubled, this integral increases by a factor of two, or 10log10(2)=3.01 dB. Thus, equal energy has "a 3 dB exchange rate."

After *p(t)* is determined (i.e., when the stimulus is over), propagation models can be used to determine *p(t;x,y,z)* for every point in the vicinity and for a given metric. Define

$$m_a(x,y,z,T) = \text{value of metric "}a\text{" at point }(x,y,z)\text{ after time }T$$

So,

$$m_{energy}(x,y,z;T) = \int_0^T p(t)^2\,dt$$

$$m_{\max SPL}(x,y,z;T) = \max 10\log_{10}\left(p^2(t)\right) over\ [0,T]$$

Since modeling is concerned with the effects of an entire event, *T* is usually implicitly defined: a number that captures the duration of the event. This means that $m_a(x,y,z)$ is assumed to be measured over the duration of the received signal.

D.5.3.1 Three Dimensions versus Two Dimensions

To further reduce the calculation burden, it is possible to reduce the domain of $m_a(x,y,z)$ to two dimensions by defining $m_a(x,y) = \max\{m_a(x,y,z)\}$ over all *z*. This reduction is not used for this analysis, which is exclusively three-dimensional.

D.5.4 Threshold

For a given metric, a threshold is a function that gives the probability of exposure at every value of m_a. This threshold function will be defined as

$$D(m_a(x,y,z)) = P(\textit{effect at } m_a(x,y,z))$$

The domain of *D* is the range of $m_a(x,y,z)$, and the range of *D* is [0,1].

An example of threshold functions is the heavyside (or unit step) function, currently used to determine permanent and temporary threshold shift (PTS and TTS) in cetaceans. For PTS, the metric is $m_{energy}(x,y,z)$, defined above, and the threshold function is a heavyside function with a discontinuity at 215 dB, shown in Figure D-13.

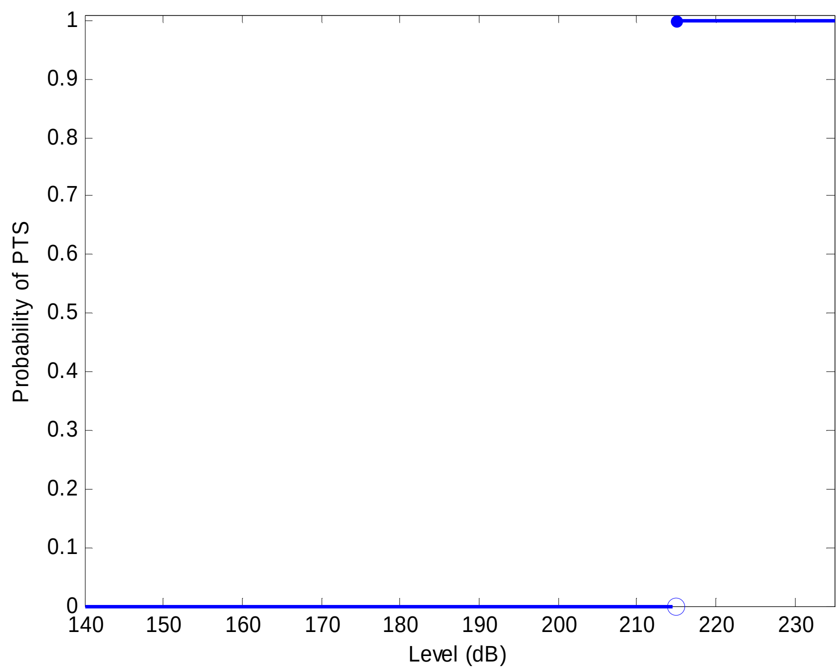

Figure D-13. PTS Heavyside Threshold Function

Symbolically, this *D* is defined as:

$$D(m_{energy}) = \begin{cases} 0 \ \textit{for } m_{energy} < 215 \\ 1 \ \textit{for } m_{energy} \geq 215 \end{cases}$$

Any function can be used for D, as long as its range is in [0,1]. The risk function uses normal Feller risk functions (defined below) instead of heavyside functions, and use the max SPL metric instead of the energy metric. While a heavyside function is specified by a single parameter, the discontinuity, a Feller function requires three parameters: the basement cutoff value, the level above the basement for 50% effect, and a steepness parameter. Mathematically, these Feller, “risk” functions, *D*, are defined as

$$D(m_{\max SPL}) = \begin{cases} \dfrac{1}{1+\left(\dfrac{K}{m_{\max SPL}-B}\right)^{A}} & for\ m_{\max SPL} \geq B \\ 0 & for\ m_{\max SPL} < B \end{cases} \qquad 1$$

where B = cutoff (or basement), K = the difference in level (dB) between the basement and the median (50% effect) harassment level, and A = the steepness factor. The dose function for odontocetes and pinnipeds uses the parameters:

B = 120 dB,

K = 45 dB, and

A = 10.

The dose function for mysticetes uses:

B = 120 dB,

K = 45 dB, and

A = 8.

Harbor porpoises are a special case. Though the metric for their behavioral harassment is also SPL, their risk function is a heavyside step function with a harassment threshold discontinuity (0 % to 100 %) at 120 dB. All other species use the continuous Feller risk-function for evaluating expected harassment.

D.5.5 Calculation of Expected Exposures

Determining the number of expected exposures for disturbance is the object of this analysis.

$$\text{Expected exposures in volume V} = \int_V \rho(V)D(m_a(V))dV$$

For this analysis, $m_a = m_{\max SPL}$, so

$$\int_V \rho(V)D(m_a(V))dV = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \rho(x,y,z)D(m_{\max SPL}(x,y,z))\,dx\,dy\,dz$$

In this analysis, the densities are constant over the *xy*-plane, and the *z* dimension is always negative, so this reduces to

$$\int_{-\infty}^{0} \rho(z) \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z))\,dx\,dy\,dz$$

1 The equation can also be represented as shown in Section 3.8.6.3 of this EIS/OEIS

D.5.6 Numeric Implementation

Numeric integration of $\int_{-\infty}^{0} \rho(z) \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z))\, dx\, dy\, dz$ can be involved because, although the bounds are infinite, *D* is non-negative out to 120 dB, which, depending on the environmental specifics, can drive propagation loss calculations and their numerical integration out to more than 100 km.

The first step in the solution is to separate out the *xy*-plane portion of the integral:

$$\text{Define } f(z) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z))\, dx\, dy\,.$$

Calculation of this integral is the most involved and time consuming part of the calculation. Once it is complete,

$$\int_{-\infty}^{0} \rho(z) \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z))\, dx\, dy\, dz = \int_{-\infty}^{0} \rho(z) f(z) dz\,,$$

which, when numerically integrated, is a simple dot product of two vectors.

Thus, the calculation of *f(z)* requires the majority of the computation resources for the numerical integration. The rest of this section presents a brief outline of the steps to calculate *f(z)* and preserve the results efficiently.

The concept of numerical integration is, instead of integrating over continuous functions, to sample the functions at small intervals and sum the samples to approximate the integral. Smaller sized intervals yield closer approximations with longer calculation time, so a balance between accuracy and time is determined in the decision of step size. For this analysis, *z* is sampled in 5 meter steps to 1000 meters in depth and 10 meter steps to 2000 meters, which is the limit of animal depth in this analysis. The step size for *x* is 5 meters, and *y* is sampled with an interval that increases as the distance from the source increases. Mathematically,

$$z \in Z = \{0,5,...1000,1010,...,2000\}$$
$$x \in X = \{0,\pm 5,...,\pm 5k\}$$
$$y \in Y = \left\{0, \pm 5 * (1.005)^0, \pm 5 * \left[(1.005)^0 + (1.005)^1\right], ..., \pm 5 * \left[\sum_{i=0}^{j} (1.005)^i\right]\right\}$$

for integers *k*, *j*, which depend on the propagation distance for the source. For this analysis, *k* = 20,000 and *j* = 600.

With these steps, $f(z_0) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z_0))dxdy$ is approximated as

$$\sum_{z\in Y}\sum_{x\in X} D(m_{\max SPL}(x,y,z_0))\Delta x \Delta y$$

where *X*,*Y* are defined as above.

This calculation must be repeated for each $z_0 \in Z$, to build the discrete function *f*(*z*).

With the calculation of *f*(*z*) complete, the integral of its product with $\rho(z)$ must be calculated to complete evaluation of

$$\int_{-\infty}^{\infty} \rho(z) \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z))dxdydz = \int_{-\infty}^{0} \rho(z) f(z) dz$$

Since *f*(*z*) is discrete, and $\rho(z)$ can be readily made discrete, this equation is approximated numerically as $\sum_{z \in Z} \rho(z) f(z)$, a dot product.

D.5.7 Preserving Calculations for Future Use

Calculating *f*(*z*) is the most time-consuming part of the numerical integration, but the most time-consuming portion of the entire process is calculating $m_{\max SPL}(x,y,z)$ over the area range required for the minimum cutoff value (120 dB). The calculations usually require propagation estimates out to over 100 km, and those estimates, with the beam pattern, are used to construct a sound field that extends 200 km × 200 km = 40,000 sq km, with a calculation at the steps for every value of *X* and *Y*, defined above. This is repeated for each depth, to a maximum of 2,000 meters.

Saving the entire $m_{\max SPL}$ for each *z* is unrealistic, requiring great amounts of time and disk space. Instead, the different levels in the range of $m_{\max SPL}$ are sorted into 0.5 dB wide bins; the volume of water at each bin level is taken from $m_{\max SPL}$, and associated with its bin. Saving this, the amount of water ensonified at each level, at a 0.5 dB resolution, preserves the ensonification information without using the space and time required to save $m_{\max SPL}$ itself. Practically, this is a histogram of occurrence of level at each depth, with 0.5 dB bins. Mathematically, this is simply defining the discrete functions $V_z(L)$, where $L = \{.5a\}$ for every positive integer *a*, and for all $z \in Z$. These functions, or histograms, are saved for future work. The information lost by saving only the histograms is *where* in space the different levels occur, although *how often* they occur is saved. But the thresholds (risk function curves) are purely a function of level, not location, so this information is sufficient to calculate *f*(*z*).

Applying the risk function to the histograms is a dot product:

$$\sum_{\ell \in L_1} D(\ell) V_{z_0}(\ell) \approx \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z_0))dxdy$$

So, once the histograms are saved, neither $m_{\max SPL}(x,y,z)$ nor *f*(*z*) must be recalculated to generate $\int_{-\infty}^{0} \rho(z) \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z))dxdydz$ for a new threshold function.

For the interested reader, the following section includes an in-depth discussion of the method, software, and other details of the *f*(*z*) calculation.

D.5.8 Software Detail

The risk-function metric uses the aforementioned Feller function to determine the probability that an animal is affected by a given sound pressure level. The acoustic quantity of interest is the maximum sound pressure level (SPL) experienced over multiple pings in a range-independent environment. The procedure for calculating the impact volume at a given depth is relatively simple. In brief, given the SPL of the source and the transmission loss (TL) curve, the received SPL is calculated on a volumetric grid. For a given depth, volume associated with each SPL interval is calculated. Then, this volume is multiplied by the probability that an animal will be affected by that sound pressure level. This gives the impact volume for that depth, which can be multiplied by the animal densities at that depth, to obtain the number of animals affected at that depth. The process repeats for each depth to construct the impact volume as a function of depth.

The case of a single emission of sound energy, one ping, illustrates the computational process in more detail. First, the sound pressure levels are segregated into a sequence of bins that cover the range encountered in the area. The SPL are used to define a volumetric grid of the local sound field. The impact volume for each depth is calculated as follows: for each depth in the volumetric grid, the SPL at each *xy*-plane grid point is calculated using the SPL of the source, the TL curve, the horizontal beam pattern of the source, and the vertical beam patterns of the source. The sound pressure levels in this grid become the bins in the volume histogram.

Figure D-14 shows an example volume histogram for a low-power source. Level bins are 0.5 dB in width and the depth is 50 meters in an environment with water depth of 100 meters. The oscillatory structure at very low levels is due to the flattening of the TL curve at long distances from the source, which magnifies the fluctuations of the TL as a function of range. The “expected” impact volume for a given level at a given depth is calculated by multiplying the volume in each level bin by the risk function evaluated at that level. Total expected impact volume for a given depth is the sum of these “expected” volumes.

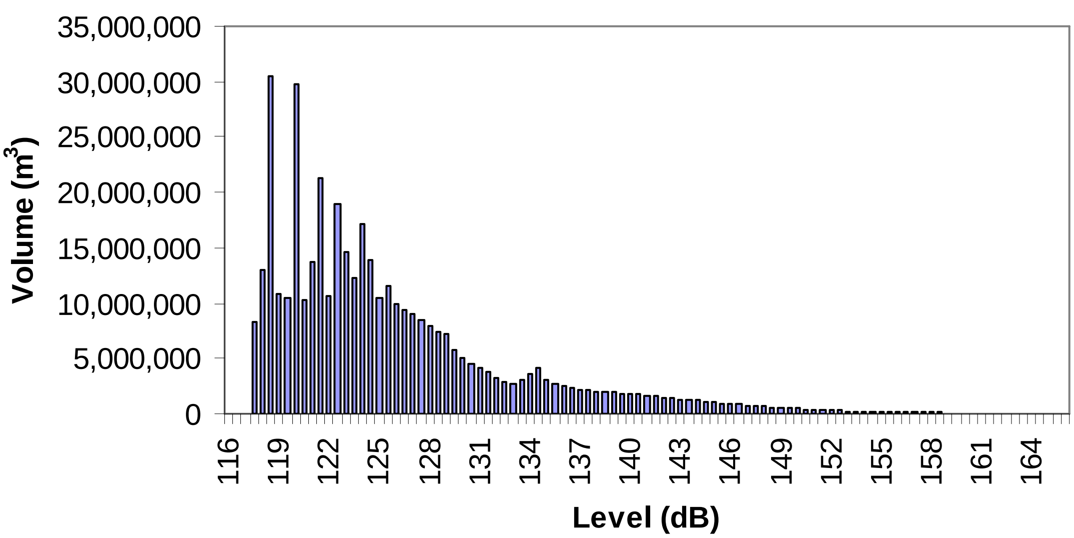

Figure D-14. Example of a Volume Histogram

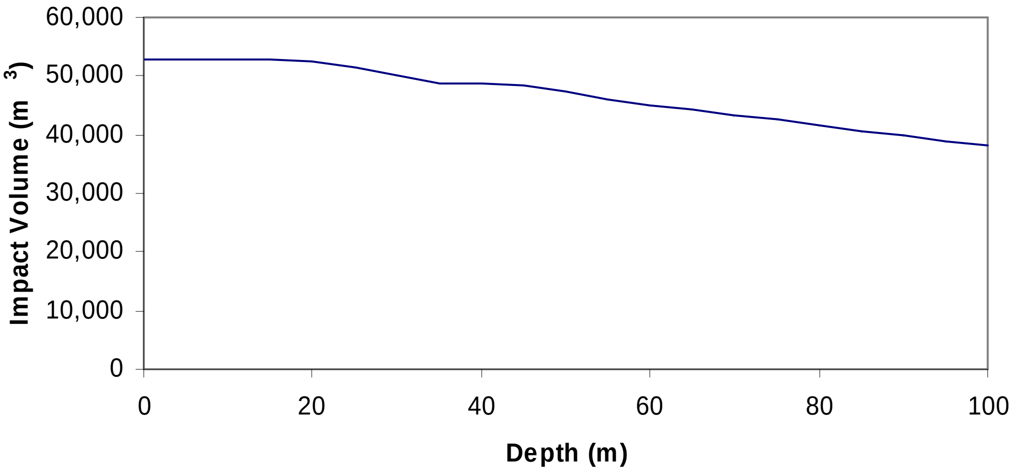

Figure D-15. Example of the Dependence of Impact Volume on Depth

The volumetric grid covers the waters in and around the area of a source's operation. The grid for this analysis has a uniform spacing of 5 meters in the *x*-coordinate and a slowly expanding spacing in the *y*-coordinate that starts with 5 meters spacing at the origin. The growth of the grid size along the *y*-axis is a geometric series where each successive grid size is obtained from the previous by multiplying it by 1 + *Ry*, where *Ry* is the *y*-axis growth factor. The n^{th} grid size is related to the first grid size by multiplying by $(1 + Ry)^{(n-1)}$. For an initial grid size of 5 meters and a growth factor of 0.005, the 100^{th} grid increment is 8.19 meters. The constant spacing in the *x*-coordinate allows greater accuracy as the source moves along the *x*-axis. The slowly increasing spacing in *y* reduces computation time, while maintaining accuracy, by taking advantage of the fact that TL changes more slowly at longer distances from the source. The *x*-and *y*-coordinates extend from $-R_{max}$ to $+R_{max}$, where R_{max} is the maximum range used in the TL calculations. The *z* direction uses a uniform spacing of 5 meters down to 1000 meters and 10 meters from 1000 to 2000 meters. This is the same depth mesh used for the effective energy metric as described above. The depth mesh does not extend below 2000 meters, on the assumption that animals of interest are not found below this depth.

The next three figures indicate how the accuracy of the calculation of impact volume depends on the parameters used to generate the mesh in the horizontal plane. Figure D-16 shows the relative change of impact volume for one ping as a function of the grid size used for the *x*-axis. The *y*-axis grid size is fixed at 5 m and the *y*-axis growth factor is 0, i.e., uniform spacing. The impact volume for a 5 meters grid size is the reference. For grid sizes between 2.5 and 7.5 meters, the change is less than 0.1%. A grid size of 5 meters for the *x*-axis is used in the calculations.

Figure D-17 shows the relative change of impact volume for one ping as a function of the grid size used for the x-axis and the *y*-axis grids, respectively. The *x*-axis grid size is fixed at 5 meters and the *y*-axis growth factor is 0. The impact volume for a 5 meters grid size is the reference. This figure is very similar to that for the *x*-axis grid size. For grid sizes between 2.5 and 7.5 meters, the change is less than 0.1%. A grid size of 5 meters is used for the *y*-axis in our calculations. Figure D-18 shows the relative change of impact volume for one ping as a function of the *y*-axis growth factor. The *x*-axis grid size is fixed at 5 meters and the initial *y*-axis grid size is 5 meters. The impact volume for a growth factor of 0 is the reference. For growth factors from 0 to 0.01, the change is less than 0.1%. A growth factor of 0.005 is used in the calculations.

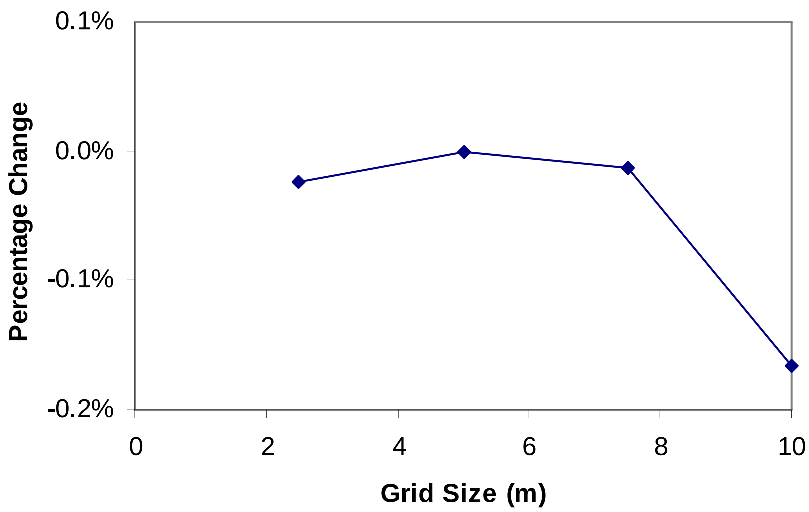

Figure D-16. Change of Impact Volume as a Function of *x*-axis Grid Size

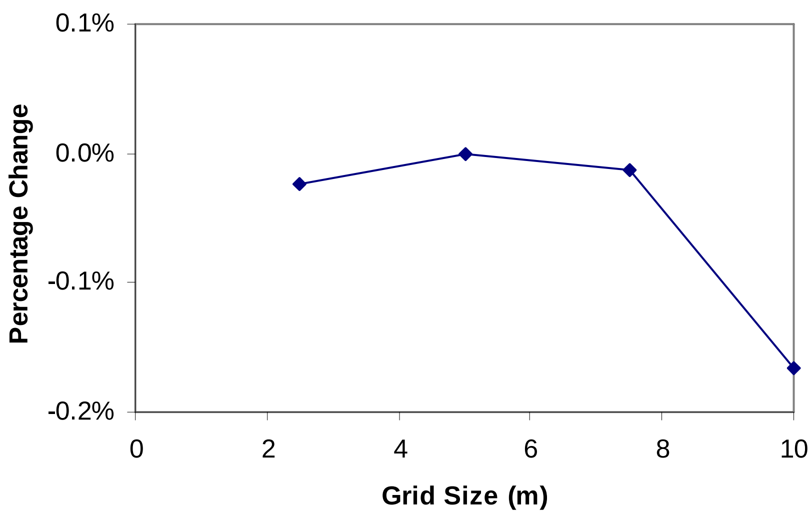

Figure D-17. Change of Impact Volume as a Function of y-axis Grid Size

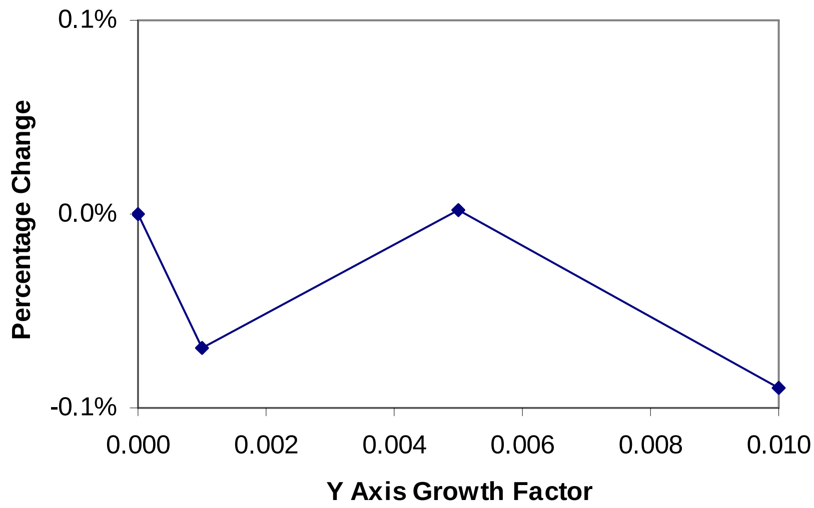

Figure D-18. Change of Impact Volume as a Function of y-axis Growth Factor

Another factor influencing the accuracy of the calculation of impact volumes is the size of the bins used for sound pressure level. The sound pressure level bins extend from 100 dB (far lower than required) up to 300 dB (much higher than that expected for any sonar system).

Figure D-19 shows the relative change of impact volume for one ping as a function of the bin width. The *x*-axis grid size is fixed at 5 meters, and the initial *y*-axis grid size is 5 meters with a *y*-axis growth factor of 0.005. The impact volume for a bin size of 0.5 dB is the reference. For bin widths from 0.25 dB to 1.00 dB, the change is about 0.1%. A bin width of 0.5 is used in our calculations.

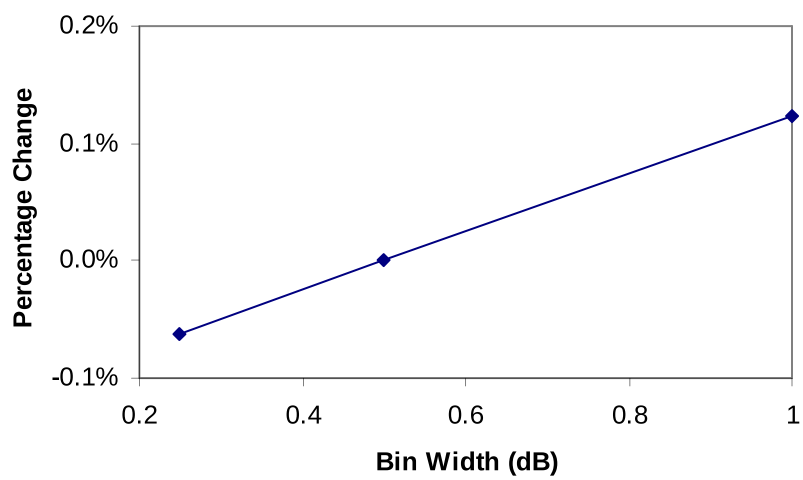

Figure D-19. Change of Impact Volume as a Function of Bin Width

Two other issues for discussion are the maximum range (R_{max}) and the spacing in range and depth used for calculating TL. The TL generated for the energy accumulation metric is used for dose-response analysis. The same sampling in range and depth is adequate for this metric because it requires a less demanding computation (i.e., maximum value instead of accumulated energy). Using the same value of R_{max} needs some discussion since it is not clear that the same value can be used for both metrics. R_{max} was set so that the TL at R_{max} is more than needed to reach the energy accumulation threshold of 173 dB for 1000 pings. Since energy is accumulated, the same TL can be used for one ping with the source level increased by 30 dB (10 $\log_{10}$(1000)). Reducing the source level by 30 dB, to get back to its original value, permits the handling of a sound pressure level threshold down to 143 dB, comparable to the minimum required. Hence, the TL calculated to support energy accumulation for 1000 pings will also support calculation of impact volumes for the dose-response metric.

The process of obtaining the maximum sound pressure level at each grid point in the volumetric grid is straightforward. The active sonar starts at the origin and moves at constant speed along the positive *x*-axis emitting a burst of energy, a ping, at regularly spaced intervals. For each ping, the distance and horizontal angle connecting the source to each grid point is computed. Calculating the TL from the source to a grid point has several steps. The TL is made up of the sum of many eigenrays connecting the source to the grid point. The beam pattern of the source is applied to the eigenrays based on the angle at which they leave the source. After summing the vertically beamformed eigenrays on the range mesh used for the TL calculation, the vertically beamformed TL for the distance from the sonar to the grid point is derived by interpolation. Next, the horizontal beam pattern of the source is applied using the horizontal angle connecting the sonar to the grid point. To avoid problems in extrapolating TL, only grid points with distances less than R_{max} are used. To obtain the sound pressure level at a grid point, the sound pressure level of the source is reduced by that TL. For the first ping, the volumetric grid is populated by the calculated sound pressure level at each grid point. For the second ping and subsequent pings, the source location increments along the *x*-axis by the spacing between pings and the sound pressure level for each grid point is again calculated for the new source location. Since the risk-function metric uses the maximum of the sound pressure levels at each grid point, the newly calculated sound pressure level at each grid point is compared to the sound pressure level stored in the grid. If the new level is larger than the stored level, the value at that grid point is replaced by the new sound pressure level.

For each bin, a volume is determined by summing the ensonified volumes with a maximum SPL in the bin's interval. This forms the volume histogram shown in Figure D-14. Multiplying by the dose-response probability function for the level at the center of a bin gives the impact volume for that bin. The result can be seen in Figure D-15, which is an example of the impact volume as a function of depth.

The impact volume for a sonar moving relative to the animal population increases with each additional ping. The rate at which the impact volume increases for the risk function metric is essentially linear with the number of pings. Figure D-20 shows the dependence of impact volume on the number of pings. The slope of the line at a given depth is the impact volume added per ping. This number multiplied by the number of pings in an hour gives the hourly impact volume for the given depth increment. Completing this calculation for all depths in a province, for a given source, gives the hourly impact volume vector which contains the hourly impact volumes by depth for a province.

Figure D-21 provides an example of an hourly impact volume vector for a particular environment. Given the speed of the sonar platform, the hourly impact volume vector could be displayed as the impact volume vector per kilometer of track.

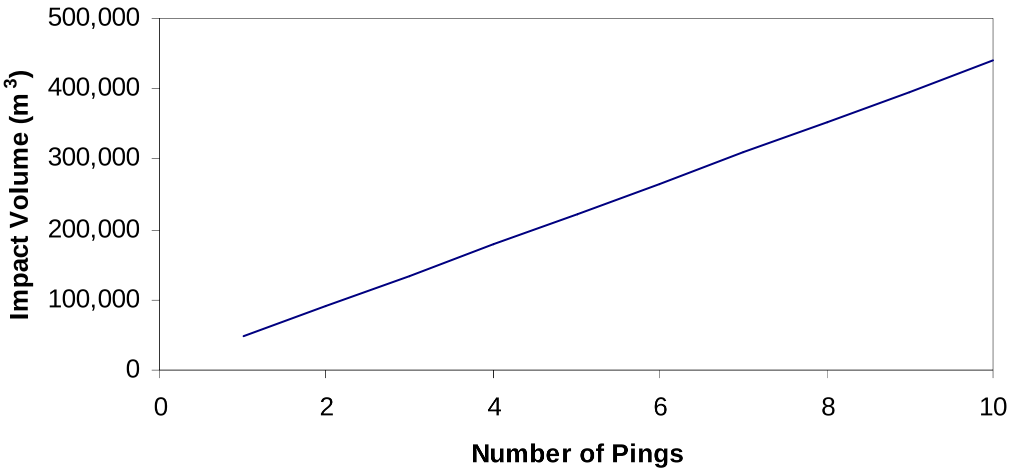

Figure D-20. Dependence of Impact Volume on the Number of Pings

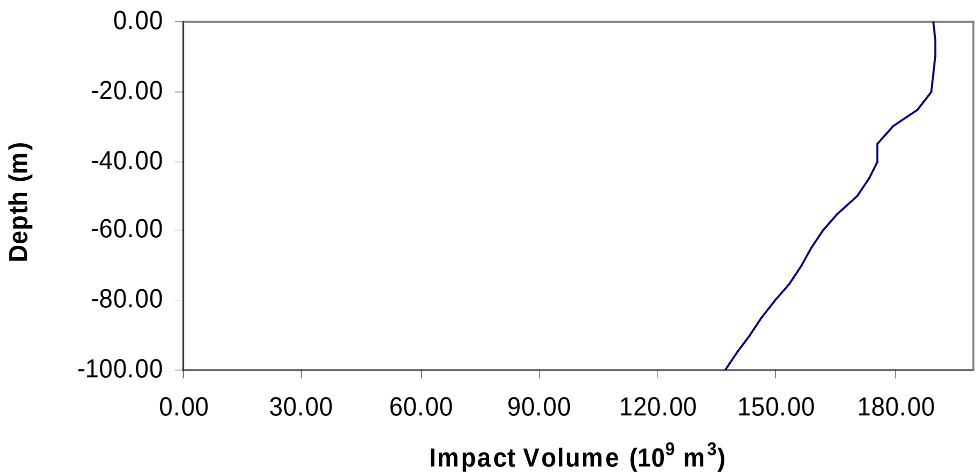

Figure D-21. Example of an Hourly Impact Volume Vector

D.5.9 Modeling Quiet and Continuous Sources

The TMAA has modeled sources whose energy contributions do not exceed EFDL thresholds, but have source levels above 120 dB, and move in a continuous fashion. The previous discussion of software detail would present under-sampling artifacts when applied to quiet sources, so an alternative approach is implemented.

Consider transmission loss with cylindrical symmetry surrounding an omni-directional source (Figure D-22):

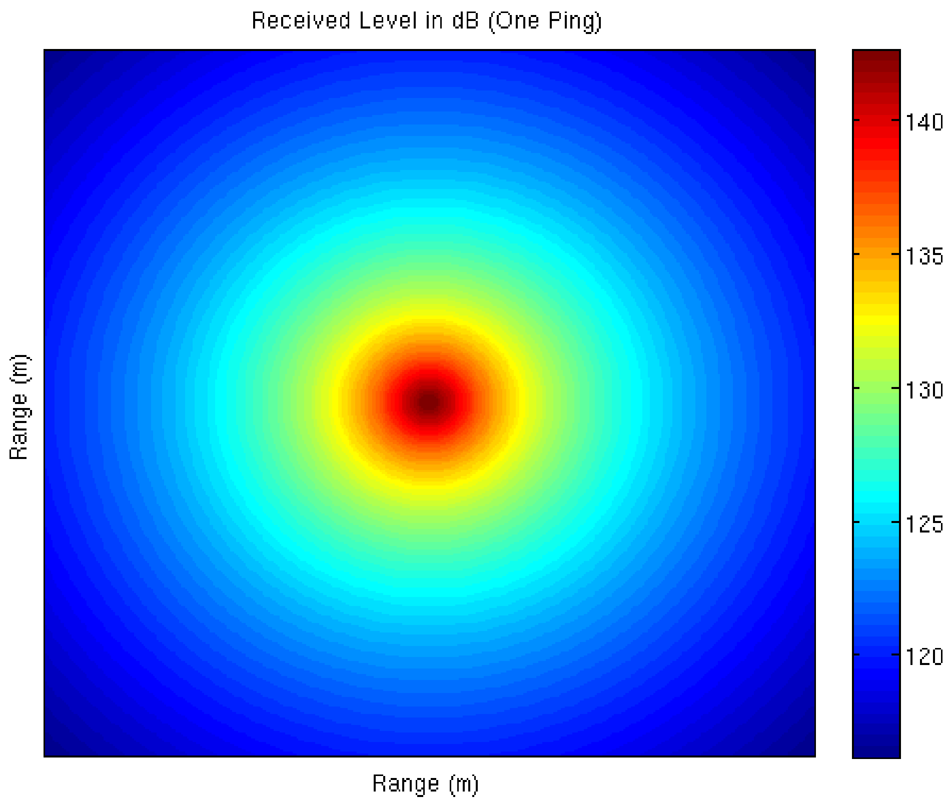

Figure D-22 – Single Ping Maximum SPL Field

When the factors of continuous pinging behavior, monotonic transmission loss in the short range, and maximum SPL as the input metric for the risk function, computing the maximum SPL field is a matter of extending the field as such (Figure D-23):

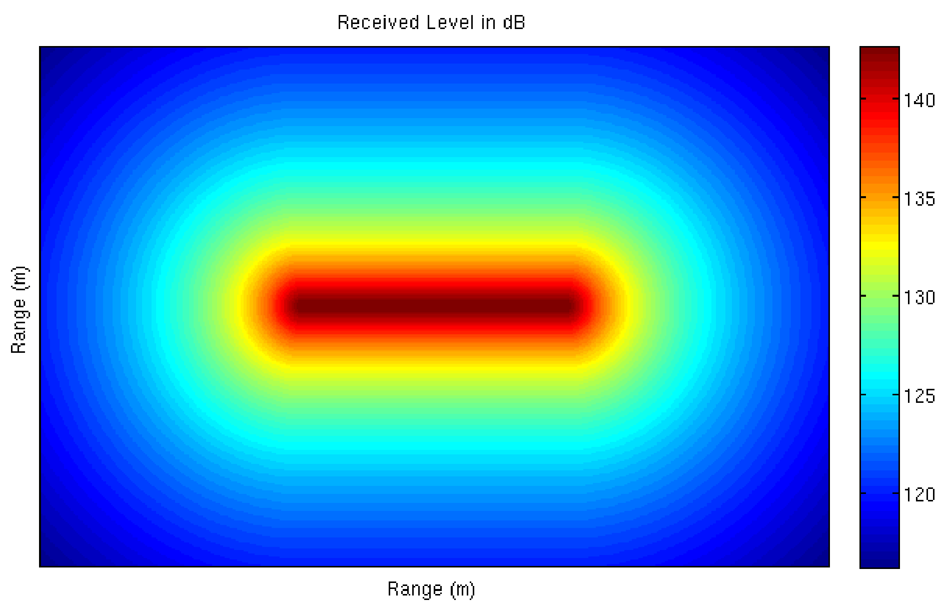

Figure D-23 – Quiet Continuous Sound Source

In the direction orthogonal to source motion, maximum SPL is achieved at CPA. This algorithm takes a 0.5-meter resolution frequency-dependent TL curve and proceeds as follows.

In a given depth interval:

- Find the received level in one meter increments about a source. In the first one meter step, calculate the area of circle ensonified at the matching received level.
- Calculate areas of subsequent n^{th} circles in 1 meter steps.
- Compute the area on a rectangular strip for a one-meter extent in parallel to annulus radius of equivalent received level. Scale by the probability of harassment based on received level at this n^{th} range. Note that received level at the outer-radius of the modified annulus was used to calculate the probability with the risk function.
- Convert annulus result to volume based on the depth increment.
- Sum all scaled volumes of interior cylinder and subsequent annuli to impact range at 120 dB to find a cumulative volume for this depth interval which inherits the probabilistic calculation.

This algorithm takes place over the entire water column to capture dynamics of ensonification over all depths, and hence produces an impact volume vector.

D.6 HARRASSMENTS

This section defines the animal densities and their depth distributions for the TMAA. This is followed by a series of tables providing MMPA harassment estimates per unit of operation for each source type (active sound sources and explosives).

D.6.1 Animal Densities

Densities are usually reported by marine biologists as animals per square kilometer, which is an area metric. This gives an estimate of the number of animals below the surface in a certain area, but does not provide any information about their distribution in depth. The impact volume vector (see subsection D.4.3) specifies the volume of water ensonified above the specified threshold in each depth interval. A corresponding animal density for each of those depth intervals is required to compute the expected value of the number of exposures. The two-dimensional area densities do not contain this information, so three-dimensional densities must be constructed by using animal depth distributions to extrapolate the density at each depth. The required depth distributions are presented in the biology subsection.

D.6.2 Harassment Estimates

The following sperm whale example demonstrates the methodology used to create a three-dimensional density by merging the area densities with the depth distributions. The sperm whale surface density is 0.0003 whales per square kilometer. From the depth distribution report, “depth distribution for sperm whales based on information in the Amano paper is: 31% in 0-10 m, 8% in 10-200 m, 9% in 201-400 m, 9% in 401-600 m, 9% in 601-800 m and 34% in >800 m.” So the sperm whale density at 0-10 m is 0.0003*0.31/0.01 = 0.0093 per cubic km, at 10-200 m is 0.0003*0.08/0.19 = .00012632 per cubic km, and so forth.

In general, the impact volume vector samples depth in finer detail than given by the depth distribution data. When this is the case, the densities are apportioned uniformly over the appropriate intervals. For example, suppose the impact volume vector provides volumes for the intervals 0-10 meters, 10-50 meters, and 50-200 meters. Then for the depth-distributed densities discussed in the preceding paragraph,

- 0.0093 whales per cubic km is used for 0-10 meters,
- 0.00012632 whales per cubic km is used for the 10-50 meters, and
- 0.00012632 whales per cubic km is used for the 50-200 meters.

Once depth-varying, three-dimensional densities are specified for each species type, with the same depth intervals and the ensonified volume vector, the density calculations are finished. The expected number of ensonified animals within each depth interval is the ensonified volume at that interval multiplied by the volume density at that interval and this can be obtained as the dot product of the ensonified volume and animal density vectors.

Since the ensonified volume vector is the ensonified volume per unit operation (i.e. per hour, per sonobuoy, etc), the final harassment count for each animal is the unit operation harassment count multiplied by the number of units (hours, sonobuoys, etc).

D.6.3 Additional Modeling Considerations in a General Modeling Scenario

When modeling the effect of sound projectors in the water, the ideal task presents modelers with complete *a priori* knowledge of the location of the source(s) and transmission patterns during the times of interest. In these cases, calculation inputs include the details of source path, proximity of shoreline, high-resolution density estimates, and other details of the scenario. However, in the TMAA, there are sound-producing events for which the source locations and transmission patterns are unknown, but still require analysis to predict effects. For these cases, a more general modeling approach is required: "We will be operating somewhere in this large area for *X* minutes. What are the potential effects on average?"

Modeling these general scenarios requires a statistical approach to incorporate the scenario nuances into harassment calculations. For example, one may ask: "If an animal receives 130 dB SPL when the source passes at closest point of approach (CPA) on Tuesday morning, how do we know it doesn't receive a higher level on Tuesday afternoon?" This question cannot be answered without knowing the path of the source (and several other facts). Because the path of the source is unknown, the number of an individual's re-exposures cannot be calculated directly. But it can, on average, be accounted for by making appropriate assumptions.

Table D-14 lists unknowns created by uncertainty about the specifics of a future proposed action, the portion of the calculation to which they are relevant, and the assumption that allows the effect to be computed without the detailed information:

Table D-14 – Unknowns and Assumptions

Unknowns	Relevance	Assumption
Path of source (esp. with respect to animals)	Ambiguity of multiple exposures, Local population: upper bound of harassments	Most conservative case: sources can be anywhere within range
Source locations	Ambiguity of multiple exposures, land shadow	Equal distribution of action in each range
Direction of sonar transmission	Land shadow	Equal probability of pointing any direction

The following sections discuss two topics that require action details, and describe how the modeling calculations used the general knowledge and assumptions to overcome the future-action uncertainty with respect to re-exposure of animals, and land shadow.

D.6.4 Multiple Exposures in General Modeling Scenario

Consider the following hypothetical scenario. A box is painted on the surface of a well-studied ocean environment with well-known propagation. A sound source and 100 whales are inserted into that box and a curtain is drawn. What will happen? The details of what will happen behind the curtain are unknown, but the existing knowledge, and general assumptions, can allow for a calculation of average affects.

For the first period of time, the source is traveling in a straight line and pinging at a given rate. In this time, it is known how many animals, on average, receive their max SPLs from each ping. As long as the source travels in a straight line, this calculation is valid. However, after an undetermined amount of time, the source will change course to a new and unknown heading.

If the source changes direction 180 degrees and travels back through the same swath of water, all the animals the source passes at closest point of approach (CPA) before the next course change have already been exposed to what will be their maximum SPL, so the population is not "fresh." If the direction does not change, only new animals will receive what will be their maximum SPL from that source (though most have received sound from it), so the population is completely "fresh." Most source headings lead to a population of a mixed "freshness," varying by course direction. Since the route and position of the source over time are unknown, the freshness of the population at CPA with the source is unknown. This ambiguity continues through the remainder of the exercise.

What is known? The source and, in general, the animals remain in the vicinity of the range. Thus, if the farthest range to a possible effect from the source is *X* km, no animals farther than *X* km outside of the TMAA can be harassed. The intersection of this area with a given animal's habitat multiplied by the density of that animal in its habitat represents the maximum number of animals that can be harassed by activity in that TMAA, which shall be defined as "the local population." Two details: first, this maximum should be adjusted down if a risk function is being used, because not 100% of animals within *X* km of the TMAA border will be harassed. Second, it should be adjusted up to account for animal motion in and out of the area.

The ambiguity of population freshness throughout the exercise means that multiple exposures cannot be calculated for any individual animal. It must be dealt with generally at the population level.

D.6.4.1 Solution to the Ambiguity of Multiple Exposures in the General Modeling Scenario

At any given time, each member of the population has received a maximum SPL (possibly zero) that indicates the probability of harassment in the exercise. This probability indicates the contribution of that individual to the expected value of the number of harassments. For example, if an animal receives a level that indicates 50% probability of harassment, it contributes 0.5 to the sum of the expected number of harassments. If it is passed later with a higher level that indicates a 70% chance of harassment, its contribution increases to 0.7. If two animals receive a level that indicates 50% probability of harassment, they together contribute 1 to the sum of the expected number of harassments. That is, we statistically expect exactly one of them to be harassed. Let the expected value of harassments at a given time be defined as "the harassed population" and the difference between the local population (as defined above) and the harassed population be defined as "the unharassed population." As the exercise progresses, the harassed population will never decrease and the unharassed population will never increase.

The unharassed population represents the number of animals statistically "available" for harassment. Since we do not know where the source is, or where these animals are, we assume an average (uniform) distribution of the unharassed population over the area of interest. The densities of unharassed animals are lower than the total population density because some animals in the local population are in the harassed population.

Density relates linearly to expected harassments. If action A in an area with a density of 2 animals per square kilometer produces 100 expected harassments, then action A in an area with 1 animal per square kilometer produces 50 expected harassments. The modeling produces the number of expected harassments per ping starting with 100% of the population unharassed. The next ping will produce slightly fewer harassments because the pool of unharassed animals is slightly less.

For example, consider the case where 1 animal is harassed per ping when the local population is 100, 100% of which are initially unharassed. After the first ping, 99 animals are unharassed, so the number of animals harassed during the second ping are

$$1\left(\frac{99}{100}\right) = 1(.99) = 0.99 \text{ animals}$$

and so on for the subsequent pings.

Mathematics

A closed form function for this process can be derived as follows.

Define $H =$ number of animals harassed per ping with 100% unharassed population. H is calculated by determining the expected harassments for a source moving in a straight line for the duration of the exercise and dividing by the number of pings in the exercise (Figure D-24).

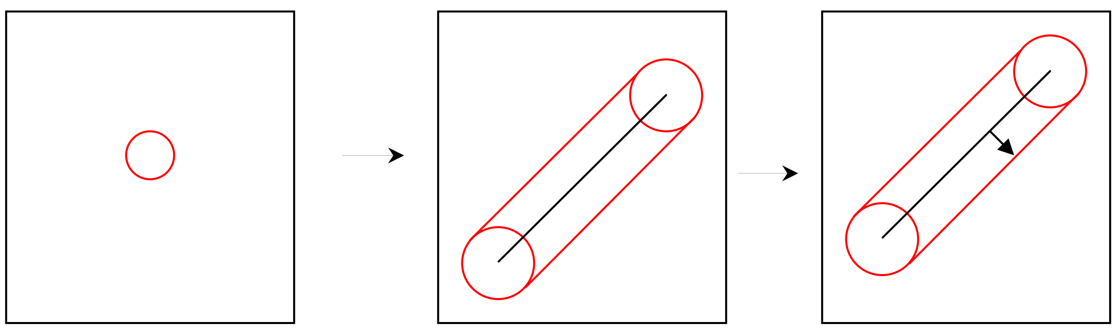

Figure D-24 – Process of calculating *H*

$$H = \frac{\iiint \rho(z) D(L(x,y,z))\,dx\,dy\,dz}{N_{pings}}$$

The total un-harassed population is then calculated by iteration. Each ping affects the un-harassed population left after all previous pings:

Define $P_n =$ unharassed population after n^{th} ping

$$P_0 = \text{local population}$$

$$P_1 = P_0 - H$$

$$P_2 = P_1 - H\left(\frac{P_1}{P_0}\right)$$

$$\ldots$$

$$P_n = P_{n-1} - H\left(\frac{P_{n-1}}{P_0}\right)$$

Therefore,

$$P_n = P_{n-1}\left(1 - \left(\frac{H}{P_0}\right)\right) = P_{n-2}\left(1 - \left(\frac{H}{P_0}\right)\right)^2 = \ldots = P_0\left(1 - \left(\frac{H}{P_0}\right)\right)^n$$

Thus, the total number of harassments depends on the per-ping harassment rate in an un-harassed population, the local population size, and the number of operation hours.

D.6.4.2 Local Population: Upper Bound on Harassments

As discussed above, Navy planners have confined periods of sonar use to operation areas. The size of the harassed population of animals for an action depends on animal re-exposure, so uncertainty about the precise source path creates variability in the “harassable” population. Confinement of sonar use to a sonar operating area allows modelers to compute an upper bound, or worst case, for the number of harassments with respect to location uncertainty. This is done by assuming that every animal which enters the operation area at any time in the exercise (and also many outside) is “harassable” and creates an upper bound on the number of harassments for the exercise. Since this is equivalent to assuming that there are sonars transmitting simultaneously from each point in the confined area throughout the action length, this greatly overestimates the harassments from an exercise.

NMFS has defined a twenty-four hour “refresh rate,” or amount of time in which an individual animal can be harassed no more than once. The Navy has determined that, in a twenty-four hour period, all training events in the TMAA involve sources that transmit for no longer than sixteen (16) hours.

The most conservative assumption for a single ping is that it harasses the entire population within the range (a gross over-estimate). However, the total harassable population for multiple pings will be even greater since animal motion over the period in the above table can bring animals into range that otherwise would be out of the harassable population.

D.6.4.3 Animal Motion Expansion

Though animals often change course to swim in different directions, straight-line animal motion would bring the more animals into the harassment area than a “random walk” motion model. Since precise and accurate animal motion models exist more as speculation than documented fact and because the modeling requires an undisputable upper bound, calculation of the upper bound for TMAA modeling areas uses a straight-line animal motion assumption. This is a conservative assumption.

For a circular area, the straight-line motion in any direction produces the same increase in harassable population. However, since the ranges are non-circular polygons, choosing the initial fixed direction as perpendicular to the longest diagonal produces greater results than any other direction. Thus, the product of the longest diagonal and the distance the animals move in the period of interest gives an overestimate of the expansion in range modeling areas due to animal motion. The expansions use this estimate as an absolute upper bound on animal-motion expansion.

Figure D-25 illustrates the overestimation, which occurs during the second arrow:

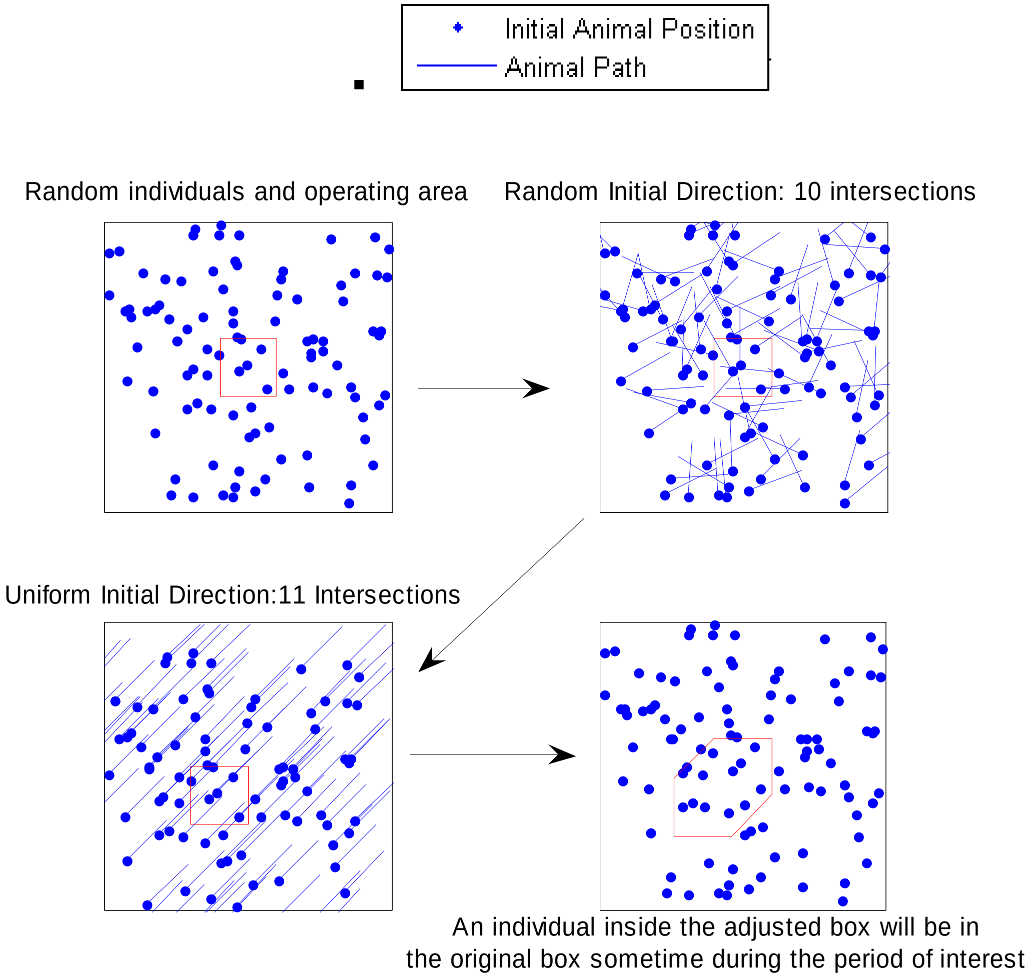

Figure D-25. Process of Setting an Upper Bound on Individuals Present in Area

It is important to recognize that the area used to calculate the harassable population, shown in Figure D-25 will, in general, be much larger than the area that will be within the ZOI of a ship for the duration of its broadcasts. For a ship moving faster than the speed of the marine animals, a better (and much smaller) estimate of the harassable population would be that within the straight line ZOI cylinder shown in Figure D-26. Using this smaller population would lead to a greater dilution of the unharassed population per ping and would greatly reduce the estimated harassments.

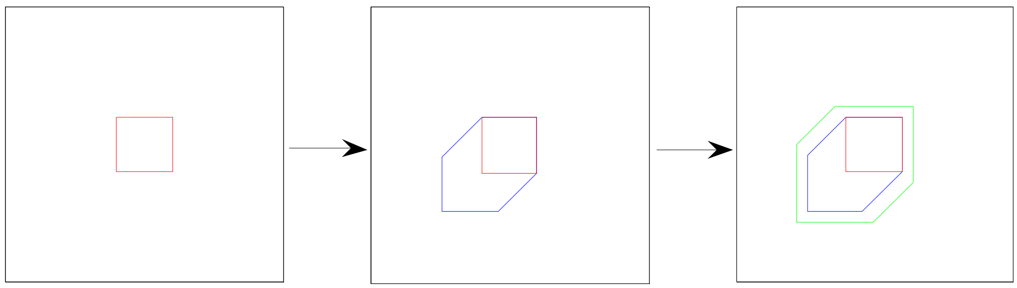

Figure D-26. Process of Expanding Area to Create Upper Bound of Harassments

D.6.4.4 Risk Function Expansion

The expanded area contains the number of animals that will enter the range over the period of interest. However, an upper bound on harassments must also include animals outside the area that would be affected by a source transmitting from the area's edge. A gross overestimation could simply assume pinging at every point on the range border throughout the exercise and would include all area with levels from a source on the closest border point greater than the risk function basement. In the case of GOA, this would include all area within approximately 105 km from the edge of the adjusted box. (See Table D-15). This basic method would give a crude and exaggerated upper bound, since only a tiny fraction of this out-of-range area can be ensonified above threshold for a given ping. A more refined upper bound on harassments can be found by maintaining the assumption that a source is transmitting from each point in the adjusted box and calculating the expected ensonified area, which would give all animals inside the area a 100% probability of harassment, and those outside the area a varying probability, based on the risk function.

$$\int_0^{L^{-1}(120\,dB)} D(L(r))dr\,,$$

Where L is the SPL function with domain in range and range in level,

r is the range from the sonar operating area,

L^{-1}(120 dB) is the range at which the received level drops to 120 dB, and

D is the risk function (probability of harassment vs. Level).

At the corners of the polygon, additional area can be expressed as

$$\frac{[\pi-\theta]\displaystyle\int_0^{L^{-1}(120\,dB)} D(L(r))rdr}{2\pi}$$

with D, L, and r as above, and

θ the inner angle of the polygon corner, in radians.

For the risk function and transmission loss of the TMAA, this method adds an area equivalent by expanding the boundaries of the adjusted box by four kilometers. The resulting shape, the adjusted box with a boundary expansion of 4 km, does not possess special meaning for the problem. But the number of individuals contained by that shape, is the harassable population and an absolute upper bound on possible harassments for that operation.

The following plots illustrate the growth of area for the sample case above. The shapes of the boxes are unimportant. The area after the final expansion, though, gives an upper bound on the “harassable”, or initially unharassed population which could be affected by operations.

Example Case

Consider a sample case from the TMAA. For the most powerful source, the SQS-53, the expected winter rate of exposures under the risk function considered behaviorial MMPA Level B harassment for minke whales is approximately 0.068985832 harassments per ping. The exercise will transmit sonar pings for 16 hours in a 24 hour period as consistent with planned use, with 120 pings per minute, a total of 120 * 16 = 1,920 pings in a 24 hour period.

The TMAA has an area of approximately 92,246 square kilometers and a diagonal of 486.5 km. Adjusting this with straight-line (upper bound) animal motion of 5.5 kilometers per hour for 16 hours, animal motion adds 486.5 * 5.5 * 16 = 42,812 square kilometers to the area. Using the risk function to calculate the expected range outside the OA approximately adds another 5,068 square kilometers, bringing the total upper-bound of the affected area to 140,126 square km.

For example, minke whales have an average winter density of 0.0006 animals per square kilometer, so the upper bound number of minke whales that can be affected by SQS-53 activity in the GOA during a 24 hour period is 140,126 * 0.0006 = 84.0756 whales.

In the first ping, 0.068985832 minke whales will be harassed. With the second ping,

$0.068985832 \left(\frac{84.0756 - 0.068985832}{84.0756}\right) = 0.068929228$ minke whales will be harassed. Using the formula derived above, after 16 hours of continuous operation, the remaining **unharassed** population is

$$P_{1920} = P_0\left(1 - \left(\frac{h}{P_0}\right)\right)^{1920} = 84.0756\left(1 - \left(\frac{0.068985832}{84.0756}\right)\right)^{1920} \approx 17.3861$$

So the **harassed** population will be 84.0756 – 17.3861 = 66.6895 animals.

Contrast this with linear accumulation of harassments without consideration of the local population and the dilution of the unharassed population:

Harassments = 0.068985832 * 1920 = 132.45 whales,

which is 57% greater than the estimated local population of 84.0756 minke whales. Because linear accumulation assumes an infinite local population, it always overestimates the number of harassments, sometimes to the point of producing impossible results.

D.6.5 Land Shadow

The risk function considers the possibility of harassment possible if an animal receives 120 dB sound pressure level, or above. In the open ocean of the GOA, this can occur as far away as 105 km, so over a large "effect" area, sonar sound could, but does not necessarily, harass an animal. The harassment calculations for a general modeling case must assume that this effect area covers only water fully populated with animals, but in some portions of the GOA, land partially encroaches on the area, obstructing sound propagation.

As discussed in the introduction of "Additional Modeling Considerations" Navy planners do not know the exact location and transmission direction of the sonars at future times. These factors however, completely determine the interference of the land with the sound, or "land shadow," so a general modeling approach does not have enough information to compute the land shadow effects directly. However, modelers can predict the reduction in harassments at any point due to land shadow for different pointing directions and use expected probability distribution of activity to calculate the average land shadow for operations in each range.

For each of the coastal points that are within 105 km of the grid, the azimuth and distance are computed. In the computation, only the minimum range at each azimuth is computed.

Now, the average of the distances to shore, along with the angular profile of land is computed (by summing the unique azimuths that intersect the coast) for each grid point. The values are then used to compute the land shadow for the grid points.

D.6.5.1 Computing the Land Shadow Effect at Each Grid Point

The effect of land shadow is computed by determining the levels, and thus the distances from the sources, that the harassments occur. The levels vary according to acoustic propagation conditions, so the analysis breaks down according to two seasons. Table D-15 gives a mathematical extrapolation of the distances and levels at which harassments occur, with average seasonal propagation in the GOA using the SQS-53 as an example and as displayed in Figures D-27 and D-28.

Table D-15 – Behavioral Harassments at each Received Level Band from SQS-53 During Summer Months

Received Level (dB SPL)	Distance at which Levels Occur in GOA	Percent of Behavioral Harassments Occurring at Given Levels
Below 138	42 km – 105 km	~ 0 %
138<Level<144	28 km – 42 km	< 1 %
144<Level<150	17 km – 28 km	~1 %
150<Level<156	9 km – 17 km	7 %
156<Level<162	5 km – 9 km	18 %
162<Level<168	2.5 km – 5 km	26 %
168<Level<174	1.2 km – 2.5 km	22 %
174<Level<180	0.5 km – 1.2 km	14 %
180<Level<186	335 m – 0.5 km	6 %
186<Level<TTS	178 m – 335 m	5 %

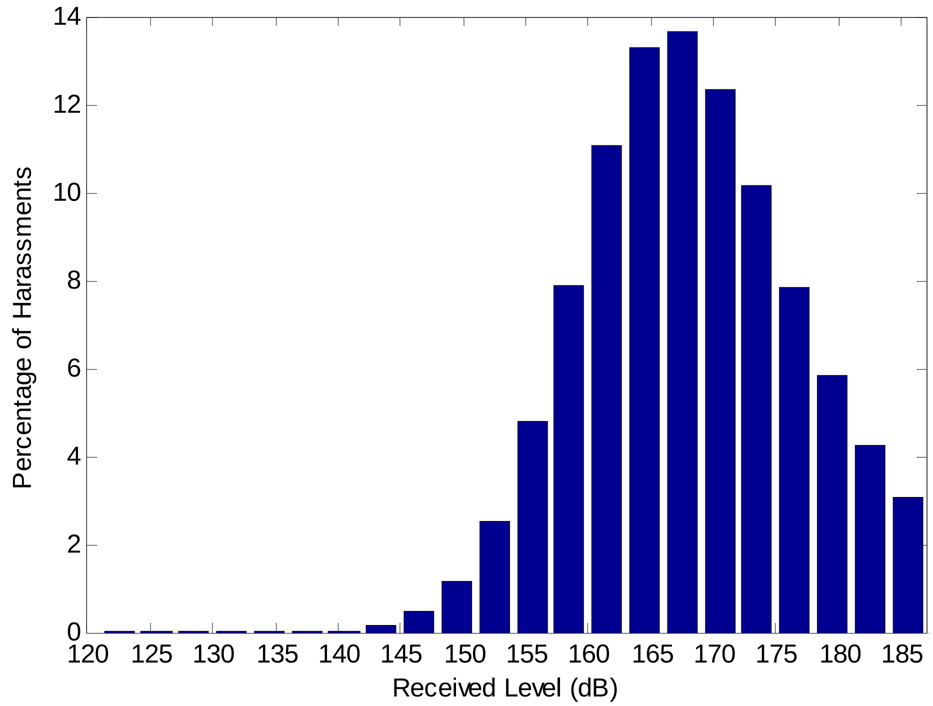

Figure D-27 – The Approximate Percentage of Behavioral Harassments for Every 3 Degree Band of Received Level from the SQS-53 During Summer Months

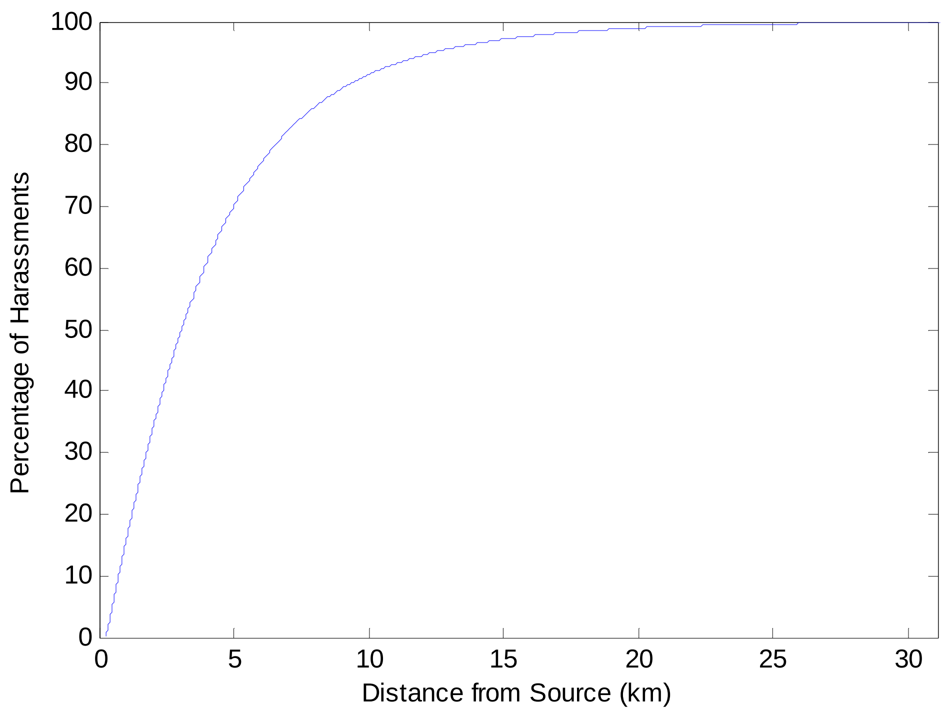

Figure D-28 – Average Percentage of Harassments Occurring Within a Given Distance during Summer Months

With the data used to produce the previous figure, the average effect reduction during summer months for a sound path blocked by land can be calculated. For the SQS-53, since approximately 92% of harassments occur within 10 km of the source, a sound path blocked by land at 10 km will, on average, cause approximately 92% of the effect of an unblocked path.

As described above, the mapping process determines the angular profile of and distance to the coastline(s) from each grid point. The distance, then, determines the reduction due to land shadow when the sonar is pointed in that direction. The angular profile, then, determines the probability that the sonar is pointed at the coast.

Define θ_n = angular profile of coastline at point n in radians

Define r_n = mean distance to shoreline

Define $A(r)$ = average effect adjustment factor for sound blocked at distance r

The land shadow at point n can be approximated by $A(r_n)\theta_n/(2\pi)$. For illustration, the following plot gives the land shadow reduction factor at each point in each range area for the SQS-53 (Figure D-29) . The white portions of the plot indicate the areas outside the range and the blue lines indicate the coastline. The color plots inside the ranges give the land shadow factor at each point. The average land shadow factor for the SQS-53 in the GOA is essentially 1, or the reduction in effect is 0% for both seasons. For the other, lower-power sources it follows that this reduction is also negligible.

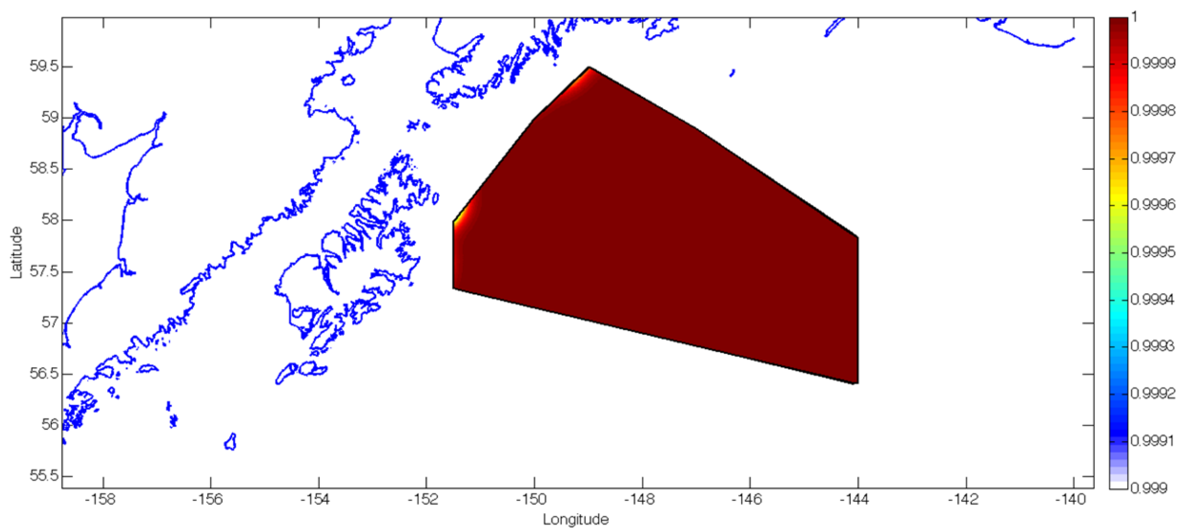

Figure D-29 – Depiction of Land Shadow over the TMAA

D.6.5.2 The Effect of Multiple Ships

Behavioral harassment, under dose response (risk function), uses maximum sound pressure level over a 24 hour period as the metric for determining the probability of harassment. An animal that receives sound from two sonars, operating simultaneously, receives its maximum sound pressure level from one of the ships. Thus, the effects of the louder, or closer, sonar determine the probability of harassment, and the more distant sonar does not. If the distant sonar operated by itself, it would create a lesser effect on the animal, but in the presence of a more dominating sound, its effects are cancelled. When two sources are sufficiently close together, their sound fields within the cutoff range will partially overlap and the larger of the two sound fields at each point in that overlap cancel the weaker. If the distance between sources is twice as large as the range to cutoff, there will be no overlap.

Computation of the overlap between sound fields requires the precise locations and number of the source ships. The general modeling scenarios of the TMAA do not have these parameters, so the effect was modeled using an average ship distance, 20 km, and an average number of ships per exercise, in this case three ships.

The formation of ships in any of the above exercised has been determined by Navy planners. The ships are located in a straight line, perpendicular to the direction has traveled. The figures below (D-30 to D-34) show examples with four ships, and their ship tracks.

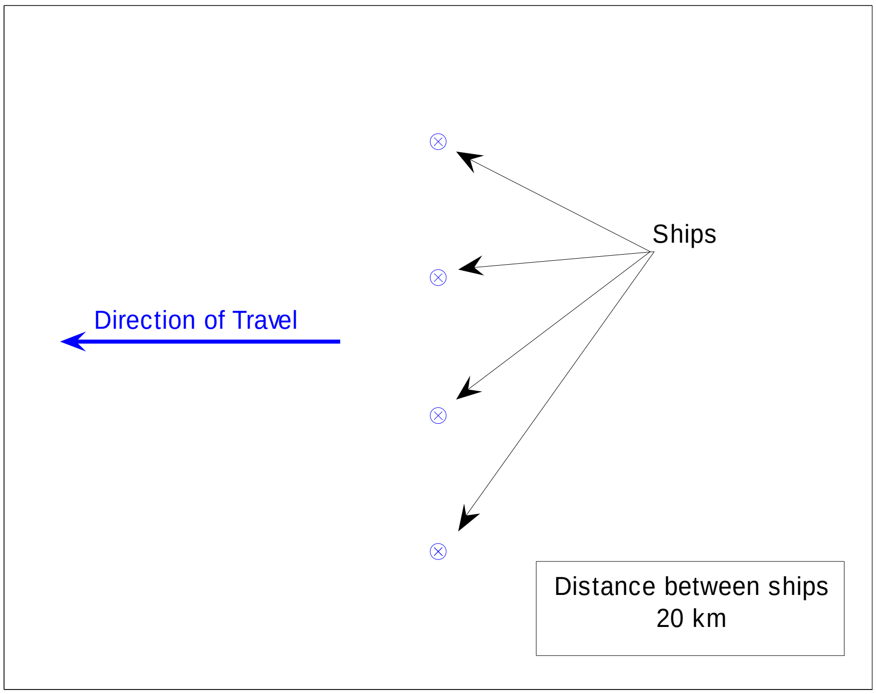

Figure D-30 – Formation and Bearing of Ships in 4-Ship Example

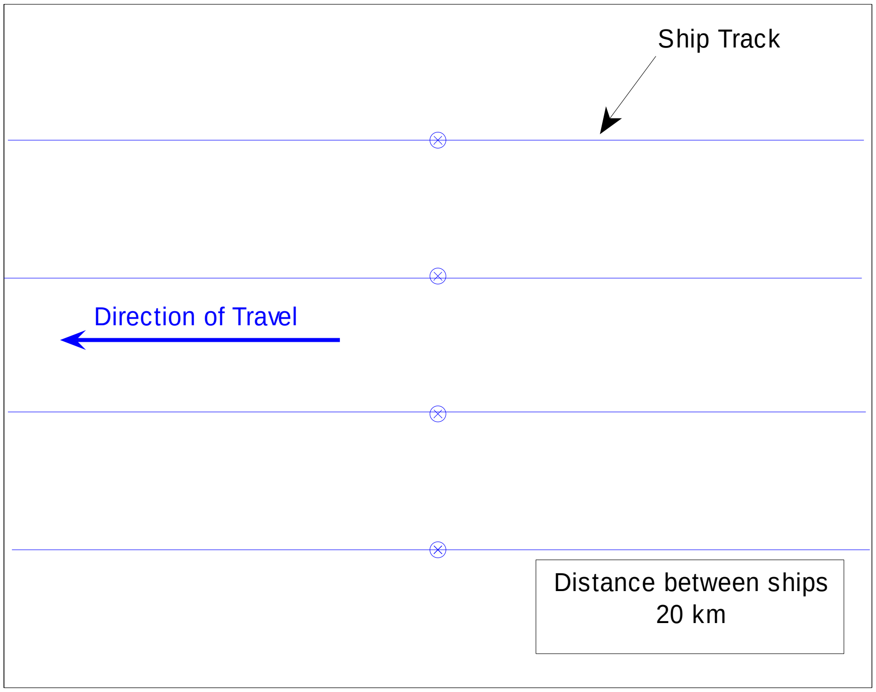

Figure D-31 – Ship Tracks of Ships in 4-Ship Example

The sound field created by these ships, which transmit sonar continually as they travel will be uniform in the direction of travel (or the "*x*" direction), and vary by distance from the ship track in the direction perpendicular to the direction of travel (or the "*y*" direction).

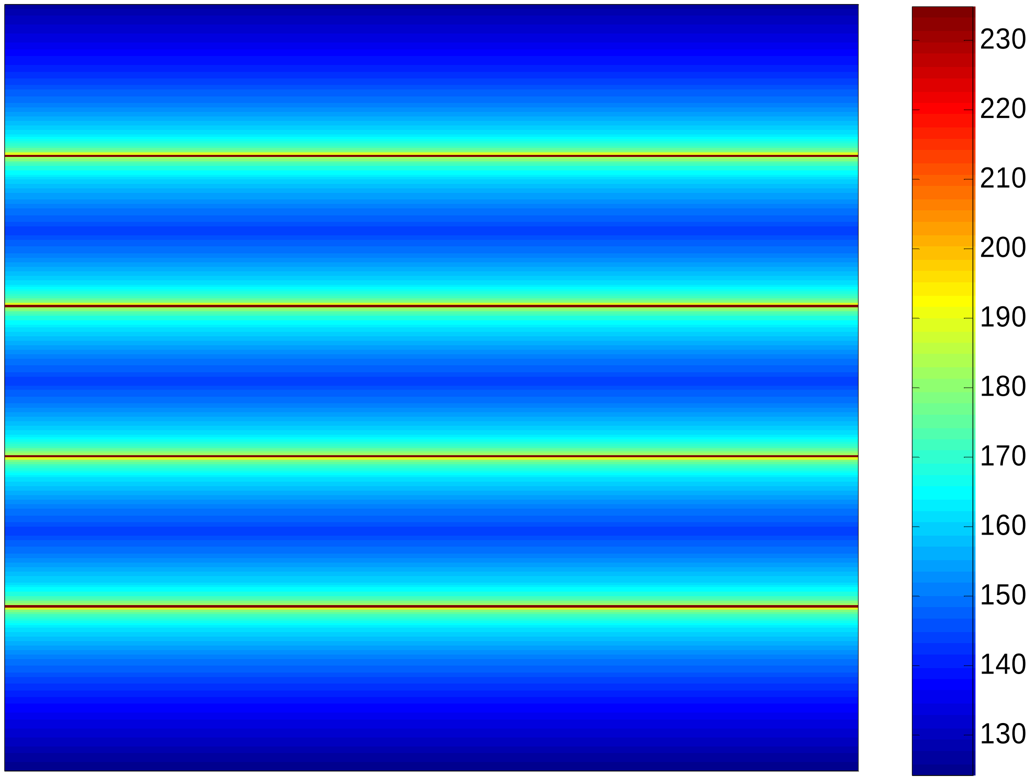

Figure D-32 – Sound Field Produced by Multiple Ships

This sound field of the four ships operating together (Figure D-32) ensonifies less area than four ships operating individually. However, because at the time of modeling, even the average number of ships and mean distances between them were unknown, a post-calculation correction should be applied.

As shown on Figure D-32, the sound field around the ship tracks, the portion above the upper-most ship track, and the portion below the lower-most ship track sum to produce exactly the sound field as an individual ship (Figure D-33).

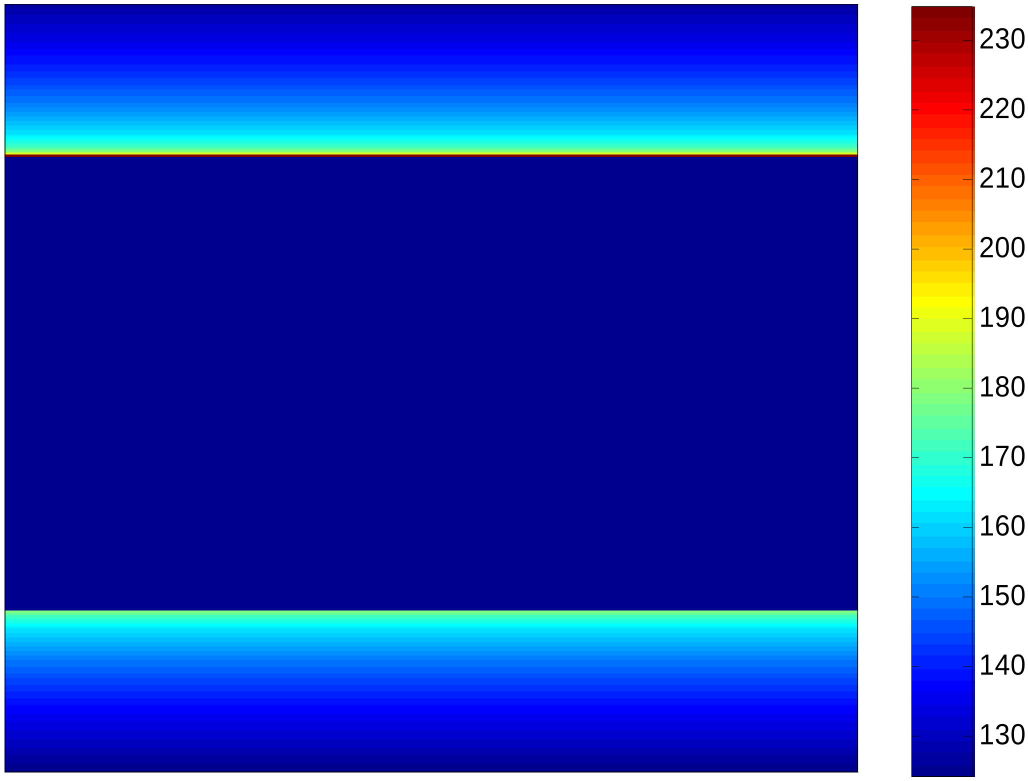

Figure D-33 – Upper and Lower Portion of Sound Field

Therefore, the remaining portion of the sound field, between the uppermost ship track and the lowermost ship track, is the contribution of the three additional ships (Figure D-34).

This remaining sound field is made up of three bands. Each of the three additional ships contributes one band to the sound field. Each band is somewhat less than the contribution of the individual ship because its sound is overcome by the nearer source at the center of the band. Since each ship maintains 20 km distance between it and the next, the height of these bands is 20 km, and the sound from each side projects 10 km before it is overcome by the source on the other side of the band. Thus, the contribution to a sound field for an additional ship is identical to that produced by an individual ship whose sound path is obstructed at 10 km. The work in the previous discussion on land shadow provides a calculation of effect reduction for obstructed sound at each range. An SQS-53-transmitting ship with obstructed signal at 10 kilometers across both seasons causes an average of 95% of the number of harassments as a ship with an unobstructed signal. Therefore, each additional ship causes 0.95 times the harassments of the individual ship. Applying this single-ship factor to the exercise type described earlier (three ships), the adjustment factor given this formation is approximately 2.90.

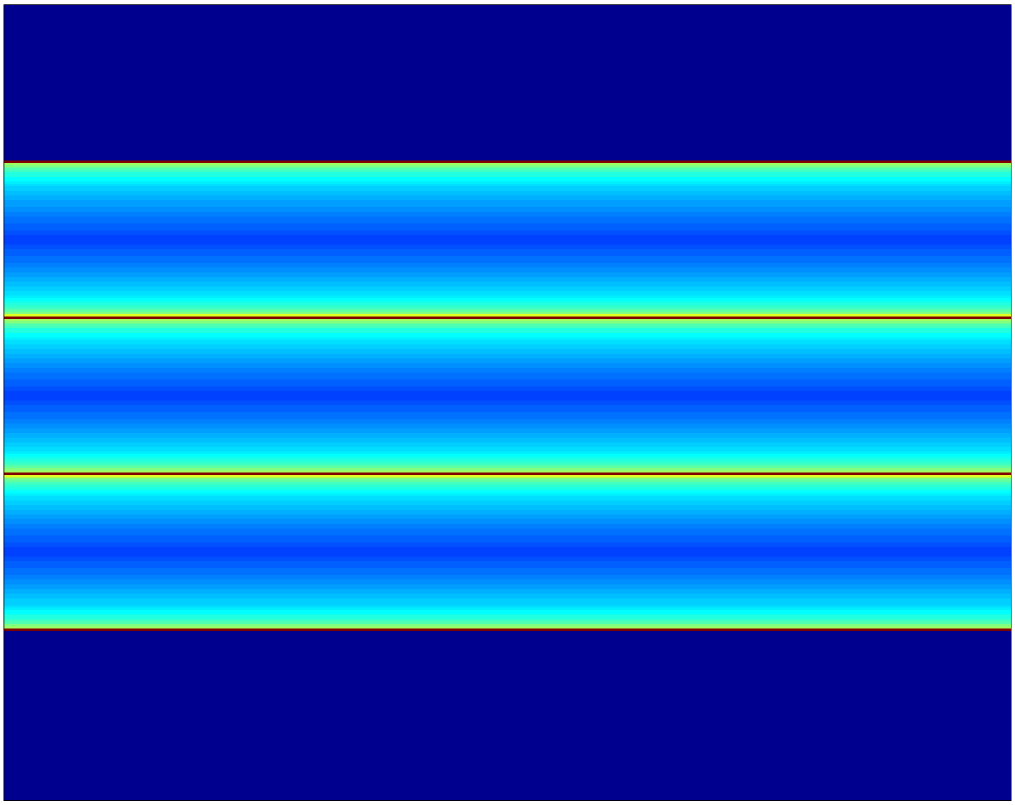

Figure D-34– Central Portion of Sound Field

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Marine Mammal Density Report

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E MARINE MAMMAL DENSITY AND DEPTH DISTRIBUTION

E.1 BACKGROUND AND OVERVIEW

Marine mammal species occurring in the Gulf of Alaska (GOA) and the GOA Temporary Maritime Activities Area (TMAA) include baleen whales (mysticetes), toothed whales (odontocetes), and seals and sea lions (commonly referred to as pinnipeds). Baleen and toothed whales, collectively known as cetaceans, spend their entire lives in the water and spend most of the time (>90% for most species) entirely submerged below the surface. When at the surface, cetacean bodies are almost entirely below the water's surface, with only the blowhole exposed to allow breathing. This makes cetaceans difficult to locate visually and also exposes them to underwater noise, both natural and anthropogenic, essentially 100% of the time because their ears are nearly always below the water's surface. Seals and sea lions (pinnipeds) spend significant amounts of time out of the water during breeding, molting and hauling out periods. In the water, pinnipeds spend varying amounts of time underwater, as some species regularly undertake long, deep dives (e.g., elephant seals) and others are known to rest at the surface in large groups for long amounts of time (e.g., California sea lions). When not actively diving, pinnipeds at the surface often orient their bodies vertically in the water column and often hold their heads above the water surface. Consequently, pinnipeds may not be exposed to underwater sounds to the same extent as cetaceans.

For the purposes of this analysis, we have adopted a conservative approach to underwater noise and marine mammals:

- Cetaceans – assume 100% of time is spent underwater and therefore exposed to noise
- Pinnipeds – adjust densities to account for time periods spent at breeding areas, haulouts, etc.; but for those animals in the water, assume 100% of time is spent underwater and therefore exposed to noise.

E.1.1 Density

Mysticetes regularly occurring in the GOA include fin, minke, humpback and gray whales; blue and North Pacific right whales have been sighted in the GOA, but are considered rare and are included here only for discussion purposes because both are endangered species. Odontocetes regularly occurring include sperm whale, Cuvier's and Baird's beaked whales, killer whale, Pacific white-sided dolphin and Dall's porpoise. Belugas are occasionally sighted in the GOA, but most sightings are in coastal areas and their occurrence in the region is extremely low. Pinnipeds regularly occurring include Steller's sea lion, northern fur seal and northern elephant seal. California sea lion range extends as far north as the Pribilof Islands in the Bering Sea but their occurrence is likely rare.

Recent survey data for marine mammals in the GOA is limited. Most survey efforts are localized and extremely near shore. There is evidence of occurrence of several species based on acoustic studies, but these do not provide measurements of abundance. Best available density data were incorporated from several different sources which are described below and summarized in Table 1.

Fin and Humpback Whales

The Gulf of Alaska Line-Transect Survey (GOALS) was conducted in April 2009 (Rone et al., 2009) in the TMAA. Line-transect visual data and acoustic data were collected over a 10-day period, which resulted in sightings of several odontocete and mysticete species. Densities were derived for fin and humpback whales for inshore and offshore strata (Table 9 in Rone et al., 2009). Densities from each stratum were weighted by the percentage of stratum area compared to the TMAA: inshore stratum was 33% of the total area and offshore stratum was 67% of the total area.

Killer Whale

Vessel surveys were conducted in nearshore areas (within 85 km) of the TMAA in 2001-2003 (Zerbini et al., 2006), between Resurrection Bay on the Kenai Peninsula to Amchitka Island in the Aleutians. Densities were calculated for fin, humpback and killer whales; only those for killer whales are included here (Table 1) because more recent densities for fin and humpback whales are available from Rone et al. (2009). Killer whale densities are from "Block 1" in Zerbini et al. (2006).

Minke, Sperm and Beaked Whales, Pacific White-sided Dolphin and Dall's Porpoise

Waite (2003) conducted vessel surveys for cetaceans near Kenai Peninsula, within Prince William Sound and around Kodiak Island, during acoustic-trawl surveys for pollock in summer 2003. Surveys extended offshore to the 1000 m contour and therefore overlapped with some of the TMAA. Waite (2003) did not calculate densities, but did provide some of the elements necessary for calculating density.

Barlow (2003) provided the following equation for calculating density:

$$\text{Density/km}^2 = \frac{(n)\,(s)\,(f_0)}{(2L)\,(g_0)}$$

Where (n) = number of animal group sightings on effort

(s) = mean group size

f(0) = sighting probability density at zero perpendicular distance (influenced by species detectability and sighting cues such as body size, blows and number of animals in a group)

(L) = transect length completed (km)

g(0) = probability of seeing a group directly on trackline (influenced by perception bias and availability bias)

Three values, n, s, and L, were provided by Waite (2003). Values for f(0) and g(0) were not provided, and were instead assigned based on values from the literature for other vessel survey efforts in the North Pacific (Table 2). Using values calculated from other vessel survey efforts is acceptable in this situation because the correction factors were calculated from vessel surveys that were conducted similarly to the GOA effort. Specifically, factors such as number of observers (three), height of the flying bridge from the water's surface (12 m), ship's speed (11 kts), number of "Bigeyes" binoculars used (two), and acceptable sea state conditions (up to B05) during the GOA survey effort were all comparable to those used during NMFS survey efforts along the west coast of the US, in Hawaii and in the eastern tropical Pacific (see Table 2). Values for f(0) and g(0) are very similar per species between efforts, therefore the most conservative value was adopted for each species and applied to the density calculation.

Table 3 illustrates how the data from Waite (2003) were used to calculate densities using correction factors from Table 2. There are no variances attached to any of the resulting density values, so overall confidence in these values is unknown. Densities based on only one or two sightings generally have fairly high variance.

Gray whales

Gray whale density was calculated from data obtained from a feeding study near Kodiak Island (Moore et al. (2007).

Steller Sea Lion, Northern Fur Seal and Northern Elephant Seal

Pinniped at-sea density is not often available because pinniped abundance is obtained via shore counts of animals at known rookeries and haulouts. Therefore, densities of pinnipeds were derived quite differently from those of cetaceans. Several parameters were identified from the literature, including area of stock occurrence, number of animals (which may vary seasonally) and season, and those parameters were then used to calculate density. Once density per "pinniped season" was determined, those values were prorated to fit the warm water (June-October) and cold water (November-May) seasons. Determining density in this manner is risky as the parameters used usually contain error (e.g., geographic range is not exactly known and needs to be estimated, abundance estimates usually have large variances) and, as is true of all density estimates, it assumes that animals are always distributed evenly within an area which is likely never true. However, this remains one of the few means available to determine at-sea density for pinnipeds.

The Marine Resource Assessment for the Gulf of Alaska Operating Area (Department of the Navy, 2006), listed six mysticetes, twelve odontocetes, and five pinnipeds as occurring or possibly occurring in the GOA region (Department of the Navy, 2006; Table 3-1). However, several of the species listed are rare and do not regularly occur. Brief species summaries are included for all marine mammals whose distribution extends to the GOA, even if rarely seen, and additional information on all species can be found in the Marine Resources Assessment referenced above.

Table 1. Marine mammals in the Gulf of Alaska; densities and season(s) included for species regularly seen.

Common Name	Scientific Name	Status	Density/km2 within TMAA	Season	Source
MYSTICETES					
Blue whale	*Balaenoptera musculus*	Endangered	-		
Fin whale	*B. physalus*	Endangered	0.010	Year round	Rone et al. (2009)
Sei whale	*B. borealis*	Endangered	-		
Minke whale	*B. acutorostrata*		0.0006	Year round	Waite (2003)
Humpback whale	*Megaptera novaeangliae*	Endangered	0.0019	Apr-Dec	Rone et al. (2009)
			-	Jan-Mar	Reeves et al. (2002)
North Pacific right whale	*Eubalaena japonica*	Endangered	-		
Gray whale	*Eschrichtius robustus*		0.0003	Year round	Moore et al. (2007)
ODONTOCETES					
Sperm whale	*Physeter catodon*	Endangered	0.0003	Year round	Waite (2003); Mellinger et al. (2004a)
Cuvier's beaked whale	*Ziphius cavirostris*		0.0022	Year round	Waite (2003)
Baird's beaked whale	*Berardius bairdii*		0.0005	Year round	Waite (2003)
Stejneger's beaked whale	*Mesoplodon stejnegeri*		-		
Killer whale	*Orcinus orca*		0.0100	Year round	Zerbini et al. (2007)
Beluga	*Delphinapterus leucas*		-		
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*		0.0208	Year round	Waite (2003)
Northern right whale dolphin	*Lissodelphis borealis*		-		
Risso's dolphin	*Grampus griseus*		-		
False killer whale	*Pseudorca crassidens*		-		
Short-finned pilot whale	*Globicephala macrorhynchus*		-		
Dall's porpoise	*Phocoenoides dalli*		0.1892	Year round	Waite (2003)
Harbor porpoise	*Phocoena phocoena*		-		
PINNIPEDS					
Steller's sea lion	*Eumetopias jubatus*	Endangered/ Threatened	0.0098	Year round	Angliss and Allen (2009); Bonnell and Bowlby (1992)
California sea lion	*Zalophus californianus*		-		
Harbor seal	*Phoca vitulina*		-		
Northern fur seal	*Callorhinus ursinus*		0.1180	June-October	Carretta et al., 2009
Northern elephant seal	*Mirounga angustirostris*		0.0022	June-October	Carretta et al., 2009

Table 2. Comparison of f(0) and g(0) values, for species being considered from Waite (2003) from survey efforts outside of the TMAA.

Reference	Barlow (2003)		Ferguson and Barlow (2001)		Forney (2007)		Barlow and Forney (2007)		Barlow (2006)		Wade and Gerrodette (1993)
Species	f_0	g_0	f_0	g_0	f_0	g_0	f_0	g_0	f_0	g_0	f_0
Minke whale	**0.567**	**0.84**	0.362	0.84	0.38	0.856	0.46	0.856			
Sperm whale	0.217	**0.87**	**0.462**	0.87	0.36	0.87	0.34	0.87	0.27	0.87	0.14
Baird's beaked whale	0.354	**0.96**	0.215	0.96	0.37	0.96	**0.52**	0.96			
Cuvier's beaked whale	**0.567**	**0.23**	0.362	0.23	0.39	0.23	0.37	0.23	0.61	0.23	0.58
Pacific white-sided dolphin	**0.809**	1	0.519	1	0.4	**0.97**	0.45	0.97			
Dall's porpoise	**1.221**	**0.79**	0.855	0.79	0.74	0.822	0.91	0.822			
Survey region	US West Coast		US West Coast		US West Coast		US West Coast		Hawaii		Eastern Tropical Pacific
Number of observers	3		3		3		3		3		3
Speed of vessel (kts)	9-10		9-10		9-10		9-10		9-10		9-10
Height of flying bridge (m)	10.5		10.5		10.5 and 15.2		10.5 and 15.2		10.5		10.5
Big Eyes binoculars	two pair		two pair		two pair		two pair		two pair		two pair
Sea conditions	up to B05		up to B05		up to B05		up to B05		up to B05		up to B05

Conservative values for each species are bolded

Table 3. Densities calculated from data presented in Waite (2003) using f(0) and g(0) values from Table 2.

Species	n = animal groups on effort[a]	s = mean group size[a]	L = transect length (km^2)[a]	f_0 = perpendicular sighting distance[b]	g_0 = probability of seeing group directly on trackline[b]	Density/km^2 = (n) (s) (f_0) / (2L) (g_0)[c]
Minke whale	3	1.3	2242	0.567	0.84	0.0006
Sperm whale	2	1.2	2242	0.462	0.87	0.0003
Baird's beaked whale	1	4	2242	0.52	0.96	0.0005
Cuvier's beaked whale	1	4	2242	0.567	0.23	0.0022
Pacific white-sided dolphin	2	56	2242	0.809	0.97	0.0208
Dall's porpoise	196	2.8	2242	1.221	0.79	0.1892

[a] from Waite (2003), [b] Values for f0 and g0 taken from Table 12, [c] Calculation taken from Barlow (2003).
There is no variance associated with these density calculations so there is no way to indicate the confidence in the value. Densities from sperm, Pacific white-sided, Baird's and Cuvier's beaked whales are quite weak as they are based on only 1-2 sightings.

E.1.2 Depth Distribution

There are limited depth distribution data for most marine mammals. This is especially true for cetaceans, as they must be tagged at-sea and by using a tag that either must be implanted in the skin/blubber in some manner or adhere to the skin. There is slightly more data for some pinnipeds, as they can be tagged while on shore during breeding or molting seasons and the tags can be glued to the pelage rather than implanted. There are a few different methodologies/ techniques that can be used to determine depth distribution percentages, but by far the most widely used technique currently is the time-depth recorder. These instruments are attached to the animal for a fairly short period of time (several hours to a few days) via a suction cup or glue, and then retrieved immediately after detachment or when the animal returns to the beach. Depth information can also be collected via satellite tags, sonic tags, digital tags, and, for sperm whales, via acoustic tracking of sounds produced by the animal itself.

There are somewhat suitable depth distribution data for a few marine mammal species. Sample sizes are usually extremely small, nearly always fewer than 10 animals total and often only one or two animals. Depth distribution information can also be interpreted from other dive and/or preferred prey characteristics, and from methods including behavioral observations, stomach content analysis and habitat preference analysis. Depth distributions for species for which no data are available were extrapolated from similar species.

Depth distribution information for marine mammal species with regular occurrence and for which densities are available is provided in Table 4. More detailed summary depth information for species in the GOA for which densities are available is included as Table 6.

E.1.3 DENSITY AND DEPTH DISTRIBUTION COMBINED

Density is nearly always reported for an area, e.g., animals/km^2. Analyses of survey results using Distance Sampling techniques include correction factors for animals at the surface but not seen as well as animals below the surface and not seen. Therefore, although the area (e.g., km^2) appears to represent only the surface of the water (two-dimensional), density actually implicitly includes animals anywhere within the water column under that surface area. Density assumes that animals are uniformly distributed within the prescribed area, even though this is likely rarely true. Marine mammals are usually clumped in areas of greater importance, for example, areas of high productivity, lower predation, safe calving, etc. Density can occasionally be calculated for smaller areas that are used regularly by marine mammals, but more often than not, there are insufficient data to calculate density for small areas. Therefore, assuming an even distribution within the prescribed area remains the norm.

The ever-expanding database of marine mammal behavioral and physiological parameters obtained through tagging and other technologies has demonstrated that marine mammals use the water column in various ways, with some species capable of regular deep dives (>800 m) and others regularly diving to <200 m, regardless of the bottom depth. Therefore, assuming that all species are evenly distributed within the water column does not accurately reflect behavior and can present a distorted view of marine mammal distribution in any region.

By combining marine mammal density with depth distribution information, a more accurate three-dimensional density estimate is possible. These 3-D estimates allow more accurate modeling of potential marine mammal exposures from specific noise sources.

This document is organized into taxonomic categories: Mysticetes, Odontocetes and the pseudo-taxonomic category Pinnipeds. Nomenclature was adopted from the Integrated Taxonomic Information System (www.itis.gov). Distribution and density summaries are followed by discussions of depth distribution for those species that have regular occurrence. Density and depth info are **bolded** in text.

Table 4. Summary of marine mammal depth distributions for the TMAA

Common Name	Scientific Name	Depth Distribution	Reference
MYSTICETES - Baleen whales			
Fin whale	*B. physalus*	44% at <50m, 23% at 50-225m, 33% at >225m	Goldbogen et al. (2006)
Minke whale	*B. acutorostrata*	53% at <20m, 47% at 21-65m	Blix and Folkow (1995)
Humpback whale	*Megaptera novaeangliae*	37% at <4m, 25% at 4-20m, 7% at 21-35m,4% at 36-50m, 6% at 51-100m, 7% at 101-150m, 8% at 151-200m, 6% at 201-300m, <1% at >300m	Dietz et al. (2002)
Gray whale	*Eschrichtius robustus*	40% at <4 m, 38% at 4-30 m, 22% at >30 m	Malcolm et al. (1995/96); Malcolm and Duffus (2000)
ODONTOCETES - Toothed whales			
Sperm whale	*Physeter catodon*	31% at <10 m, 8% at 10-200 m, 9% at 201-400 m, 9% at 401-600 m, 9% at 601-800 m and 34% at >800 m	Amano and Yoshioka (2003)
Cuvier's beaked whale	*Ziphius cavirostris*	27% at <2 m, 29% at 2-220 m, 4% at 221-400 m, 4% at 401-600 m, 4% at 601-800 m, 5% at 801-1070 m and 27% at >1070 m	Tyack et al. (2006)
Baird's beaked whale	*Berardius bairdii*	34% at 0-40 m, 39% at 41-800 m, 27% at >800 m	extrapolated from northern bottlenose whale (Hooker and Baird, 1999)
Killer whale	*Orcinus orca*	96% at 0-30 m, 4% at >30 m	Baird et al. (2003)
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	Daytime: 100% at 0-65 m; Nighttime: 100% at 0-130 m	extrapolated from other *Lagenorhynchus* (Mate et al., 1994; Benoit-Bird et al., 2004)
Dall's porpoise	*Phocoenoides dalli*	39% at <1 m, 8% at 1-10 m, 45% at 11-40 m, and 8% at >40 m	Hanson and Baird (1998)
PINNIPEDS			
Northern fur seal	*Callorhinus ursinus*	Daytime: 74% at <2 m; 26% at 2-260 m; Nighttime: 74% at <2 m; 26% at 2-75 m	Ponganis et al. (1992); Kooyman and Goebel (1986); Sterling and Ream (2004); Gentry et al. (1986)
Steller sea lion	*Eumetopias jubatus*	60% at 0-10 m, 22% at 11-20 m, 12% at 21-50 m, 5% at 51-100 m and 1% at >100 m	Merrick and Loughlin (1997)
Northern elephant seal	*Mirounga angustirostris*	9% at <2 m, 11% at 2-100 m, 11% at 101-200 m, 11% at 201-300 m, 11% at 301-400 m, 11% at 401-500 m and 36% at >500 m	Asaga et al. (1994)

E.2 MYSTICETES

E.2.1 Blue whale, *Balaenoptera musculus*

Blue whales were previously sighted and caught throughout the GOA, but are rarely seen in the post-whaling era; two blue whales seen in 2004 during a NMFS humpback whale study and approximately 150 nm southeast of Prince William Sound are the first documented sightings of blue whales in several decades. There may be two to five stocks of blue whale in the north Pacific (Angliss and Allen, 2009).

The Eastern North Pacific population, which winters as far south as the eastern tropical Pacific, has been sighted off Oregon and Washington although sightings are rare and there is no abundance estimate (Angliss and Allen, 2009). Blue whale calls attributed to this stock as well as the Northwestern stock were recorded in the Gulf of Alaska (Stafford, 2003) via hydrophones located offshore of the TMAA. Both call types were recorded seasonally, with peak occurrence from August-November. Blue whales are likely present in low numbers in the GOA; **there is no density estimate available (Table 1)**.

E.2.2 Fin whale, *Balaenoptera physalus*

Fin whales were extensively hunted in coastal waters of Alaska as they congregated at feeding areas in the spring and summer (Mizroch et al., 2009). There has been little effort in the GOA since the cessation of whaling activities to assess abundance of large whale stocks. Fin whale calls have been recorded year-round in the GOA, but are most prevalent from August-February (Moore et al., 1998; 2006). Zerbini et al. (2006) sighted fin whales south of the Kenai Peninsula, and calculated a density of 0.008/km^2 (see Table 4, Block 1 in Zerbini et al., 2006). Waite (2003) recorded 55 fin whale sightings on effort, with several occurring within the TMAA (see Figure 2 in Waite, 2003). Rone et al. (2009) recorded 24 sightings of 64 fin whales during a 10-day cruise in the TMAA in April 2009. Density for the inshore stratum was estimated as 0.012/km^2, while density in the offshore stratum was estimated as 0.009/km^2 (Table 9, Rone et al., 2009). **Combined density for the TMAA was 0.010/km^2, which is applicable to the entire region year round (Table 1).**

Fin whales feed on planktonic crustaceans, including *Thysanoessa* sp and *Calanus* sp, as well as schooling fish including herring, capelin and mackerel (Aguilar, 2002). Depth distribution data from the Ligurian Sea in the Mediterranean are the most complete (Panigada et al., 2003; Panigada et al., 2006), and showed differences between day and night diving; daytime dives were shallower (<100m) and night dives were deeper (>400m), likely taking advantage of nocturnal prey migrations into shallower depths; this data may be atypical of fin whales elsewhere in areas where they do not feed on vertically-migrating prey. Traveling dives in the Ligurian Sea were generally shorter and shallower (mean = 9.8 m, maximum = 20 m) than feeding dives (mean = 181m, maximum = 474 m) (Jahoda et al., 1999). Goldbogen et al. (2006) studied fin whales in southern California and found that ~56% of total time was spent diving, with the other 44% near surface (<50m); dives were to >225 m and were characterized by rapid gliding ascent, foraging lunges near the bottom of dive, and rapid ascent with flukes. Dives are somewhat V-shaped although the bottom of the V is wide. **Therefore, % of time at depth levels is estimated as 44% at <50m, 23% at 50-225 m (covering the ascent and descent times) and 33% at >225 m.**

E.2.3 Sei whale, *Balaenoptera borealis*

Sei whales occur in all oceans from subtropical to sub-arctic waters, and can be found on the shelf as well as in oceanic waters (Reeves et al., 2002). They are known to occur in the GOA and as far north as the Bering Sea in the north Pacific. However, their distribution is poorly understood. The only stock estimate for U.S. waters is for the eastern north Pacific stock offshore California, Oregon and Washington (Carretta et al., 2009); abundance in Alaskan waters is unknown and they were not been sighted during recent surveys (Waite, 2003; Rone et al., 2009). Sei whales are likely present in low numbers in the GOA; **there is no density estimate available (Table 1)**.

E.2.4 Minke whale, *Balaenoptera acutorostrata*

Minke whales are the smallest of all mysticete whales. They are widely distributed in the north Atlantic and Pacific, and appear to undergo migration between warmer waters in winter and colder waters in summer. Minke whales can be found in near shore shallow waters and have been detected acoustically in offshore deep waters. There is no current abundance estimate for the Alaska stock of minke whales (Angliss and Allen, 2009). Zerbini et al. (2006) sighted minke whales near Kodiak Island (and a single sighting nearshore off the Kenai Peninsula), and calculated a density of 0.006/km^2 (see Table 4, Block 3 in Zerbini et al., 2006). Waite (2003) recorded three minke sightings on effort, all southeast of the Kenai

Peninsula (see Figure 2 in Waite, 2003). Rone et al. (2009) sighted three minke whales in April 2009, all of which were in the Nearshore stratum, but no density was calculated. **Density calculated from Waite (2003) data yielded a density of 0.0006/km^2 (Table 1), which is applicable to the entire region year round.** Although this is lower than density calculated by Zerbini et al. (2006), it is likely more representative of minke whale abundance in the region as the Waite (2003) surveys were farther offshore.

Minke whales feed on small schooling fish and krill, and are the smallest of all balaenopterid species which may affect their ability to dive. Hoelzel et al. (1989) observed minke whales feeding off the San Juan Islands of Puget Sound, Washington, where 80% of the feeding occurred over depths of 20-100m and two types of feeding were observed near surface, lunge feeding and bird association. The only depth distribution data for this species were reported from a study on daily energy expenditure conducted off northern Norway and Svalbard (Blix and Folkow, 1995). The limited depth information available (from Figure 2 in Blix and Folkow, 1995) was representative of a 75-min diving sequence where the whale was apparently searching for capelin, then foraging, then searching for another school of capelin. Search dives were mostly to ~20 m, while foraging dives were to 65 m. **Based on this very limited depth information, rough estimates for % of time at depth are as follows: 53% at <20 m and 47% at 21-65 m.**

E.2.5 Humpback whale, *Megaptera novaeangliae*

Humpback whales are found in all oceans, in both coastal and continental waters as well as near seamounts and in deep water during migration (Reeves et al., 2002). Some populations have been extensively studied (e.g., Hawaii, Alaska, Caribbean), and details about migratory timing, feeding and breeding areas are fairly well known (e.g., Calambokidis et al., 2008). Humpbacks are highly migratory, feeding in summer at mid and high latitudes and calving and breeding in winter in tropical or subtropical waters. Humpbacks feeding in the TMAA in summer appear to winter in Hawaiian and Mexican waters (Calambokidis et al., 2008). Humpbacks are present in Alaskan waters during summer and fall, although there may be a few stragglers that remain year round. Waite (2003) recorded 41 humpback whale sightings on effort, with several occurring near shore around the Kenai Peninsula (see Figure 2 in Waite, 2003). Rone et al. (2009) recorded 11 sightings of 20 individuals during a 10-day cruise in the TMAA in April 2009. Density for the inshore stratum was estimated as 0.004/km^2, while density in the offshore stratum was estimated as 0.0005/km^2 (Table 9, Rone et al., 2009). **Combined density for the TMAA was 0.0019/km^2, which is applicable to the entire region year round (Table 1).** Calambokidis et al. (2008) estimated 3,000-5,000 humpbacks in the entire GOA, an area much larger than the TMAA.

Humpback whales feed on pelagic schooling euphausiids and small fish including capelin, herring and mackerel (Clapham, 2002). Like other large mysticetes, they are a “lunge feeder” taking advantage of dense prey patches and engulfing as much food as possible in a single gulp. They also blow nets, or curtains, of bubbles around or below prey patches to concentrate the prey in one area, then lunge with open mouths through the middle. Dives appear to be closely correlated with the depths of prey patches, which vary from location to location. In the north Pacific, most dives were of fairly short duration (<4 min) with the deepest dive to 148 m (southeast Alaska; Dolphin, 1987), while whales observed feeding on Stellwagen Bank in the North Atlantic dove to <40 m (Hain et al., 1995). Hamilton et al. (1997) tracked one possibly feeding whale near Bermuda to 240 m depth. Depth distribution data collected at a feeding area in Greenland resulted in the following estimation of depth distribution: **37% of time at <4 m, 25% of time at 4-20 m, 7% of time at 21-35m, 4% of time at 36-50 m, 6% of time at 51-100 m, 7% of time at 101-150 m, 8% of time at 151-200 m, 6% of time at 201-300 m, and <1% at >300 m** (Dietz et al., 2002).

E.2.6 North Pacific right whale, *Eubalaena japonica*

North Pacific right whales were heavily hunted near Kodiak Island from the mid-1800s through the early 1900s. Despite international protection, the species has not recovered and remains one of the rarest of all cetaceans. There have been only two verified sightings of right whales in the GOA since the 1970s, with one occurring very near Kodiak Island (Shelden et al., 2005). Regular sightings of right whales do occur in the southeastern Bering Sea in summer, where up to 13 individual whales have been identified based on photos and biopsy dart data, but their winter habitat remains unknown. Acoustic monitoring for right whales was carried out via autonomous hydrophones in 2000-2001 near Kodiak Island, and right whale calls were recorded in August and early September (Moore et al., 2006; Mellinger et al., 2004b). Right whales are likely present in extremely low numbers in the GOA; **there is no density estimate available (Table 1).**

E.2.7 Gray whale, *Eschrichtius robustus*

The current stock estimate for the eastern north Pacific stock of gray whales is 18,813 (Angliss and Allen, 2009). Gray whales undertake a well-documented migration from winter calving lagoons in Baja California to summer feeding areas in the Bering and Chukchi seas (Swartz et al., 2006). Their migration route is primarily near shore in shallow water, although gray whales have been documented swimming offshore near the Channel Islands in the Southern California Bight. In addition to the Bering and Chukchi sea feeding areas, gray whales are known to feed opportunistically at several locations along the migratory route. Two such areas are near Ugak Bay, Kodiak Island, and along the outer coast of southeast Alaska where 30-50 gray whales have been sighted feeding year round (Moore et al., 2007). Gray whales would not be found in most of the TMAA but likely do cross the northernmost section (estimated at 2,400 km^2 via ArcMap and representing 2.75% of the total TMAA; 2,400 km^2/87,250 km^2 as measured in ArcMap) migrating to and from both local and distant feeding grounds. Rone et al. (2009) recorded three sightings of eight gray whales (see Figure 3 in Rone), which were located nearshore at Kodiak Island to the west of the TMAA and in the westernmost section of the TMAA on the continental shelf. The number of gray whales within the TMAA at any given time is likely quite small as it is probably at the deeper limit of their occurrence. Therefore, the lower estimate of Kodiak Island feeding gray whales from Moore et al. (2007) was used to estimate density. **Density was estimated at 0.0125/km^2 (30 gray whales/2,400 km^2) year round, and is applicable only for the farthest north area of the TMAA (2.75 % of area, see Figure 1) for an overall density for the TMAA of 0.0003/km^2 (Table 1).**

Gray whales migrate from breeding and calving grounds in Baja California to primary feeding grounds in the Bering and Chukchi Seas between Alaska and Russia. Behavior, including diving depth and frequency, can vary greatly between geographic regions. Gray whales feed on the bottom, mainly on benthic amphipods that are filtered from the sediment (Reeves et al., 2002), so dive depth is dependent on depth at location for foraging whales. There have been several studies of gray whale movement within the Baja lagoons (Harvey and Mate, 1984; Mate and Harvey, 1984), but these are likely not applicable to gray whales elsewhere. Mate and Urban Ramirez (2003) noted that 30 of 36 locations for a migratory gray whale with a satellite tag were in water <100m deep, with the deeper water locations all in the southern California Bight within the Channel Islands. There has been only one study of a gray whale dive profile, and all information was collected from a single animal that was foraging off the west coast of Vancouver Island (Malcolm and Duffus, 2000; Malcolm et al.,1995/96). They noted that the majority of time was spent near the surface on interventilation dives (<3 m depth) and near the bottom (extremely nearshore in a protected bay with mean dive depth of 18 m, range 14-22 m depth). There was very little time spent in the water column between surface and bottom. Foraging depth on summer feeding grounds is generally between 50-60 m (Jones and Swartz, 2002). Based on this very limited information, **the following is a rough estimate of depth distribution for gray whales: 40% of time at <4 m (surface and interventilation dives), 38% of time at 3-30 m (active migration), 22% of time at >30 m (foraging).**

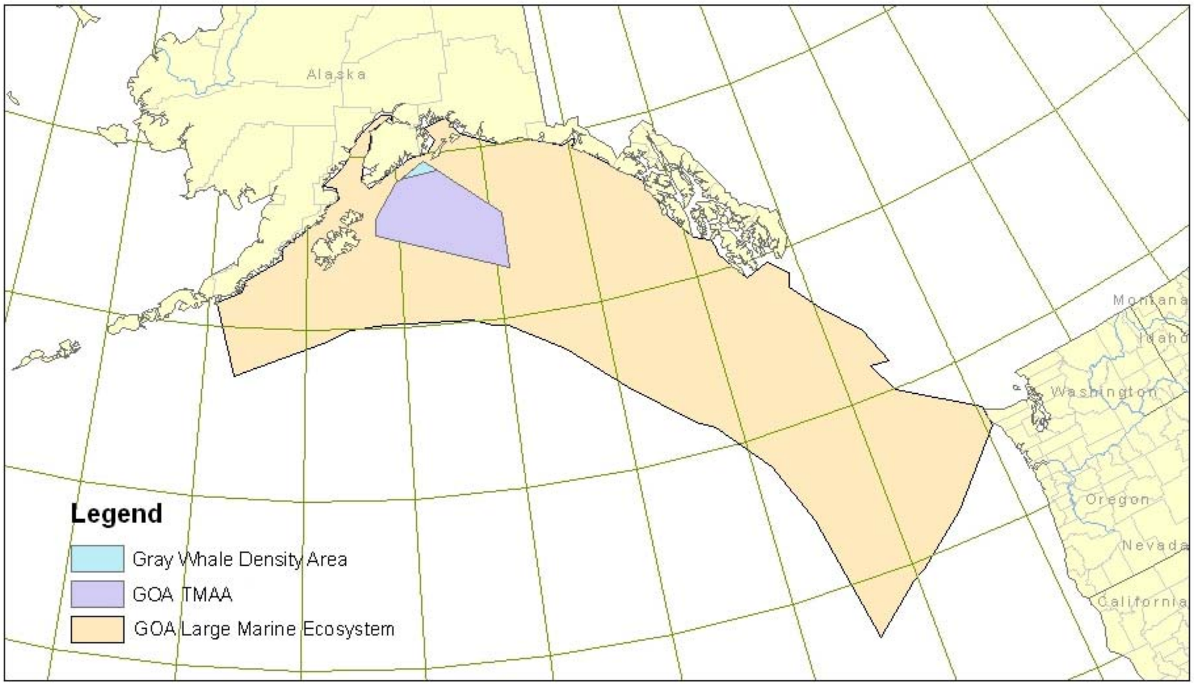

Figure E-1. TMAA, GOA Large Marine Ecosystem and Gray Whale Density Area.

E.3 ODONTOCETES

E.3.1 Sperm whale, *Physeter catodon*

Sperm whales are well known from the GOA region. Sperm whales are most often found in deep water, near submarine canyons, and along the edges of banks and over continental slopes (Reeves et al., 2002). Acoustic evidence collected via autonomous recorders suggests that sperm whales are present in the offshore regions of the GOA year round (see Figure 2 in Mellinger et al., 2004a). Rone et al. (2009; Figure 8) recorded sperm whales acoustically in both the inshore and offshore strata of the TMAA in April 2009; no sperm whales were detected visually. Waite (2003) recorded two on-effort sightings of sperm whales; both within the TMAA (see Figure 2 in Waite, 2003). **Data from vessel surveys conducted by Waite (2003) yielded a density of 0.0003/km^2 (Table 1), which is applicable to the entire region year round.** Density was based on only two sightings, so confidence in the value is low, but it is the only density that exists at this time for the region.

Unlike other cetaceans, there is a preponderance of dive information for this species, most likely because it is the deepest diver of all cetacean species so generates a lot of interest. Sperm whales feed on large and medium-sized squid, octopus, rays and sharks, on or near the ocean floor (Whitehead, 2002; Clarke, 1986). Some evidence suggests that they do not always dive to the bottom of the sea floor (likely if food is elsewhere in the water column), but that they do generally feed at the bottom of the dive. Davis et al. (2007) report that dive-depths (100-500 m) of sperm whales in the Gulf of California overlapped with depth distributions (200-400 m) of jumbo squid, based on data from satellite-linked dive recorders placed on both species, particularly during daytime hours. Their research also showed that sperm whales foraged throughout a 24-hour period, and that they rarely dove to the sea floor bottom (>1000 m). The most consistent sperm whale dive type is U-shaped, during which the whale makes a rapid descent to the bottom of the dive, forages at various velocities while at depth (likely while chasing prey) and then ascends rapidly to the surface. There is some evidence that male sperm whales, feeding at higher latitudes during summer months, may forage at several depths including <200 m, and utilize different strategies depending on position in the water column (Teloni et al., 2007). Perhaps the best source for depth distribution data comes from Amano and Yoshioka (2003), who attached a tag to a female sperm whale near Japan in an area where water depth was 1000-1500m. Based on values in Table 1 (in Amano and Yoskioka, 2003) for dives with active bottom periods, the total dive sequence was 45.9 min (mean surface time plus dive duration). Mean post-dive surface time divided by total time (8.5/45.9) plus time at surface between deep dive sequences yields a percentage of time at the surface (<10 m) of 31%. Mean bottom time divided by total time (17.5/45.9) and adjusted to include the percentage of time at the surface between dives, yields a percentage of time at the bottom of the dive (in this case >800 m as the mean maximum depth was 840 m) of 34%. Total time in the water column descending or ascending results from the duration of dive minus bottom time (37.4-17.5) or ~20 minutes. Assuming a fairly equal descent and ascent rate (as shown in Table 1 in Amano and Yoshioka) and a fairly consistent descent/ascent rate over depth, we assume 10 minutes each for descent and ascent and equal amounts of time in each depth gradient in either direction. Therefore, 0-200 m = 2.5 minutes one direction (which correlates well with the descent/ascent rates provided) and therefore 5 minutes for both directions. The same is applied to 201-400 m, 401-600 m and 601-800 m. **Therefore, the depth distribution for sperm whales based on information in the Amano paper is: 31% in <10 m, 8% in 10-200 m, 9% in 201-400 m, 9% in 401-600 m, 9% in 601-800 m and 34% in >800 m.** The percentages derived above from data in Amano and Yoshioka (2003) are in fairly close agreement with those derived from Table 1 in Watwood et al. (2006) for sperm whales in the Ligurian Sea, Atlantic Ocean and Gulf of Mexico.

E.3.2 Cuvier's beaked whale, *Ziphius cavirostris*

Cuvier's beaked whale has the widest distribution of all beaked whales, and occurs in all oceans. It is most often found in deep offshore waters, and appear to prefer slope waters with steep depth gradients. There are no reliable population estimates for this species in Alaskan waters (Angliss and Allen, 2009). **Data from vessel surveys conducted by Waite (2003) yielded a density of 0.0022/km^2 (Table 1), which is applicable to the entire region year round.** Density was based on a single sighting, so confidence in the value is low, but it is the only density available for this region.

Cuvier's feed on mesopelagic or deep water benthic organisms, particularly squid (Heyning, 2002). Stomach content analyses indicate that they take advantage of a larger range of prey species than do other deep divers (e.g., Santos et al., 2001; Blanco and Raga, 2000). Cuvier's, like other beaked whales, are likely suction feeders based on the relative lack of teeth and enlarged hyoid bone and tongue muscles. Foraging dive patterns appear to be U-shaped, although inter-ventilation dives are shallower and have a parabolic shape (Baird et al., 2006a). Depth distribution studies in Hawaii (Baird et al., 2005a; Baird et al., 2006a) found that Cuvier's undertook three or four different types of dives, including intermediate (to depths of 292-568 m), deep (>1000 m) and short-inter-ventilation (within 2-3 m of surface); this study was of a single animal. Studies in the Ligurian Sea indicated that Cuvier's beaked whales dived to >1000 m and usually started "clicking" (actively searching for prey) around 475 m (Johnson et al., 2004; Soto et al., 2006). Clicking continued at depths and ceased once ascent to the surface began, indicating active foraging at depth. In both locations, Cuvier's spent more time in deeper water than did Blainville's beaked whale, although maximum dive depths were similar. There was no significant difference between day and night diving indicating that preferred prey likely does not undergo vertical migrations.

Dive information for Cuvier's was collected in the Ligurian Sea (Mediterranean) via DTAGs on a total of seven animals (Tyack et al., 2006) and, despite the geographic difference and the author's cautions about the limits of the data set, the Ligurian Sea dataset represents a more complete snapshot than that from Hawaii (Baird et al., 2006a). Cuvier's conducted two types of dives – U-shaped deep foraging dives (DFD) and shallow duration dives. Dive cycle commenced at the start of a DFD and ended at the start of the next DFD, and included shallow duration dives made in between DFD.

Mean length of dive cycle = 121.4 min (mean DFD plus mean Inter-deep dive interval)

Number of DFD recorded = 28

Mean DFD depth = 1070 m (range 689-1888 m)

Mean length DFD = 58.0 min

Mean Vocal phase duration = 32.8 min

Mean inter-deep dive interval = 63.4 min

Mean shallow duration dive = 221 m (range 22-425 m)

Mean # shallow duration dives per cycle = 2 (range 0-7)

Mean length of shallow duration dives = 15.2 min

Total time at surface (0-2 m) was calculated by subtracting the mean length of DFD and two shallow duration dives from the total dive cycle (121.4 - 58.0 – 30.4 = 33 min). Total time at deepest depth was taken from the Vocal phase duration time, as echolocation clicks generally commenced when animals were deepest, and was 32.8 min. The amount of time spent descending and ascending on DFDs was calculated by subtracting the mean Vocal phase duration time from the mean total DFD (58.0 - 32.8 = 25.2 min) and then dividing by five (# of 200 m depth categories between surface and 1070 m) which equals ~five min per 200 m. The five-minute value was applied to each 200 m depth category from 400-1070 m; for the 2-220 m category, the mean length of shallow duration dives was added to the time for descent/ascent (30.4 + 5 = 35.4 min). **Therefore, the depth distribution for Cuvier's beaked whales based on best available information from Tyack et al. (2006) is: 27% at <2 m, 29% at 2-220 m, 4% at 221-400 m, 4% at 401-600 m, 4% at 601-800 m, 5% at 801-1070 m and 27% in >1070 m.**

E.3.3 Baird's beaked whale, *Berardius bairdii*

Baird's beaked whales, like most beaked whales, are a deep water species that inhabits the north Pacific. They generally occur close to shore only in areas with a narrow continental shelf. There is no reliable population estimate for this species in Alaskan waters (Angliss and Allen, 2009). **Data from vessel surveys conducted by Waite (2003) yielded a density of 0.0005/km^2 (Table 1), which is applicable to the entire region year round.** Density was based on a single sighting, so confidence in the value is low, but it is the only density available for this region.

There are no depth distribution data for this species. Studies conducted on the diet of Baird's from stomach content analysis reveal some insight into feeding patterns. Samples collected off the Pacific coast of Honshu, Japan, revealed a preference primarily for benthopelagic fish (87%) and cephalopods (13%), while samples collected in the southern Sea of Okhotsk were primarily cephalopods (Walker et al., 2002). Other stomach samples collected from same geographic regions indicated demersal fish were the most commonly identified prey, and that Baird's were feeding at the bottommost depths of at least 1000 m (Ohizumi et al., 2003). The overall dive behavior of this beaked whale is not known (e.g., shape of dive, interventilation dives, etc). In lieu of other information, the depth distribution for northern bottlenose whales, *Hyperoodon ampullatus,* will be extrapolated to Baird's. There has been one study on northern bottlenose whales, which provides some guidance as to depth distribution (Hooker and Baird, 1999). Most (62-70%, average = 66%) of the time was spent diving (deeper than 40 m), and most dives were somewhat V-shaped. Both shallow dives (<400 m) and deep dives (>800 m) were recorded, and whales spent 24-30% (therefore, average of 27%) of dives at 85% maximum depth indicating they feed near the bottom. Using these data points, we **estimate 34% of time at 0-40 m, 39% at 41-800 m, 27% at >800 m for *H. ampullatus* and extrapolate this to *B. berardius*.**

E.3.4 Stejneger's beaked whale, *Mesoplodon stejnegeri*

Stejneger's beaked whale is known from the north Pacific only, ranging in subarctic and cool temperate waters. It is likely the only mesoplodont whale to be found in the GOA, as other *Mesoplodon* species do not range that far north. There is no abundance estimate for this species, as it is rarely seen at-sea and is most often recorded via stranding events (Angliss and Allen, 2009). Stejneger's beaked whales are likely present in low numbers in the GOA; **there is no density estimate available (Table 1)**.

E.3.5 Killer whale, *Orcinus orca*

There are two stocks of killer whales in the north Pacific whose ranges overlap in the GOA, but who differ in feeding preferences, acoustics and genetics. The Alaska Resident stock feeds primarily on fish, ranges from southeast Alaska to the Aleutian Islands and Bering Sea, and has a minimum population estimate of 1,123 based on photo ID (Angliss and Allen, 2009). The Gulf of Alaska, Aleutian Islands and Bering Sea Transient stock feeds primarily on other marine mammals and ranges farther offshore in the GOA than the resident stock, as well as to the Aleutian Islands and Bering Sea. The minimum estimate based on photo ID for that population is 314. Vessel surveys for killer whales were conducted in July and August from 2001-2003 near Steller sea lion haulouts from the Kenai Peninsula to Amchitka Pass in the Aleutian Islands (Zerbini et al., 2007). The surveys did not venture far from shore but do provide density estimates for transient and resident stocks. **Survey blocks closest to the TMAA (blocks 2-5) had an average density of 0.010/km^2 resident killer whales (IGS density which the authors indicate is more appropriate for resident killer whales), which is applicable to the entire region year round (Table 3).** Killer whales were seen and heard during a vessel cruise in the TMAA in April 2009 (Rone et al., 2009; Figures 4 and 8), but density was not calculated.

Diving studies on killer whales have been undertaken mainly on "resident" (fish-eating) killer whales in the Puget Sound and may not be applicable across all populations of killer whales. Diving is usually related to foraging, and mammal-eating killer whales may display different dive patterns. Killer whales in one study (Baird et al., 2005b) dove as deep as 264 m, and males dove more frequently and more often to depths >100 m than females, with fewer deep dives at night. Using best available data from Baird et al. (2003), it would appear that **killer whales spend ~4% of time at depths >30 m and 96% of time at depths <30 m**. Dives to deeper depths were often characterized by velocity bursts which may be associated with foraging or social activities.

E.3.6 Beluga, *Delphinapterus leucas*

A genetically and geographically discrete population of belugas exists in Cook Inlet. Scattered sightings of belugas in the northern GOA have been recorded since the mid-1970s, and these animals may be part of the Cook Inlet stock (Laidre et al., 2000) or may be part of a group of belugas that appear to be resident to Yakutat Bay (O'Corry-Crowe et al., 2006). An in-depth review of 13 dedicated cetacean surveys in the GOA found that all northern GOA sightings were coastal and none were reported in offshore areas. **No density is available (Table 1).**

E.3.7 Pacific white-sided dolphin, *Lagenorhychus obliquidens*

Pacific white-sided dolphins range throughout the north Pacific in cold temperate waters. Movements between inshore/offshore and north/south are not well understood. The north Pacific stock of this species, which ranges from British Columbia across the north Pacific and including the GOA, is currently estimated to have a minimum abundance of 26,880 based on data collected from 1987-90 (Angliss and Allen, 2009). **Data from vessel surveys conducted by Waite (2003) yielded a density of 0.0208/km^2 (Table 1), which is applicable to the entire region year round.** This density was based on just two sightings so confidence in this value is low, but it is the only density available for this region. Rone et al. (2009) collected one sighting of 60 Pacific white-sided dolphins during the April 2009 cruise; the sighting was outside of the TMAA, south of Kodiak Island (See Figure 4 in Rone).

Pacific white-sided dolphins are generalist feeders (von Waerebeek and Wursig, 2002). Studies on diving by this species have not been undertaken. Satellite tag studies of a rehabilitated related species (*Lagenorhynchus acutus*) in the Gulf of Maine indicated that nearly all time was spent in waters <100 m total depth with largely directed movement (Mate et al., 1994). Another related species, *Lagenorhynchus obscurus*, was observed feeding in two circumstances; at night to 130 m depth to take advantage of the deep scattering layer closer to the surface and during the day in shallower depths (<65 m) where they fed on schooling fish (Benoit-Bird et al., 2004). **In lieu of the lack of other data available for this Pacific lags, the following are very rough estimates of time at depth: daytime - 100% at 0-65 M; night time – 100% at 0-130 m.**

E.3.8 Northern right whale dolphin, *Lissodelphis borealis*

The northern right whale dolphin occurs in a band across the north Pacific, generally between 34˚ and 47˚N (Reeves et al., 2002). They are primarily an open ocean species, and rarely come near shore. Their presence in the GOA is unknown but, based on the lack of sightings of this gregarious species, is likely rare; **there is no density for this species (Table 1)**.

E.3.9 Risso's dolphin, *Grampus griseus*

This species is known from tropical and warm temperate oceans, primarily in waters with surface temperatures between 50 and 82˚F (Reeves et al., 2002). Their presence in the GOA is likely extremely rare and extralimital; **there is no density for this species (Table 1).**

E.3.10 False killer whale, *Pseudorca crassidens*

False killer whales are found from tropical to warm temperate waters, with well known populations near Japan and in the eastern tropical Pacific. They were not seen along the Pacific US coast during surveys conducted from 1986-2001 (Ferguson and Barlow, 2003; Barlow, 2003) nor in 2005 (Forney, 2007), although they have occasionally been sighted as far north as British Columbia (Reeves et al., 2002). Their presence in the GOA is likely extremely rare and extralimital; **there is no density for this species (Table 1).**

E.3.11 Short-finned pilot whale, *Globicephala macrorhynchus*

This species is known from tropical and warm temperate waters and, in the northeast Pacific, its distribution likely extends as far north as Vancouver Island (Reeves et al., 2002). Pilot whales were not seen during vessel surveys conducted offshore Washington and Oregon in 1996 or 2001 (Barlow, 2003) and there was only one sighting during surveys conducted in 2005 (Forney, 2007). Their presence in the GOA is likely extremely rare and extralimital; **there is no density for this species (Table 1).**

E.3.12 Dall's porpoise, *Phocoenoides dalli*

Dall's porpoises are endemic to the north Pacific, ranging north of ~32˚N into the Bering Sea. It is generally found in deep, cool waters but is also common in coastal areas. The Alaska stock is currently estimated at 83,400 animals (Angliss and Allen, 2009). Waite (2003) sighted Dall's porpoise frequently throughout their study area, including several sightings south of the Kenai Peninsula and therefore within the TMAA. **Data from vessel surveys conducted by Waite (2003) yielded a density of 0.1892/km^2 (Table 1), which is applicable to the entire region year round.** Rone et al. (2009; Figure 4) recorded 10 sightings of 59 Dall's porpoise in both the inshore and offshore strata, but density was not calculated.

Dall's porpoise feed on a wide variety of schooling fish, including herring and anchovies, mesopelagic fish including deep-sea smelts, and squids (a, 2002). One study of this species includes dive information for a single animal (Hanson and Baird, 1998). The authors concluded that the animal responded to the TDR tag for the initial eight minutes it was in place. Therefore, using data only from dives 7-17 (after the abnormally deep high velocity dive) in Table 2 of Hanson and Baird (1998), total time of the sequence was 26.5 min (from start of dive 7 to end of dive 17). Total time at the surface was 10.27 min (time between dives minus the dive durations). Dives within 10 m totaled 2.11 min, dives to >60 m totaled 0.4 min, and dives with bottom time between 41 and 60 m totaled 1.83 min. The remaining time can be assumed to be spent diving between 11 and 40 m. **Based on this information, the depth distribution can be estimated as 39% at <1 m, 8% at 1-10 m, 45% at 11-40 m, and 8% at >40 m.**

E.3.13 Harbor porpoise, *Phocoena phocoena*

Harbor porpoise are found in coastal regions of northern temperate and subarctic waters (Reeves et al., 2002). To determine abundance of harbor porpoises in southern Alaska, Dahlheim et al. (2000) conducted aerial surveys from 1991-1993 only within 30 km of shore, based on data from Dohl et al. (1983) that indicated that harbor porpoise off California were almost exclusively within 0.25 nm of shore. Sightings around Kodiak Island were clustered in near shore bays on the north side of the island, with only two sightings up to 30 km offshore (see Figures 2 and 4 in Dahlheim et al., 2000). Harbor porpoise are generally not found in water deeper than 100 m, and decline linearly as depth increases (Carretta et al., 2001; Barlow, 1988; Angliss and Allen, 2009). A survey conducted in the GOA in June 2003 yielded a single sighting of two individuals (Waite, 2003). The vessel survey conducted in April 2009 yielded 30 sightings of 89 harbor porpoise, most of which were outside of the TMAA (Rone et al., 2009; Figure 4). The coastal distribution and limitation to shallower depths make it likely that harbor porpoises would not be within the TMAA; **there is no density for this species (Table 1)**.

E.4 PINNIPEDS

E.4.1 Steller's sea lion, *Eumetopias jubatus*

The range of the Steller's sea lion (SSL) crosses the north Pacific from Japan to northern California. This species does not undergo extensive migrations but will disperse widely during the non-breeding season. There are two US stocks, which are delineated based on location of rookeries. The Western US stock, listed as Endangered, encompasses SSL using rookeries west of 144˚W, and the Eastern US stock, listed as Threatened, include SSL whose rookeries are east of 144˚W. SSL from both stocks likely use the TMAA. Most SSL remain fairly close to rookeries and haulouts throughout the year, with adult females with pups averaging 17 km trip length in summer and 130 km trip length in winter; however foraging trips extended to >500 km offshore (Loughlin, 2002; Merrick and Loughlin, 1997) which encompasses the entire TMAA. Foraging trips are interspersed with time spent at haulouts throughout the year, and different age and sex classes molt at different times from late summer through early winter. Consequently, at any particular time during the year, at least some portion of the population will be at-sea. Call et al. (2007) found that the duration of at-sea and on-shore cycles of juvenile SSL differed between regions. In the Aleutian Islands and GOA, juvenile SSL departed at dusk and returned to haul out just prior to sunrise, while juvenile SSL in southeast Alaska departed throughout the day. Time of day departures and length of time at-sea are likely related to foraging opportunities and the distance/depth required for juveniles to travel finding food.

Pinniped at-sea density is not generally calculated because they are counted much more easily while on shore. Therefore, to determine densities of SSL in the TMAA, two sets of parameters need to be identified – the specific area and the number of animals. The area of the TMAA (measured in ArcMap) is ~87,250 km^2 (Figure 1). This represents 6.25% of the entire GOA Large Marine Ecosystem (LME) as defined by NOAA (www.lme.noaa.gov), and measured via ArcMap (~1,396,800 km^2, not including inland passages). The GOA LME extends from the Alaska Peninsula in the west to the British Columbia-Washington border in the east. To determine the number of SSL in the GOA LME, the most recent counts of adult, juvenile and pup SSL at rookeries in the GOA (pups = 4,518, non-pups = 13,892; data from 2004-2005), southeast Alaska (n=20,793, data from 2005) and British Columbia (n=15,402, data from 2002) were combined for a total of 54,605 SSL (Angliss and Allen, 2009). These are considered minimum counts, as they were not corrected for animals not counted because they were at sea. Bonnell and Bowlby (1992) estimated that 25% of the SSL sea lion population was feeding at sea at any given time. Therefore, 13,651

SSL (54,605 * 0.25) would be expected feeding at-sea in the GOA LME. To estimate the number within the TMAA, the number of SSL in the entire GOA (13,651) was multiplied by the percent area of the TMAA compared to the GOA LME (0.0625) for a total of 853 SSL. **Density was then calculated as 853 SSL/87,250 km^2, or 0.0098/km^2, which is applicable to the entire region year round (Table 1).**

Acoustic modeling was calculated for two seasons, warm (June-October) and cold (November-May) water. Pinniped densities were therefore averaged to these two seasons by summing monthly densities and dividing by the number of months in each season (Table 5). For Steller sea lions the warm and cold water densities are the same, as densities are expected to remain consistent throughout the year.

Steller sea lions feed on fishes and invertebrates, including walleye pollock, Pacific cod, mackerel, octopus, squid and herring (Loughlin, 2002). Ongoing studies of SSL diving behavior have been conducted by NMFS in Alaska and Washington as part of an overall effort to determine why sea lion populations have been steadily declining (Merrick and Loughlin, 1997; Loughlin et al., 2003). Tagging studies often focus on different age classes (weanling, young of year, adult female). Steller sea lion prey changes depending on the season, with some prey moving farther offshore in winter, which affects maximum depth. Females dived the longest and deepest, with young of the year and weanlings having lesser values for both categories (Call et al., 2007; Loughlin et al., 2003). Adult males generally disperse farthest (commonly 120 km but as far as 500 km) from haulouts (Raum-Suryan et al., 2004). Loughlin et al. (2003) recorded maximum dive depth of 328 m, although most dives were shallower. Some SSL appear to take advantage of vertically migrating prey, leaving haulouts at dusk and returning at dawn (Call et al., 2007) but other SSL appear to feed throughout daylight hours as well. Because all age classes may be in the water at any given time, the depth distribution was estimated from the proportion of dives per depth range for all age classes (Merrick and Loughlin, 1997; Figures 4 and 2, respectively). **Based on this information, the depth distribution can be roughly estimated at 60% at 0-10 m, 22% at 11-20 m, 12% at 21-50 m, 5% at 51-100 m and 1% at >100 m.**

Table 5. Averaging of Stellers sea lion, Northern fur seal, and Northern elephant seal densities to fit warm (June-October) and cold (November-May) water seasons.

Species	Stellers sea lion	Northern fur seal	Northern elephant seal
Month	**Density**		
June	0.0098	0.1059	0.0000
July	0.0098	0.0000	0.0000
August	0.0098	0.0000	0.0000
September	0.0098	0.0072	0.0055
October	0.0098	0.4768	0.0055
Average Warm Season	**0.0098**	**0.1180**	**0.0022**
November	0.0098	0.4768	0.0055
December	0.0098	0.4768	0.0000
January	0.0098	0.0072	0.0000
February	0.0098	0.0072	0.0000
March	0.0098	0.0072	0.0055
April	0.0098	0.0072	0.0055
May	0.0098	0.1059	0.0000
Average Cold Season	**0.0098**	**0.1555**	**0.0024**

E.4.2 Northern fur seal, *Callorhinus ursinus*

The northern fur seal is endemic to the north Pacific. Breeding sites are located in the Pribilof Islands (up to 70% of the world population) and Bogoslof Island in the Bering Sea, Kuril and Commander Islands in the northwest Pacific, and San Miguel Island in the southern California Bight. Abundance of the Eastern Pacific Stock has been decreasing at the Pribilof Islands since the 1940s although increasing on Bogoslof Island. The stock is currently estimated to number 665,550 (Angliss and Allen, 2009). The San Miguel Island Stock is much smaller, estimated at 9,424 (Carretta et al., 2009); this stock is believed to remain predominantly offshore California year round.

Males are present in the rookeries from around mid-May until August; females are present in the rookeries from mid-June to late-October. Nearly all fur seals from the Pribilof Island rookeries are foraging at sea from fall through late spring. Females and young males migrate through the Gulf of Alaska and feed primarily off the coasts of British Columbia, Washington, Oregon and California before migrating north to the rookeries (Ream et al., 2005). Immature males and females may remain in southern foraging areas year round until they are old enough to mate (National Marine Fisheries Service, 2006). Adult males migrate only as far as the Gulf of Alaska or to the west off the Kuril Islands. Therefore, adult males (September-April), adult females (October-December; May-June) and all non-adult fur seals (October-December) can potentially be found in the TMAA depending on the time of year.

Counts conducted in 2004 of males at Pribilof Island rookeries yielded a total 9,978 (Table 2 in National Marine Fisheries Service, 2006). Assuming an even distribution of fur seals throughout the GOA, and using a similar method as for other pinnipeds, the number of male fur seals was multiplied by the percent area of the TMAA compared to the GOA LME (0.0625) for a total of 624 fur seals. **Density was then calculated as 624 fur seals/87,250 km^2, or 0.0072/km^2, which is applicable for the entire region in September and January through April.** Because some northern fur seal adult males feed near the Kuril Islands, this density is likely an over-estimate.

To determine density for migration time periods when adult female, adult male and non-adult fur seals would be present in the TMAA while enroute to feeding areas (October-December), the total number of fur seals in the eastern Pacific stock (665,550) was multiplied by the percent area of the TMAA compared to the GOA LME (0.0625) for a total of 41,597 fur seals. **Density was then calculated as 41,597 fur seals/87,250 km^2, or 0.4768/km^2. This density is applicable for the entire TMAA for October-December.** Because this number includes pups of the year and first year mortality due to predation and other factors is very high, the density is very likely an over-estimate.

To account for migration time periods when adult females would be migrating north thru the TMAA enroute to the rookeries (May-June), the number of pups born (2006 Pribilof Islands and Bogoslof Island count= 147,900; Angliss and Allen, 2009) was used to estimate the number of adult females (assuming all adult females birthed a pup). Assuming an even distribution of fur seal females as they migrate through the GOA, the number of female fur seals was multiplied by the percent area of the TMAA compared to the GOA LME (0.0625) for a total of 9,244 fur seals**. Density was then calculated as 9,244 fur seals/87,250 km^2, or 0.1059/km^2. This density is applicable for the entire** TMAA **for May-June.**

In most years, northern fur seals would not be expected in the GOA in July and August, because adults would still be in the rookeries and non-adults would be foraging farther south, so density would be zero.

Acoustic modeling was calculated for two seasons, warm (June-October) and cold (November-May) water. Northern fur seal densities were therefore averaged to these two seasons by summing monthly densities and dividing by the number of months in each season (Table 5). **The warm water density for northern fur seals was 0.1180/km^2 and the cold water density was 0.1555/km^2 (see Table 1), which are applicable to the entire area.**

Northern fur seals feed on small fish and squid in deep water and along the shelf break; deep dives occur on the shelf and feeding probably occurs near the bottom (Gentry, 2002). There have been a few studies of this species' diving habits during feeding and migrating, although there is no information on dive depth distribution. Ponganis et al. (1992) identified two types of northern fur seal dives, shallow (<75 m) and deep (>75 m). Kooyman and Goebel (1986) found that the mean dive depth for seven tagged females was 68 m (range 32-150 m) and the mean maximum depth was 168 m (range 86-207). Sterling and Ream (2004) reported that the mean dive depth for 19 juvenile males was 17.5 m, with a maximum depth attained of 175 m. Diving was deeper in the daytime than during nighttime, perhaps reflecting the different distribution of prey (especially juvenile pollock), and also differed between inner-shelf, mid-shelf, outer-shelf and off-shelf locations. Deeper diving in the Sterling and Ream study tended to occur on-shelf, with shallower diving off-shelf. Diving patterns during migration tended to be shallower, with diving occurring mainly at night (indicating some feeding on vertically migrating prey) and most time during the day in the upper 5 m of the water column (Baker, 2007). **Based on these very limited depth data, the following are very rough order estimates of time at depth: daytime: 74% at <2 m; 26% at 2-260 m; nighttime: 74% at <2 m; 26% at 2-75 m.**

E.4.3 California sea lion, *Zalophus californianus*

California sea lions breed in the Channel Islands in the southern California Bight and south into Baja California. Males will migrate after the breeding season north to near shore waters of Washington, Oregon and British Columbia (some immature males will remain in northern feeding areas year round). Females generally do not migrate as far north as males. California sea lions have been documented at several locations in Alaska (Maniscalco et al., 2004), including southeast Alaska, Kenai Peninsula and as far north and west at St. Paul Island in the Bering Sea. There were a total of 52 animals documented between 1963 and 2003, and they were observed during all seasons of the year. Their presence in the GOA Exercise Area is likely extremely low both due to the extralimital nature of the occurrence and the species preference for near shore habitat. **No density estimate is available (Table 1).**

E.4.4 Northern elephant seal, *Mirounga angustirostris*

The California stock of elephant seals breeds at rookeries located along the California coast. The most recent population estimate (2005) was 124,000 animals, and was based primarily on pup counts and correction factors (Carretta et al., 2009). Only male elephant seals migrate as far north as the GOA during foraging trips, information known from extensive satellite tagging studies (LeBoeuf et al., 1986, 1993, 2000). Adult males are present at the California rookeries from December through February for mating, and again from May to August during molting. The number of males in the population is particularly difficult to estimate because all adult males are generally not present at the rookery at any one time.

Counts of males at rookeries in the Channel Islands and some central California sites in 2005 yielded 3,815 males and juveniles for which sex could not be determined. Some rookeries were not included in this estimate, including a rapidly growing rookery at Piedras Blancas, which in 2007 had an estimated population of 16,000 animals of all age and sex classes (www.elephantseal.org). The California elephant seal population has also been steadily increasing over time (Carretta et al., 2009). To account for males at rookeries not counted and an increase in the population since 2005, the number of males and juveniles reported in the 2009 stock assessment report (3,815) was doubled to 7,630. Using similar methods as described for Steller's, the number of male elephant seals (7,630) was multiplied by percent area of the TMAA compared to the GOA LME (0.0625) for a total of 477 elephant seals. **Density was then calculated as 475 seals/87,250 km^2, or 0.0055/km^2, which is applicable for the entire TMAA for March-April and September-November.** Because all elephant seal adult males are not at-sea at the same time, the density is probably an over-estimate.

As with northern fur seals, elephant seal densities were averaged to warm (June-October) and cold (November-May) water seasons to provide data suitable for acoustic modeling. To do so, monthly densities were summer and divided by the number of months in each season (Table 5). **The warm water density for elephant seals was 0.0022/km^2 and the cold water density was 0.0023/km^2 (see Table 1, which is applicable to the entire area.**

Elephant seals feed on deep-water squid and fish, and likely spend about 80% of their annual cycle at sea feeding (Hindell, 2002). There has been a disproportionate amount of research done in the diving capabilities of northern elephant seals. Breeding and molting beaches are all located in California and Baja California, and elephant seals are relatively easy to tag (compared to cetaceans) when they are hauled out on the beach; the tag package can be retrieved when the animal returns to shore rather than relying on finding it in the ocean. They are deep divers, and have been tracked to depths >1000 m, although mean depths are usually around 400-600 m. Elephant seals have more than one dive type, termed Types A-E, including rounded and squared-off U-shape, V-shape and others. Particular dive types appear to be used mainly during transit (Types A and B), "processing" of food (Type C), and foraging (Types D and E; Crocker et al., 1994). Asaga et al. (1994) collected dive information on three female seals and provided summary statistics for three dive types. Davis et al. (2001) recorded the diving behavior of a seal returning to the beach, and demonstrated transit depths averaging 186 m with range of depth from 8 m to 430 m. LeBoeuf et al. (1986; 1988), Stewart and DeLong (1993) and LeBoeuf (1994) provided histograms of dives per depth range for tagged females. LeBoeuf et al. (2000; 1988) and LeBoeuf (1994) provided details on foraging trips for males and females offshore California, including information on percentage of time at surface. Hassrick et al. (2007) noted that larger animals (adult males) exhibited longer bottom times and that surface swimming was not noted in the sixteen elephant seals that they tagged. Hindell (2002) noted that traveling likely takes place at depths >200m.

Even with this abundance of information, the numerous types of dives and lack of clear-cut depth distribution data means that the percentage of time at depth needs to be estimated. The closest information provided is from Asaga et al. (1994), which was used here. Note that this information is representative of type D foraging dives of female only. This is the type of dive that would be likely of an elephant seal at-sea. Summary stats from Table 17.3 (Asaga et al., 1994) were used; the data were collected from females only but will be applied to both sexes and all age classes due to lack of other concise data. Mean dive duration and mean surface intervals were added together to come up with total dive cycle in minutes. Amount of time to traverse from surface to bottom and bottom to surface was calculated by subtracting bottom time (given) from dive duration. Values for total cycle, surface interval, bottom time and descent/ascent were then averaged for all three females. Roundtrip surface to bottom and back averaged 12.9 minutes. Assuming a mean rate of descent/ascent over 527 m (average mean dive depth for all three females combined), the average rate per 100 m was 2.4 min. **Based on these averaged numbers, the following are estimates of time at depth: 9% at <2 m, 11% at 2-100 m, 11% at 101-200 m, 11% at 201-300 m, 11% at 301-400 m, 11% at 401-500 m and 36% at >500 m.**

E.4.5 Harbor seal, *Phoca vitulina*

Harbor seals are distributed throughout coastal areas of the North Pacific. Their distribution is largely tied to suitable beaches for hauling out, pupping and molting, and areas offering good foraging and protection from predators such as killer whales. Most harbor seals are non-migratory. Satellite-tracking studies of movements of adults and pups near Kodiak Island and elsewhere in the GOA indicate that mean distance between haul out and at-sea foraging was 10-25 km for juveniles and 5-10 km for adults (e.g., Lowry et al., 2001; Rehberg and Small, 2001), and nearly all locations were in water <200 m deep, with an apparent preference for depths 20-100 m (Frost et al., 2001). The coastal distribution and limitation to shallower depths make it likely that harbor seals would not be within the TMAA; **there is no density for this species (Table 1).**

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Table 6. Summary of Marine Mammal Depth and Diving Information for Species Found in the TMAA

NOTE: some species that are not endemic to GOA are included in this appendix because data on their depth and diving preferences were extrapolated to GOA species.

	GENERAL INFORMATION			DEPTH SPECIFIC INFORMATION					
Common Name	**Food Preference**	**Depth or Oceanic Preference**	**References**	**Behavioral State**	**Geographic Region**	**Depth Information**	**Depth Distribution**	**Sample Size/ Time of Year/Method**	**References**
MYSTICETES - Baleen whales									
Fin whale	Planktonic crustaceans, including *Thyanoessa* sp and *Calanus* sp, as well as scholling fishes such as capelin (*Mallotus*), herring (*Clupea*) and mackerel (*Scomber*)	Pelagic with some occurrence over continental shelf areas, including in island wake areas of Bay of Fundy	Aguilar (2002); Croll et al. (2001); Acevado et al. (2002): Notarbartolo-di-Sciara et al. (2003); Bannister (2002); Johnston et al. (2005); Watkins and Schevill (1979)	Feeding at depth	Northeast Pacific (Mexico, California)	Mean depth 98 +- 33 m; mean dive time 6.3+- 1.5 min		Fifteen whales/ April-October/Time-depth-recorder	Croll et al. (2001)
Fin whale				Non-feeding	Northeast Pacific (Mexico, California)	Mean depth 59 +-30 m; mean dive time 4.2 +- 1.7 min; most dives to ~ 30 m with occasional deeper V-shaped dives to >90 m		Fifteen whales/ April-October/Time-depth-recorder	Croll et al. (2001)
Fin whale				Feeding	Mediterranean (Ligurian Sea)	Shallow dives (mean 26-33 m, with all <100m) until late afternoon; then dives in excess of 400 m (perhaps to 540 m); in one case a whale showed deep diving in midday; deeper dives probably were to feed on specific prey (*Meganyctiphanes norvegica*) that undergo diel vertical migration		Three whales/ Summer/ Velocity-time-depth-recorder	Panigada et al. (1999); Panigada et al. (2003); Panigada et al. (2006)
Fin whale				Traveling	Mediterranean (Ligurian Sea)	Shallow dives (mean 9.8 +- 5.3 m, with max 20 m) , shorter dive times and slower swimming speed indicate travel mode; deep dives (mean 181.3 +- 195.4 m, max 474 m), longer dive times and faster swimming speeds indicate feeding mode		One whale/ Summer/ Velocity-time-depth-recorder	Jahoda et al. (1999)
Fin whale				Feeding	Northeast Pacific (Southern California Bight)	Mean dive depth 248+-18 m; total dive duration mean 7.0+-1.0 min with mean descent of 1.7+-0.4 min and mean ascet of 1.4+-0.3 min; 60% (i.e., 7.0 min) of total time spent diving with 40% (i.e., 4.7 min) total time spent near sea surface (<50m)	44% in 0-49m (includes surface time plus descent and ascent to 49 m); 23% in 50-225 m (includes descent and ascent times taken from Table 1 minus time spent descending and ascending through 0-49 m); 33% at >225 m (total dive duration minus surface, descent and ascent times)	Seven whales/ August/ Bioacoustic probe	Goldbogen et al. (2006)
Fin whale				Feeding	Northeast Pacific (Southern California Bight)	Distribution of foraging dives mirrored distribution of krill in water collumn, with peaks at 75 and 200-250 m.		Two whales/ September-October/ Time-depth-recorder	Croll et al. (2001)

	GENERAL INFORMATION			DEPTH SPECIFIC INFORMATION					
Common Name	**Food Preference**	**Depth or Oceanic Preference**	**References**	**Behavioral State**	**Geographic Region**	**Depth Information**	**Depth Distribution**	**Sample Size/ Time of Year/Method**	**References**
Minke whale	Regionally dependent; can include euphausiids, copepods, small fish and squids; Japanese anchovy preferred in western North Pacific, capelin and krill in the Barents Sea; armhook squids in North Pacific	Coastal, inshore and offshore; known to concentrate in areas of highest prey density, including during flood tides	Perrin and Brownell (2002); Jefferson et al. (1993); Murase et al. (2007); Bannister (2002); Lindstrom and Haug (2001); Johnston et al. (2005); Hoelzel et al. (1989); Haug et al. (2002); Haug et al. (1995); Haug et al. (1996); Konishi and Tamura (2007); Clarke (1986)	Feeding, Searching	North Atlantic (Norway)	Searching for capelin at less than 20 m, then lunge-feeding at depths from 15 to 55 m, then searching again at shallower depths	Based on time series in Figure 2, 47% of time was spent foraging from 21-55 m; 53% of time was spent searching for food from 0-20 m	One whale/ August/ Dive-depth-transmitters	Blix and Folkow (1995)
Minke whale				Feeding	North Pacific (San Juan Islands)	80% of feeding occurred over depths of 20-100m; two types of feeding observed both near surface - lunge feeding and bird association		23 whales/ June-September/ behavioral observations	Hoelzel et al. (1989)
Humpback whale	Pelagic schooling euphausiids and small fish including capelin, herring, mackerel, croaker, spot, and weakfish	Coastal, inshore, near islands and reefs, migration through pelagic waters	Clapham (2002); Hain et al. (1995); Laerm et al. (1997); Bannister (2002); Watkins and Schevill (1979)	Feeding	North Atlantic (Stellwagen Bank)	Depths <40 m		Several whales/ August/ Visual Observations	Hain et al. (1995)
Humpback whale				Feeding (possible)	Tropical Atlantic (Bermuda)	Dives to 240 m		One whale/ April/ VHF tag	Hamilton et al. (1997)
Humpback whale				Feeding (in breeding area)	Tropical Atlantic (Samana Bay - winter breeding area)	Not provided; lunge feeding with bubblenet		One whale/ January/ Visual observations	Baraff et al. (1991)
Humpback whale				Breeding	North Pacific (Hawaii)	Depths in excess of 170 m recorded; some depths to bottom, others to mid- or surface waters; dive duration was not necessarily related to dive depth; whales resting in morning with peak in aerial displays at noon	40% in 0-10 m, 27% in 11-20 m, 12% in 21-30 m, 4% in 31-40 m, 3% in 41-50 m, 2% in 51-60 m, 2% in 61-70 m, 2% in 71-80 m, 2% in 81-90 m, 2% in 91-100 m, 3% in >100 m (from Table 3)	Ten Males/ February-April/ Time-depth-recorder	Baird et al. (2000); Helweg and Herman (1994)
Humpback whale				Feeding	Northeast Atlantic (Greenland)	Dive data was catalogued for time spent in upper 8 m as well as maximum dive depth; diving did not extend to the bottom (~1000 m) with most time in upper 4 m of depth with few dives in excess of 400 m	37% of time in <4 m, 25% of time in 4-20 m, 7% of time in 21-35m, 4% of time in 36-50 m, 6% of time in 51-100 m, 7% of time in 101-150 m, 8% of time in 151-200 m, 6% of time in 201-300 m, and <1% in >300 m	Four whales/ June-July/ Satellite transmitters	Dietz et al. (2002)
Humpback whale				Feeding	North Pacific (Southeast Alaska)	Dives were short (<4 min) and shallow (<60 m); deepest dive to 148m; percent of time at surface increased with increased dive depth and with dives exceeding 60 m; dives related to position of prey patches		Several whales/ July-September/ Passive sonar	Dolphin (1987); Dolphin (1988)

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Gray whale	Amphipods, including *Ampelisca* sp, and other organisms living in the sea floor; also occasionally surface skim and engulfing; dependent on location; euphausiids along frontal systems may also be important	Continental shelf, 4-120 m depth	Dunham and Duffus (2002); Jones and Swartz (2002); Bannister (2002); Yazvenko et al. (2007); Bluhm et al. (2007)	Migrating	Northeast Pacific (coastal Baja California to northern California)	30 of 36 locations in depths <100m deep (mean 39 m); consistent speed indicating directed movement		One whale/ February/ Satellite tag	Mate and Urban Ramirez (2003)
Gray whale				Feeding	Bering and Chukchi Seas	Depths at feeding locations from 5-51 m depth		Several whales/ July-November/ Aerial surveys and benthic sampling	Clarke et al. (1989); Clarke and Moore (2002); Moore et al. (2003)
Gray whale				Feeding	Northeast Pacific (Kodiak Island)	Feeding on cumacean invertebrates		Several whales/ Year-round/ Aerial surveys	Moore et al. (2007)
Gray whale				Feeding	Northeast Pacific (Vancouver Island)	Majority of time was spent near the surface on interventilation dives (<3 m depth) and near the bottom (extremely nearshore in a protected bay with mean dive depth of 18 m, range 14-22 m depth; little time spent in the water column between surface and bottom.	40% of time at <4 m (surface and interventilation dives), 38% of time at 3-18 m (active migration), 22% of time at >18 m (foraging).	One whale/ August/ Time-depth recorder	Malcolm et al. (1995/96); Malcolm and Duffus (2000)
ODONTOCETES - Toothed whales									
Sperm whale	Squids and other cephalopods, demersal and mesopelagic fish; varies according to region	Deep waters, areas of upwelling	Whitehead (2002); Roberts (2003); Clarke (1986)	Feeding	Mediterranean Sea	Overall dive cycle duration mean = 54.78 min, with 9.14 min (17% of time) at the surface between dives; no measurement of depth of dive		16 whales/ July-August/ visual observations and click recordings	Drouot et al. (2004)
Sperm whale				Feeding	South Pacific (Kaikoura, New Zealand)	83% of time spent underwater; no change in abundance between summer and winter but prey likely changed between seasons		>100 whales/ Year-round/ visual observations	Jacquet et al. (2000)
Sperm whale				Feeding	Equatorial Pacific (Galapagos)	Fecal sampling indicated four species of cephalopods predominated diet, but is likely biased against very small and very large cephalopods; samples showed variation over time and place		Several whales/ January-June/ fecal sampling	Smith and Whitehead (2000)
Sperm whale				Feeding	Equatorial Pacific (Galapagos)	Dives were not to ocean floor (2000-4000 m) but were to mean 382 m in one year and mean of 314 in another year; no diurnal patterns noted; general pattern was 10 min at surface followed by dive of 40 min; clicks (indicating feeding) started usually after descent to few hundred meters		Several whales/ January-June/ acoustic sampling	Papastavrou et al. (1989)
Sperm whale				Feeding	North Pacific (Baja California)	Deep dives (>100m) accounted for 26% of all dives; average depth 418 +- 216 m; most (91%) deep dives were to 100-500 m; deepest dives were 1250-1500m; average dive duration was 27 min; average surface time was 8.0; whale dives closely correlated with depth of squid (200-400 m) during day; nighttime squid were shallower but whales still dove to same depths	74% in <100 m; 24% in 100-500 m; 2% in >500m	Five whales/ October-November/ Satellite-linked dive recorder	Davis et al. (2007)

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Common Name	Food Preference	Depth or Oceanic Preference	References	Behavioral State	Geographic Region	Depth Information	Depth Distribution	Sample Size/ Time of Year/Method	References
Sperm whale				Resting/ socializing	North Pacific (Baja California)	Most dives (74%) shallow (8-100 m) and short duration; likely resting and/or socializing		Five whales/ October-November/ Satellite-linked dive recorder	Davis et al. (2007)
Sperm whale				Feeding	North Atlantic (Norway)	Maximum dive depths near sea floor and beyond scattering layer		Unknown # male whales/ July/ hydrophone array	Wahlberg (2002)
Sperm whale				Feeding	North Pacific (Southeast Alaska)	Maximum dive depth if 340 m when fishing activity was absent; max dive depth during fishing activity was 105 m		Two whales/ May/ acoustic monitoring	Tiemann et al. (2006)
Sperm whale				Feeding	Northwest Atlantic (Georges Bank)	Dives somewhat more U-shaped than observed elsewhere; animals made both shallow and deep dives; average of 27% of time at surface; deepest dive of 1186 m while deepest depths in area were 1500-3000 m so foraging was mid-water column; surface interval averaged 7.1 min		Nine Whales/ July 2003/ DTAG	Palka and Johnson (2007)
Sperm whale				Feeding	Northwest Atlantic (Georges Bank)	37% of total time was spent near surface (0-10m); foraging dive statistics provided in Table 1 and used to calculate percentages of time in depth categories, adjusted for total time at surface	48% in <10 m; 3% in 10-100 m; 7% in 101-300 m; 7% in 301-500 m; 4% in 501-636 m; 31% in >636 m	Six females or immatures/ September-October/ DTAG	Watwood et al. (2006)
Sperm whale				Feeding	Mediterranean Sea	20% of total time was spent near surface (0-10m); foraging dive statistics provided in Table 1 and used to calculate percentages of time in depth categories, adjusted for total time at surface	35% in <10 m; 4% in 10-100 m; 9% in 101-300 m; 9% in 301-500 m; 5% in 501-623 m; 38% in >636 m	Eleven females or immatures/ July/ DTAG	Watwood et al. (2006)
Sperm whale				Feeding	Gulf of Mexico	28% of total time was spent near surface (0-10m); foraging dive statistics provided in Table 1 and used to calculate percentages of time in depth categories, adjusted for total time at surface	41% in <10 m; 4% in 10-100 m; 8% in 101-300 m; 7% in 301-468 m; 40% >468 m	20 females or immatures/ June-September/ DTAG	Watwood et al. (2006)
Sperm whale				Feeding/ Resting	North Pacific (Japan)	Dives to 400-1200 m; active bursts in velocity at bottom of dive suggesting search-and-pursue strategy for feeding; 14% of total time was spent at surface not feeding or diving at all, with 86% of time spent actively feeding; used numbers from Table 1 to determine percentages of time in each depth category during feeding then adjusted by total time at surface	31% in <10 m (surface time); 8% in 10-200 m; 9% in 201-400 m; 9% in 401-600 m; 9% in 601-800m; 34% in >800 m	One female/ June/ Time-depth-recorder	Amano and Yoshioka (2003)
Sperm whale				Feeding	North Pacific (Japan)	Diel differences in diving in one location offshore Japan, with deeper dives (mean 853 m) and faster swimming during the day than at night (mean 469 m); other location along Japan's coast showed no difference between day and night dives; most time (74%) spent on dives exceeding 200 m; surface periods of 2.9 h at least once per day; max depth recorded 1304 m		Ten whales/ May-June, October/ depth data loggers and VHF radio transmitters	Aoki et al. (2007)

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Sperm whale				Feeding/ Resting	North Atlantic (Caribbean)	Whales within 5 km of shore during day but moved offshore at night; calves remained mostly at surface with one or more adults; night time tracking more difficult due to increased biological noise from scattering layer; both whales spent long periods of time (>2hr) at surface during diving periods		Two whales/ October/ Acoustic transponder	Watkins et al. (1993)
Sperm whale					North Atlantic (Caribbean)	Dives did not approach bottom of ocean (usually >200 m shallower than bottom depth); day dives deeper than night dives but not significantly; 63% of total time in deep dives with 37% of time near surface or shallow dives (within 100 m of surface)		One whale/ April/ Time-depth tag	Watkins et al. (2002)
Sperm whale				Feeding	Northern Pacific (Hawaii)	Cephalopods of several genera recovered		Two animals/ uknown/ stomach contents	Clarke and Young (1998)
Sperm whale				Occurrence	Mediterranean Sea (Alborian Sea south of Spain)	Preferred waters >700m		Vessel transects	Canadas et al. (2002)
Sperm whale				Feeding	Arctic Ocean (Norway)	Dives from 14-1860 m with median of 175 m; clicking (searching for prey) began at 14-218 m and stopped at 1-1114 m, and whale spent 91% of overall dives emitting clicks; shallower dives were apparently to target more sparse prey while deep dives led to frequent prey capture attempts and were likely within denser food layers		Four adult males/ July/ DTAG	Teloni et al. (2007)
Cuvier's beaked whale	Meso-pelagic or deep water benthic organisms, particularly squid (Cephalapoda: Teuthoidea); may have larger range of prey species than other deep divers; likely suction feeders based on lack of teeth and enlarged hyoid bone and tongue muscles	Offshore, deep waters of continental slope (200-2000 m) or deeper	Heyning (2002); Santos et al. (2001); Blanco and Raga (2000); Clarke (1986)	Feeding	Northeast Pacific (Hawaii)	Max dive depth = 1450 m; identified at least three dive categories including inter-ventilation (<4 m, parabolic shape), long duration (>1000m, U-shaped but with inflections in bottom depth), and intermediate duration (292-568 m, U-shaped); dive cycle usually included one long duration per 2 hours; one dive interval at surface of >65 min; mean depth at taggin was 2131 m so feeding occurred at mid-depths; no difference between day and night diving		Two whales/September-November/Time-depth recorders	Baird et al. (2006a); Baird et al. (2005a)
Cuvier's beaked whale				Feeding	Mediterranean (Ligurian Sea)	Two types of dive, U-shaped deep foraging dives (>500 m, mean 1070 m) and shallower non-foraging dives (<500 m, mean 221 m); depth distribution taken from information in Table 2	27% in <2 m (surface); 29% in 2-220 m; 4% in 221-400 m; 4% in 401-600 m; 4% in 601-800 m; 5% in 801-1070; 27% in >1070 m	Seven whales/ June/ DTAGs	Tyack et al. (2006)
Cuvier's beaked whale				Feeding	Mediterranean (Ligurian Sea)	Deep dives broken into three phases: silent descent, vocal-foraging and silent ascent; vocalizations not detected <200m depth; detected when whales were as deep as 1267 m; vocalizations ceased when whale started ascending from dive; clicks ultrasonic with no significant energy below 20 kHz		Two whales/ September/ DTAGs	Johnson et al. (2004); Soto et al. (2006)

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Baird's beaked whale	Benthic fishes and cephalopods, also pelagic fish including mackerel and sardine; primarily squid off northern coast of Hokkaido and deep sea fish off Pacific coast of Japan	Deep waters over continental slope	Kasuya (2002); Kasuya (1986); Walker et al. (2002); Clarke (1986)	Feeding	Northwest Atlantic (Japan)	Whales caught at depths of ~1000 m; stomach contents included prey species normally found from 1100-1300 m; likely feeding at or near bottom		Several whales/ August-September/ Stomach contents	Ohizumi et al. (2003)
Northern bottlenose whale	Squid of genus *Gonatus* and *Taonius* and occasionally fish and benthic invertebrates	Deep waters >500 m; can dive to >1400 m	Gowans (2002); Kasuya (2002); Clarke and Kristensen (1980); Clarke (1986)	Feeding	Northeast Atlantic (Nova Scotia "Gully")	Most (62-70%, average = 66%) of the time was spent diving (deeper than 40 m); most dives somewhat V-shaped; shallow dives (<400 m) and deep dives (>800 m); whales spent 24-30% (therefore, average of 27%) of dives at 85% maximum depth indicating they feed near the bottom; deepest dive 1453 m; depth distribution taken from info in Table 1	34% at 0-40 m, 39% at 41-800 m, 27% at >800 m	Two whales/ June-August/ Time-depth recorders	Hooker and Baird (1999)
Killer whale	Diet includes fish (salmon, herring, cod, tuna) and cephalopods, as well as other marine mammals (pinnipeds, dolphins, mustelids, whales) and sea birds; most populations show marked dietary specialization	Widely distributed but more commonly seen in coastal temperate waters o fhigh productivity	Ford (2002); Estes et al. (1998); Ford et al. (1998); Saulitis et al. (2000); Baird et al. (2006b)	Feeding	North Pacific (Puget Sound)	Resident-type (fish-eater) whales; maximum dive depth recorded 264 m with maximum depth in study area of 330 m; population appeared to use primarily near-surface waters most likely because prey was available there; some difference between day and night patterns and between males and femalesl depth distribution info from Table 5 in Baird et al. (2003)	96% at 0-30 m; 4% at >30 m	Eight whales/ Summer-fall/ Time-depth recorders	Baird et al. (2005b); Baird et al. (2003)
Killer whale				Feeding	Southwest Atlantic (Brazil)	Small to medium-sized cephalopods, both offshore and coastal		Unknown animals/ unknown/ stomach contents	Santos and Haimovici (2001)
Killer whale				Feeding	North Pacific	Offshore type whales, likely fish eaters based on behavioral observations and stomach content analysis		Several/ Year round/ Observations and stomach contents	Dahlheim et al. (2008)
Pacific white-sided dolphin	Lanternfish, anchovies, hake and squid; also herring, salmon, cod, shrimp and capelin	Mostly pelagic and temperate; may syncrhonize movements with anchovy and other prey	van Waerebeek and Wursig (2002); Clarke (1986)	Feeding	Northeast Pacific (British Columbia inland waters)	Prey collected included herring, capelin, Pacific sardine and possibly eulachon		Unknown/ year round/ dipnet collection of prey	Morton (2000)
Atlantic white-sided dolphin	Herring, small mackerel, gadid fishes, smelts, hake, sand lances, squid; likely change from season to season	Continental shelf and slope from deep oceanic areas to occasionally coastal waters	Cipriano (2002); Clarke (1986)		North Atlantic (Gulf of Maine)	Most (89%) of time spent submerged; most (76%) dives were <1 min duration and none were for longer that 4 minute duration		One animal/ February/ satellite-monitored radio tag	Mate et al. (1994)
Atlantic white-sided dolphin				Feeding	North Atlantic (Ireland)	Most frequent prey were mackerel and silvery pout		Four animals/ year round/ stomach contents	Berrow and Rogan (1996)
White-beaked dolphin	Mesopelagic fish, especially cod, whiting and other gadids, and squid		Kinze (2002); Clarke (1986)	Feeding	North Atlantic (Ireland)	Stomach contained Gadoid fish and scad remains		One animal/ year round/ stomach contents	Berrow and Rogan (1996)
Dall's porpoise	Small schooling and mesopelagic fish and cephalopods	Deep offshore as well as deeper near shore waters; diurnal as well as nocturnal feeders to take advantage of prey availability	Jefferson (2002), Amano et al. (1998); Clarke (1986)	Travelling	North Pacific (Puget Sound)	Feasibility study to determine if Dall's could be successfully tagged with suction cup tag; depth distribution info from Table 2 and excludes initial dive data when animal responded to tag event	39% at <1 m, 8% at 1-10 m, 45% at 11-40 m and 8% at >40 m	One animal/ August/ time-depth recorder	Hanson and Baird (1998)

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PINNIPEDS									
Northern fur seal	Small fish and squid in deep water and along the shelf break; Pacific herring, squid and walleye pollock dominated in the Gulf of Alaska, British Columbia, Washington and Oregon; northern anchovy and squid primary in Oregon, Washington and California	Deep dives occur on the shelf and feeding probably occurs near the bottom	Gentry (2002); Ream et al. (2005)			Maximum dive depth 256 m		Two females/ July/ time-depth recorders	Ponganis et al. (1992)
Northern fur seal				Feeding	North Pacific (Bering Sea)	Mean dive depth 68 m (range 32-150 m); mean maximum depth 168 m (range 86-207 m); two types of dives, shallow (<75 m; mean = 30 m; occur at night) and deep (>75 m; mean = 130 m; occur during day and night); total activity budget during feeding trips was 57% active at surface, 26% diving and 17% resting; depth distribution info from Gentry and others	Daytime: 74% at <2 m, 24% at 2-260 m; night time: 74% at <2 m, 24% at 2-75 m	Seven females/ July/ time-depth recorders	Gentry et al. (1986)
Northern fur seal				Feeding	North Pacific (Bering Sea)	Mean dive depth of 17.5 m, with a maximum depth of 175 m; diving deeper in the daytime than during nighttime, perhaps reflecting the different distribution of prey (especially juvenile pollock) that undertake night time vertical migrations, and also differed between inner-shelf, mid-shelf, outer-shelf and off-shelf locations; deeper diving tended to occur on-shelf, with shallower diving off-shelf.		19 juvenile males/ July-September/ satellite transmitters	Sterling and Ream (2004)
Northern fur seal				Feeding	North Pacific (Bering Sea to California)	Higher dive rates during night time hours compared with daytime; variation in mean dive depth between migratory travelling and destination area (eastern North Pacific coast) where meand dive depth was <25 m; night time mean dive depths were greater during full moon than during new moon		Three females/ November-May/ satellite transmitters	Ream et al. (2005)
Northern fur seal				Feeding	North Pacific (Bering Sea)	Activity budgets of lactating females of 44% locomoting, 23% diving and 33% resting at the surface		Four females/ August/ platform terminal transmitters	Insley et al. (2008)
Northern fur seal				Migrating	North Pacific (Bering Sea to Gulf of Alaska)	Diving behavior consistent regardless of habitat (pelagic or continental shelf); diving largely at night and in evening and morning with little diving during day suggesting feeding on vertically migrating prey	71% at <2 m, 14% at 2-5 m, 5% at 6-10 m, 6% at 11-25 m and 3% at 26-50 m	20 post-weaning pups/ November-May/ satellite-linked time-depth recorders	Baker (2007)

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Steller sea lion	Fish, including walleye pollock, Pacific herring, sand lance, salmon, flounder, rockfish and cephalopods	Diets and feeding patterns change with seasons; population levels are related to prey with increasing populations correlated with diverse diets and decreasing populations correlated with diets of primarily one prey item; females feed mostly at night during breeding season; feeding occurs throughout the day during non-breeding season	Trites et al. (2007); Loughlin (2002); Merrick et al. (1994)	Feeding	North Pacific (southeast Alaska)	Characterized by relatively brief trips to sea that represent about on-half of total time, and by fairly frequent, short and shallow dives that occur mostly at night. Maximum depth recorded was 424 m; mean depth was 26.4 m, and 49% of all dives were <10 m.		13 females/ May-June, January/ satellite-linked time-depth recorders	Swain (1996)
Steller sea lion				Feeding	North Pacific (Gulf of Alaska)	Adult females forage close to land in summer (<20 km) and make brief trips (<2 days) and shallow dives (<30 m); in winter, divers are longer in distance (up to 300 km), time (up to several months) and deeper (>250 m), Average dive depth of 36.5 and 42.9 m		Two females/ unknown/ satellite-linked time-depth recorder	Merrick et al. (1994)
Steller sea lion					North Pacific (Gulf of Alaska)	Adult females capable of foraging throughout GOA and Bering Sea, while young-of-year have smaller ranges and shallower dives; females in winter dove deepest (median 24 m, maximum >250 m, while young-of-year were shallowest (median 9 m, max 72 m); depth distribution taken from Figure 4 and represent averaging of all age/season classes	60% at 0-10 m, 22% at 11-20 m, 12% at 21-50 m, 5% at 51-100 m and 1% at >100 m.	15 animals/ June-July, November-March/ satellite-linked time-depth recorders and VHF transmitters	Merrick and Loughlin (1997)
Steller sea lion					North Pacific (Gulf of Alaska)	Young of year dove for shorter periods and shallower depths than yearlings; maximum dive depth was 288 m; long-range transits began at >10 months of age; depth distirubiton taken from Figure 2	78% in 0-10 m, 13% in 11-20 m, 7% in 21-50 m, and 2% in > 51 m	18 animals/ October-June/ satellite-linked time-depth recorders	Loughlin et al. (2003)
Steller sea lion					North Pacific (Washington)	Maximum dive depth was 328 m; depth distribution taken from Figure 2	28% in 0-10 m, 30% in 11-20 m, 18% in 21-50 m, 14% in 51-100 m and 10% in >100 m	Seven animals/ October-June/ satellite-linked time-depth recorders	Loughlin et al. (2003)
Steller sea lion					North Pacific (Gulf of Alaska)	Juveniles from western Alaska rookeries left on foraging trips at dusk and returned at dawn (taking advantage of polluck that vertically migrates and hauling out during the day), while juveniles from eastern Alaska rookeries left on foraging trips throughout the day and night, likely feeding on prey other than vertical migrants		129 animals/ August-November, January-May/ satellite dive recorders	Call et al. 2007)
Steller sea lion					North Pacific (Gulf of Alaska)	Round trip distance and duration of pups and juveniles increased with age, trip distance was greater for western rookeries than for eastern rookeries, trip duration was greater for females than males; 90% of trips were <=15 km from haul-outs; dispersals >500 km were undertaken only by males although dispersals of >120 km were common.		103 animals/ year round/ satellite dive recorders	Raum-Suryan et al. (2004)

	GENERAL INFORMATION			DEPTH SPECIFIC INFORMATION					
Common Name	**Food Preference**	**Depth or Oceanic Preference**	**References**	**Behavioral State**	**Geographic Region**	**Depth Information**	**Depth Distribution**	**Sample Size/ Time of Year/Method**	**References**
Northern elephant seal	Feed on deep-water squid and fish, and likely spend about 80% of their annual cycle at sea feeding; feed in meso-pelagic zone on vertically migrating squid	Deeper waters (>1000 m); males farther north than females	Hindell (2002); Stewart and DeLong (1993; 1995); LeBoeuf et al. (1988); Asaga et al. (1994); LeBoeuf (1994)	Feeding	North Pacific	Dive continuously for 8-10 months/year; disperson and migratory patterns related to oceanographic features and areas of biological productivity; primarily squid eaters; males travel farther than females; females submerged 91% and males submerged 88% of time at sea; dive continuously; average depth for females was 479 m (post-moult) and 518 m (post-breeding) and for males 364 m (post-breeding) and 366 m (post-moult)		36 adults (both sexes)/ February-August/ dive and location recorders	Stewart and Delong (1993)
Northern elephant seal				Feeding	North Pacific	seals use same foraging areas during post-breeding and post-moulting periods; sexes are segregated geographically		36 adults (both sexes)/ January-February; May; July/ geographic location time depth recorders	Stewart and DeLong (1995)
Northern elephant seal				Feeding	North Pacific	little time at depths <200 m or >800 m; post-breeding migration is directed northward and quick until feeding areas are obtained; dives in transit are shallower than those on foraging grounds		14 adults (both sexes)/ February-July/ geographic location time depth recorders	Stewart and DeLong (1994)
Northern elephant seal				Feeding	North Pacific	Sea surface temperature appears to influence female forage area choice; foraging occurred in near shore areas of Gulf of Alaska, offshore Gulf of Alaska, near shore off Washington and Oregon and offshore between 40 and 50 N		12 adult females/ year round/ time depth recorders	Simmins et al. (2007)
Northern elephant seal				Feeding	North Pacific	Post-lactation monitoring; 86% of time at-sea spent submerged; maximum dive of 894 m, but dives >700 m were rare; modal dive depths between 350 and 650 m; continuous deep diving while at-sea; night dives were more numerous, shallower and of shorter duration; most dives types D (deep and u-shaped)		Seven adult females/ February-March/ time-depth recorders	LeBoeuf et al. (1988)
Northern elephant seal				Feeding	North Pacific	Mean depth of dive 333 m; maximum dive 630 m; 6% of all dives <200 m		One adult female/ February/ time-depth recorder	LeBoeuf et al. (1986)
Northern elephant seal				Feeding	North Pacific	Differences in foraging locations and behavior between males and females; females exhibited pelagic diving with varying dive depths depending on prey location in deep scattering layer; males exhibited pelagic diving as well as flat-bottom benthic dives near continental margins; males migrated to northern Gulf of Alaska and eastern Aleutians with females distributed west to 150 W between 44 and 52 N		32 adults (both sexes)/ March-July/ radio-telemetry	LeBoeuf et al. (1993)
Northern elephant seal				Transiting	North Pacific	90% of time submerged; mean depth 289 m; directed swimming even while submerged used prolonged gliding during dive descents which reduces cost of transport and can increase the duration of the dive		One adult female/ April/ video and satellite telemetry	Davis et al. (2001)

	GENERAL INFORMATION			DEPTH SPECIFIC INFORMATION					
Common Name	**Food Preference**	**Depth or Oceanic Preference**	**References**	**Behavioral State**	**Geographic Region**	**Depth Information**	**Depth Distribution**	**Sample Size/ Time of Year/Method**	**References**
Northern elephant seal				Feeding	North Pacific	Type D (foraging) dives account for 75-80% of all dives; type A (transit dives) rarely occurred in series; type C dives were shallowest; depth distribution information from table 17.3, type D dives which are foraging dives as they are the most common	9% at <2 m, 11% at 2-100 m, 11% at 101-200 m, 11% at 201-300 m, 11% at 301-400 m, 11% at 401-500 m and 36% at >500 m.	Two adult females/ February-May/ time-depth recorders	Asaga et al. (1994)
Northern elephant seal				Feeding	North Pacific	Transit dives in males cover large horizontal distances and are shallower than pelagic dive depths; transit dives in females and juveniles are both for transiting and search for prey patches; foraging dives have steeper angles than transit dives in females, but angles are not noticeably different in juveniles; swim speeds were similar across age and sex		16 animals (various ages)/ April-May/ time-depth recorders and platform terminal transmitters	Hassrick et al. (2007)
Northern elephant seal				Feeding	North Pacific	Males feed primarily from coastal Oregon to western Aleutian Islands, along continental margin and feed primarily on benthic organisms, migration is direct to forage areas across Pacific; females have wider foraging area from 38-60 N and from the coast to 172 E, and forage on pelagic prey in the water column, migration is more variable to take advantage of prey patches		47 adults (both sexes)/ March-June, September-December/ time-depth swim speed recorders	LeBoeuf et al. (2000)
Northern elephant seal				Feeding, Transiting	North Pacific	Different types of dives serve three general functions: type AB dives are transit dives (covering great horizontal distance and with shallow ascent and descent angles); type C dives are "processing" dives for internal processes such as digestions (slower swimming speed and short horizontal distance; type DE dives are foraging (both chasing prey pelagically and benthic foraging)		unknown	Crocker et al. (1994)

Appendix F

Cetacean Stranding Report

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F CETACEAN STRANDING REPORT

F.1 CETACEAN STRANDINGS AND THREATS

Strandings can involve a single animal or several to hundreds of animals. An event where animals are found out of their normal habitat may be considered a stranding even though animals do not necessarily end up beaching (such as the July 2004 "Hanalei Mass Stranding Event"; Southall et al., 2006). Several hypotheses have been given for the mass strandings which include the impact of shallow beach slopes on odontocete echolocation, disease or parasites, geomagnetic anomalies that affect navigation, following a food source in close to shore, avoiding predators, social interactions that cause other cetaceans to come to the aid of stranded animals, and human actions. Generally, inshore species do not strand in large numbers but generally just as individual animals. This may be due to their unfamiliarity with the coastal area. By contrast, pelagic species that are unfamiliar with obstructions or sea bottom tend to strand more often in larger numbers (Woodings, 1995). The Navy has studied several stranding events in detail that may have occurred in association with Navy sonar activities. To better understand the causal factors in stranding events that may be associated with Navy sonar activities, the main factors - including bathymetry (i.e. steep drop offs), narrow channels (less than 35 nm), environmental conditions (e.g. surface ducting), and multiple sonar ships (see Section on Stranding Events Associated with Navy Sonar) - were compared among the different stranding events.

F.1.1 What is a Stranded Marine Mammal?

When a live or dead marine mammal swims or floats onto shore and becomes "beached" or incapable of returning to sea, the event is termed a "stranding" (Geraci et al., 1999; Perrin and Geraci, 2002; Geraci and Lounsbury, 2005; NMFS, 2007). The legal definition for a stranding within the U.S. is that "a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance." (16 United States Code [U.S.C.] section 1421h).

The majority of animals that strand are dead or moribund (NMFS, 2007). For animals that strand alive, human intervention through medical aid and/or guidance seaward may be required for the animal to return to the sea. If unable to return to sea, rehabilitation at an appropriate facility may be determined as the best opportunity for animal survival. An event where animals are found out of their normal habitat may be considered a stranding depending on circumstances even though the animals do not necessarily end up beaching (Southall, 2006).

Three general categories can be used to describe strandings: single, mass, and unusual mortality events. The most frequent type of stranding involves only one animal (or a mother/calf pair) (NMFS, 2007).

Mass stranding involves two or more marine mammals of the same species other than a mother/calf pair (Wilkinson, 1991), and may span one or more days and range over several miles (Simmonds and Lopez-Jurado, 1991; Frantzis, 1998; Walsh et al., 2001; Freitas, 2004). In North America, only a few species typically strand in large groups of 15 or more and include sperm whales, pilot whales, false killer whales, Atlantic white-sided dolphins, white-beaked dolphins, and rough-toothed dolphins (Odell 1987, Walsh et al. 2001). Some species, such as pilot whales, false-killer whales, and melon-headed whales occasionally strand in groups of 50 to 150 or more (Geraci et al. 1999). All of these normally pelagic off-shore species are highly sociable and infrequently encountered in coastal waters. Species that commonly strand in smaller numbers include pygmy killer whales, common dolphins, bottlenose dolphins, Pacific white-sided dolphin Frasier's dolphins, gray whale and humpback whale (West Coast only), harbor porpoise, Cuvier's beaked whales, California sea lions, and harbor seals (Mazzuca et al. 1999, Norman et al. 2004, Geraci and Lounsbury 2005).

Unusual mortality events (UMEs) can be a series of single strandings or mass strandings, or unexpected mortalities (i.e., die-offs) that occur under unusual circumstances (Dierauf and Gulland, 2001; Harwood, 2002; Gulland, 2006; NMFS, 2007). These events may be interrelated: for instance, at-sea die-offs lead to increased stranding frequency over a short period of time, generally within one to two months. As published by the NMFS, revised criteria for defining a UME include (71 FR 75234, 2006):

(1) A marked increase in the magnitude or a marked change in the nature of morbidity, mortality, or strandings when compared with prior records.

(2) A temporal change in morbidity, mortality or strandings is occurring.

(3) A spatial change in morbidity, mortality or strandings is occurring.

(4) The species, age, or sex composition of the affected animals is different than that of animals that are normally affected.

(5) Affected animals exhibit similar or unusual pathologic findings, behavior patterns, clinical signs, or general physical condition (e.g., blubber thickness).

(6) Potentially significant morbidity, mortality, or stranding is observed in species, stocks or populations that are particularly vulnerable (e.g., listed as depleted, threatened or endangered or declining). For example, stranding of three or four right whales may be cause for great concern whereas stranding of a similar number of fin whales may not.

(7) Morbidity is observed concurrent with or as part of an unexplained continual decline of a marine mammal population, stock, or species.

UMEs are usually unexpected, infrequent, and may involve a significant number of marine mammal mortalities. As discussed below, unusual environmental conditions are probably responsible for most UMEs and marine mammal die-offs (Vidal and Gallo-Reynoso, 1996; Geraci et al., 1999; Walsh et al., 2001; Gulland and Hall, 2005).

F.1.2 United States Stranding Response Organization

Stranding events provide scientists and resource managers information not available from limited at-sea surveys, and may be the only way to learn key biological information about certain species such as distribution, seasonal occurrence, and health (Rankin, 1953; Moore et al., 2004; Geraci and Lounsbury, 2005). Necropsies are useful in attempting to determine a reason for the stranding, and are performed on stranded animals when the situation and resources allow.

In 1992, Congress amended the MMPA to establish the Marine Mammal Health and Stranding Response Program (MMHSRP) under authority of the NMFS. The MMHSRP was created out of concern started in the 1980s for marine mammal mortalities, to formalize the response process, and to focus efforts being initiated by numerous local stranding organizations and as a result of public concern.

Major elements of the MMHSRP include (NMFS, 2007):

- National Marine Mammal Stranding Network
- Marine Mammal UME Program

- National Marine Mammal Tissue Bank (NMMTB) and Quality Assurance Program
- Marine Mammal Health Biomonitoring, Research, and Development
- Marine Mammal Disentanglement Network
- John H. Prescott Marine Mammal Rescue Assistance Grant Program (a.k.a. the Prescott Grant Program)
- Information Management and Dissemination.

The United States has a well-organized network in coastal states to respond to marine mammal strandings. Overseen by the NMFS, the National Marine Mammal Stranding Network is comprised of smaller organizations manned by professionals and volunteers from nonprofit organizations, aquaria, universities, and state and local governments trained in stranding response animal health, and diseased investigation. Currently, 141 organizations are authorized by NMFS to respond to marine mammal strandings (National Marine Fisheries Service, 2007o). Through a National Coordinator and six regional coordinators, NMFS authorizes and oversees stranding response activities and provides specialized training for the network.

NMFS Regions and Associated States and Territories

NMFS Northeast Region- ME, NH, MA, RI, CT, NY, NJ, PA, DE, MD, VA

NMFS Southeast Region- NC, SC, GA, FL, AL, MS, LA, TX, PR, VI

NMFS Southwest Region- CA

NMFS Northwest Region- OR, WA

NMFS Alaska Region- AK

NMFS Pacific Islands Region- HI, Guam, American Samoa, Commonwealth of the Northern Mariana Islands (CNMI)

Stranding reporting and response efforts over time have been inconsistent, although effort and data quality within the U.S. have been improving within the last 20 years (NMFS, 2007). Given the historical inconsistency in response and reporting, however, interpretation of long-term trends in marine mammal stranding is difficult (NMFS, 2007). Nationwide, between 1995-2004, there were approximately 700-1500 cetacean strandings per year and between 2000-4600 pinniped strandings per year (NMFS, 2007). In Alaska from 2001-2004, there were 45-165 cetacean strandings per year and 58-125 pinniped strandings per year (NMFS, 2007). Detailed regional stranding information including most commonly stranded species can be found in Zimmerman (1991), Geraci and Lounsbury (2005), and NMFS (2007).

F.1.3 Unusual Mortality Events (UMEs)

From 1991 to the present, there have been 45 formally recognized UMEs in the U.S. The UMEs have either involved single or multiple species and dozens to hundreds of individual marine mammals per event (NOAA Fisheries, Office of Protected Resources 2008). Table F-1 contains a list of documented UMEs in and along the Pacific coast of the U.S.

Table F-1. Documented UMEs in the Pacific.

Year	Composition	Determination
2007	Guadeloupe fur seals in the Northwest	Cause not determined
2007	Large whales in California	Human Interaction
2007	Cetaceans in California	Cause not determined
2006	Harbor porpoises in the Pacific Northwest	Cause not determined
2006	Sea otters in Alaska	Cause not determined
2003	Sea otters in California	Ecological Factors
2002	Multiple species (common dolphins, California sea lion, sea otters) in California	Biotoxin
2001-2002	Hawaiian monk seals in the Northwest Hawaiian Islands	Ecological Factors
2000	Harbor seals in California	Infectious disease
2000	California sea lions in California	Biotoxin
1999/2000	Gray whales in California, Oregon and Washington	Cause not determined
1998	California sea lions in California	Harmful algal bloom; Domoic acid
1997	Harbor seals in California	Unknown infectious respiratory disease
1994	Common dolphins in California	Cause not determined
1993	Harbor seals, Steller sea lions, and California sea lions on the central Washington coast	Human Interaction
1992-1993	Pinnipeds in California	Ecological Factors
1991	California sea lions in California	Infectious disease

Source: NOAA Fisheries, Office of Protected Resources 2008

Stranding of cetaceans and pinnipeds reported to NMFS Alaska Region from 1998-2007 are summarized in Table F-2. The southcentral area includes the area from Cape Suckling to Cape Douglas and the Kodiak area follows the boundaries of the Kodiak Borough.

Strandings constituting this record were reported by fishermen, hunters, fishery observers, and other members of the public and include animals found dead (floating and beach-cast) and reports of live stranded, mass stranded, abandoned, sick or injured animals. Strandings where the animal(s) could not be examined are included in the numbers as long as the animal was at least identified as either cetacean or pinniped. Human interactions like ship strike/collisions, fishery interactions and entanglements are also included. Known subsistence takes are not included, but suspected subsistence animals are in some cases included (e.g., animals reported shot). Fishery observer reports are not included unless the animal was observed outside of statistical reporting protocols (and thus would not be included by the observer program as part of their watch data set). (NMFS, Alaska Region, Protected Resources, 2008).

Both unconfirmed and confirmed reports are included. (NMFS, Alaska Region, Protected Resources, 2008). This practice differs somewhat from strandings tabulated in the official record for other regions (such as for the Northwest Region), where a field investigation must confirm the reported stranding, however, Alaska's size, weather conditions, geography, and remote coastlines do not always allow for a field investigation/ confirmation to be a reasonable use of resources.

While the Alaska records could potentially be argued to constitute a variable record based on opportunistic reports, this data collection (sampling) method has been consistent for a decade and therefore constitutes a record that can be compared across reporting years. It is recognized that controls were not established for other important variables influencing the occurrence of strandings and/or the reporting of strandings (e.g, weather, seismic events, changes in fisheries).

Table F-2. Alaska Region Marine Mammal Strandings

Year	Cetacea – All Areas	Beaked Whales – All Areas	Cetacea – Southcentral and Kodiak Areas	Pinnipedia – All Areas	Pinnipedia – Southcentral and Kodiak Areas
1998 – 2002*	110	8	74	50	25
2003	166	1	131	81	14
2004	62	8	33	59	12
2005	63	2	30	54	20
2006	92	1	34	57	26
2007	63	0	30	54	20

Source: NMFS, Alaska Region, Protected Resources 2004; 2005; 2006; 2007; 2008

Records gathered by Zimmerman (1991) for the period between 1975 and 1987 indicate that 325 stranded cetaceans were reported for the entire state of Alaska. Prior to 1985, a centralized Federal stranding network had not been established, which limited the number of stranding reports recorded. Table F-3 details the most commonly stranded cetaceans in the Gulf of Alaska for that period.

Table F-3. Most Commonly Reported Species of Cetaceans Found Stranded in the Gulf of Alaska 1975 – 1987

Species	Number Stranded
Gray Whale	7
Beluga Whale	20
Stejneger's Beaked Whale	5
Killer Whale	6
Cuvier's Beaked Whale	5
Minke Whale	10
Bowhead Whale	0
Humpback Whale	9
Sperm Whale	4
Baird's Beaked Whale	1
Fin Whale	3
Total	70

Source: Zimmerman, 1991

F.1.4 Threats to Marine Mammals and Potential Causes for Stranding

Reports of marine mammal strandings can be traced back to ancient Greece (Walsh et al., 2001). Like any wildlife population, there are normal background mortality rates that influence marine mammal population dynamics, including starvation, predation, aging, reproductive success, and disease (Geraci et al. 1999; Carretta et al. 2007). Strandings in and of themselves may be reflective of this natural cycle or, more recently, may be the result of anthropogenic sources (i.e., human impacts). Current science suggests that multiple factors, both natural and man-made, may be acting alone or in combination to cause a marine mammal to strand (Geraci et al., 1999; Culik, 2002; Perrin and Geraci, 2002; Hoelzel, 2003; Geraci and Lounsbury, 2005; NRC, 2006). While post-stranding data collection and necropsies of dead animals are attempted in an effort to find a possible cause for the stranding, it is often difficult to pinpoint exactly one factor that can be blamed for any given stranding. An animal suffering from one ailment becomes susceptible to various other influences because of its weakened condition, making it difficult to determine a primary cause. In many stranding cases, scientists never learn the exact reason for the stranding.

Specific potential stranding causes can include both natural and human influenced (anthropogenic) causes listed below and described in the following sections:

Natural Stranding Causes
- Disease
- Natural toxins
- Weather and climatic influences
- Navigation errors
- Social cohesion
- Predation

Human Influenced (Anthropogenic) Stranding Causes
- Fisheries interaction
- Vessel strike
- Pollution and ingestion
- Noise

F.1.4.1 Natural Stranding Causes

Significant natural causes of mortality, die-offs, and stranding discussed below include disease and parasitism; marine neurotoxins from algae; navigation errors that lead to inadvertent stranding; and climatic influences that impact the distribution and abundance of potential food resources (i.e., starvation). Other natural mortality not discussed in detail includes predation by other species such as sharks (Cockcroft et al., 1989; Heithaus, 2001), killer whales (Constantine et al. 1998; Guinet et al. 2000; Pitman et al. 2001), and some species of pinniped (Hiruki et al. 1999; Robinson et al. 1999).

Disease

Like other mammals, marine mammals frequently suffer from a variety of diseases of viral, bacterial, parasitic, and fungal origin (Visser et al. 1991; Dunn et al. 2001; Harwood 2002). Gulland and Hall (2005) provide a more detailed summary of individual and population effects of marine mammal diseases.

Microparasites such as bacteria, viruses, and other microorganisms are commonly found in marine mammal habitats and usually pose little threat to a healthy animal (Geraci et al. 1999). For example, long-finned pilot whales that inhabit the waters off of the northeastern coast of the U.S. are carriers of the morbillivirus, yet have grown resistant to its usually lethal effects (Geraci et al. 1999). Since the 1980s, however, virus infections have been strongly associated with marine mammal die-offs (Domingo et al., 1992; Geraci and Lounsbury, 2005). Morbillivirus is the most significant marine mammal virus and suppresses a host's immune system, increasing risk of secondary infection (Harwood 2002). A bottlenose dolphin UME in 1993 and 1994 was caused by infectious disease. Die-offs ranged from northwestern Florida to Texas, with an increased number of deaths as it spread (NMFS 2007c). A 2004 UME in Florida was also associated with dolphin morbillivirus (NMFS 2004). Influenza A was responsible for the first reported mass mortality in the U.S., occurring along the coast of New England in 1979-1980 (Geraci et al. 1999; Harwood 2002). Canine distemper virus (a type of morbillivirus) has been responsible for large scale pinniped mortalities and die-offs (Grachev et al. 1989; Kennedy et al., 2000; Gulland and Hall, 2005), while a bacteria, *Leptospira pomona*, is responsible for periodic die-offs in California sea lions about every four years (Gulland et al. 1996; Gulland and Hall 2005). It is difficult to determine whether microparasites commonly act as a primary pathogen, or whether they show up as a secondary infection in an already weakened animal (Geraci et al. 1999). Most marine mammal die-offs from infectious disease in the last 25 years, however, have had viruses associated with them (Simmonds and Mayer 1997; Geraci et al. 1999; Harwood 2002).

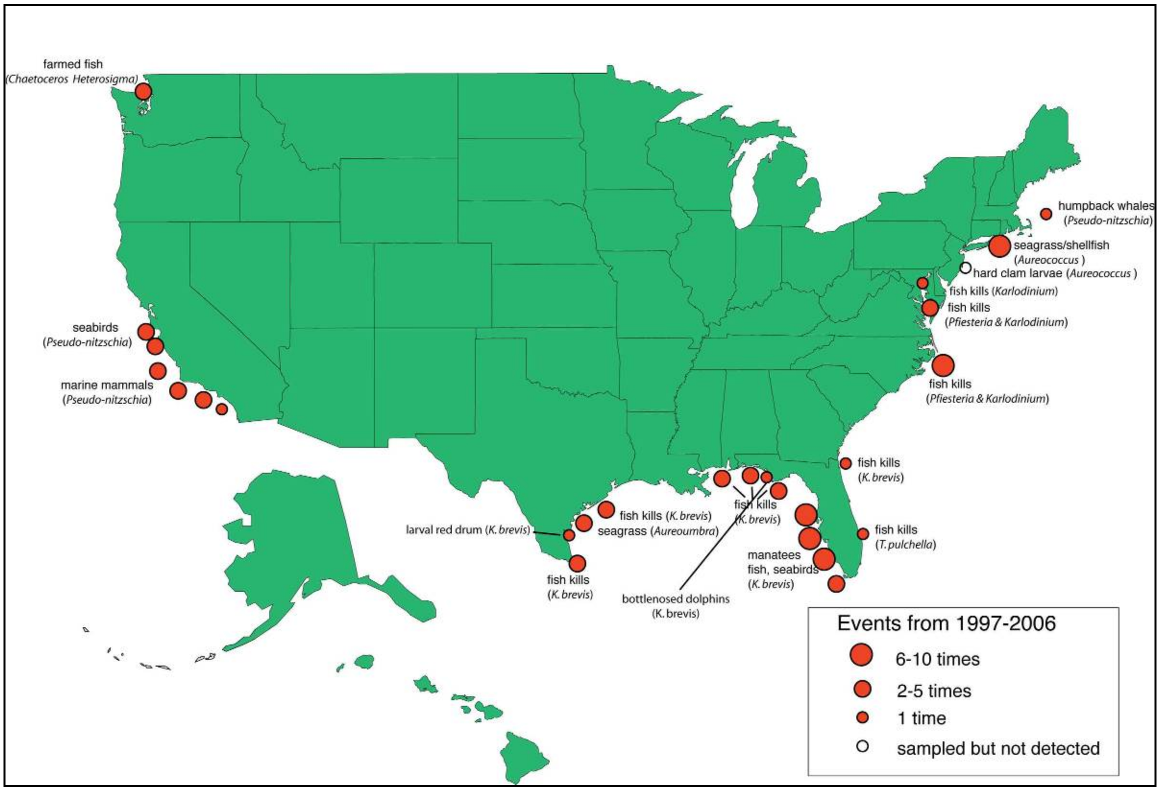
Macroparasites are usually large parasitic organisms and include lungworms, trematodes (parasitic flatworms), and protozoans (Geraci and St. Aubin 1987; Geraci et al. 1999). Marine mammals can carry many different types, and have shown a robust tolerance for sizeable infestation unless compromised by illness, injury, or starvation (Morimitsu et al. 1987; Dailey et al. 1991; Geraci et al., 1999). Nasitrema, a usually benign trematode found in the head sinuses of cetaceans (Geraci et al. 1999), can cause brain damage if it migrates (Ridgway and Dailey 1972). As a result, this worm is one of the few directly linked to stranding in the cetaceans (Dailey and Walker 1978; Geraci et al. 1999).

Non-infectious disease, such as congenital bone pathology of the vertebral column (osteomyelitis, spondylosis deformans, and ankylosing spondylitis [AS]), has been described in several species of cetacean (Paterson 1984; Alexander et al. 1989; Kompanje 1995; Sweeny et al. 2005). In humans, bone pathology such as AS, can impair mobility and increase vulnerability to further spinal trauma (Resnick and Niwayama 2002). Bone pathology has been found in cases of single strandings (Paterson 1984; Kompanje 1995), and also in cetaceans prone to mass stranding (Sweeny et al. 2005), possibly acting as a contributing or causal influence in both types of events.

Naturally Occurring Marine Neurotoxins

Some single cell marine algae common in coastal waters, such as dinoflagellates and diatoms, produce toxic compounds that can accumulate (termed bioaccumulation) in the flesh and organs of fish and invertebrates (Geraci et al. 1999; Harwood 2002). Marine mammals become exposed to these compounds when they eat prey contaminated by these naturally produced toxins although exposure can also occur through inhalation and skin contact (Van Dolah 2005). Figure F-1 shows U.S. animal mortalities from 1997-2006 resulting from toxins produced during harmful algal blooms.

In the Gulf of Mexico and mid- to southern Atlantic states, "red tides," a form of harmful algal bloom, are created by a dinoflagellate (*Karenia brevis*). *K. brevis* is found throughout the Gulf of Mexico and sometimes along the Atlantic coast (Van Dolah 2005; NMFS 2007). It produces a neurotoxin known as brevetoxin. Brevetoxin has been associated with several marine mammal UMEs within this area (Geraci 1989; Van Dolah et al. 2003; NMFS 2004; Flewelling et al. 2005; Van Dolah 2005; NMFS 2007). On the U.S. West Coast and in the northeast Atlantic, several species of diatoms produce a toxin called domoic acid which has also been linked to marine mammal strandings (Geraci et al. 1999; Van Dolah et al. 2003; Greig et al. 2005; Van Dolah 2005; Brodie et al. 2006; NMFS 2007; Bargu et al. 2008; Goldstein et al. 2008). Other algal toxins associated with marine mammal strandings include saxitoxins and ciguatoxins and are summarized by Van Dolah (2005).



Source: Woods Hole Oceanographic Institute (WHO) http://www.whoi.edu/redtide/HABdistribution/HABmap.html

Figure F-1. Animal Mortalities from Harmful Algal Blooms within the U.S., 1997-2006.

Weather events and climate influences

Severe storms, hurricanes, typhoons, and prolonged temperature extremes may lead to localized marine mammal strandings (Geraci et al., 1999; Walsh et al. 2001). Hurricanes may have been responsible for mass strandings of pygmy killer whales in the British Virgin Islands and Gervais' beaked whales in North Carolina (Mignucci-Giannoni et al. 2000; Norman and Mead 2001). Storms in 1982-1983 along the California coast led to deaths of 2,000 northern elephant seal pups (Le Boeuf and Reiter 1991). Ice movement along southern Newfoundland has forced groups of blue whales and white-beaked dolphins ashore (Sergeant 1982). Seasonal oceanographic conditions in terms of weather, frontal systems, and local currents may also play a role in stranding (Walker et al. 2005).

The effect of large scale climatic changes to the world's oceans and how these changes impact marine mammals and influence strandings is difficult to quantify given the broad spatial and temporal scales involved, and the cryptic movement patterns of marine mammals (Moore 2005; Learmonth et al. 2006). The most immediate, although indirect, effect is decreased prey availability during unusual conditions. This, in turn, results in increased search effort required by marine mammals (Crocker et al. 2006), potential starvation if not successful, and corresponding stranding due directly to starvation or succumbing to disease or predation while in a more weakened, stressed state (Selzer and Payne 1988; Geraci et al. 1999; Moore 2005; Learmonth et al. 2006; Weise et al. 2006).

Two recent papers examined potential influences of climate fluctuation on stranding events in southern Australia, including Tasmania, an area with a history of more than 20 mass stranding since the 1920s (Evans et al., 2005; Bradshaw et al. 2006). These authors note that patterns in animal migration, survival, fecundity, population size, and strandings will revolve around the availability and distribution of food resources. In southern Australia, movement of nutrient-rich waters pushed closer to shore by periodic meridinal winds (occurring about every 12 to 14 years) may be responsible for bringing marine mammals closer to land, thus increasing the probability of stranding (Bradshaw et al. 2006). The papers conclude, however, that while an overarching model can be helpful for providing insight into the prediction of strandings, the particular reasons for each one are likely to be quite varied.

Navigation Error

Geomagnetism - It has been hypothesized that, like some land animals, marine mammals may be able to orient to the Earth's magnetic field as a navigational cue, and that areas of local magnetic anomalies may influence strandings (Bauer et al. 1985; Klinowska 1985; Kirschvink et al. 1986; Klinowska, 1986; Walker et al. 1992; Wartzok and Ketten 1999). In a plot of live stranding positions in Great Britain with magnetic field maps, Klinowska (1985; 1986) observed an association between live stranding positions and magnetic field levels. In all cases, live strandings occurred at locations where magnetic minima, or lows in the magnetic fields, intersect the coastline. Kirschvink et al. (1986) plotted stranding locations on a map of magnetic data for the East Coast of the U.S., and were able to develop associations between stranding sites and locations where magnetic minima intersected the coast. The authors concluded that there were highly significant tendencies for cetaceans to beach themselves near these magnetic minima and coastal intersections. The results supported the hypothesis that cetaceans may have a magnetic sensory system similar to other migratory animals, and that marine magnetic topography and patterns may influence long-distance movements (Kirschvink et al. 1986). Walker et al. (1992) examined fin whale swim patterns off the northeastern U.S. continental shelf, and reported that migrating animals aligned with lows in the geometric gradient or intensity. While a similar pattern between magnetic features and marine mammal strandings at New Zealand stranding sites was not seen (Brabyn and Frew, 1994), mass strandings in Hawaii typically were found to occur within a narrow range of magnetic anomalies (Mazzuca et al. 1999).

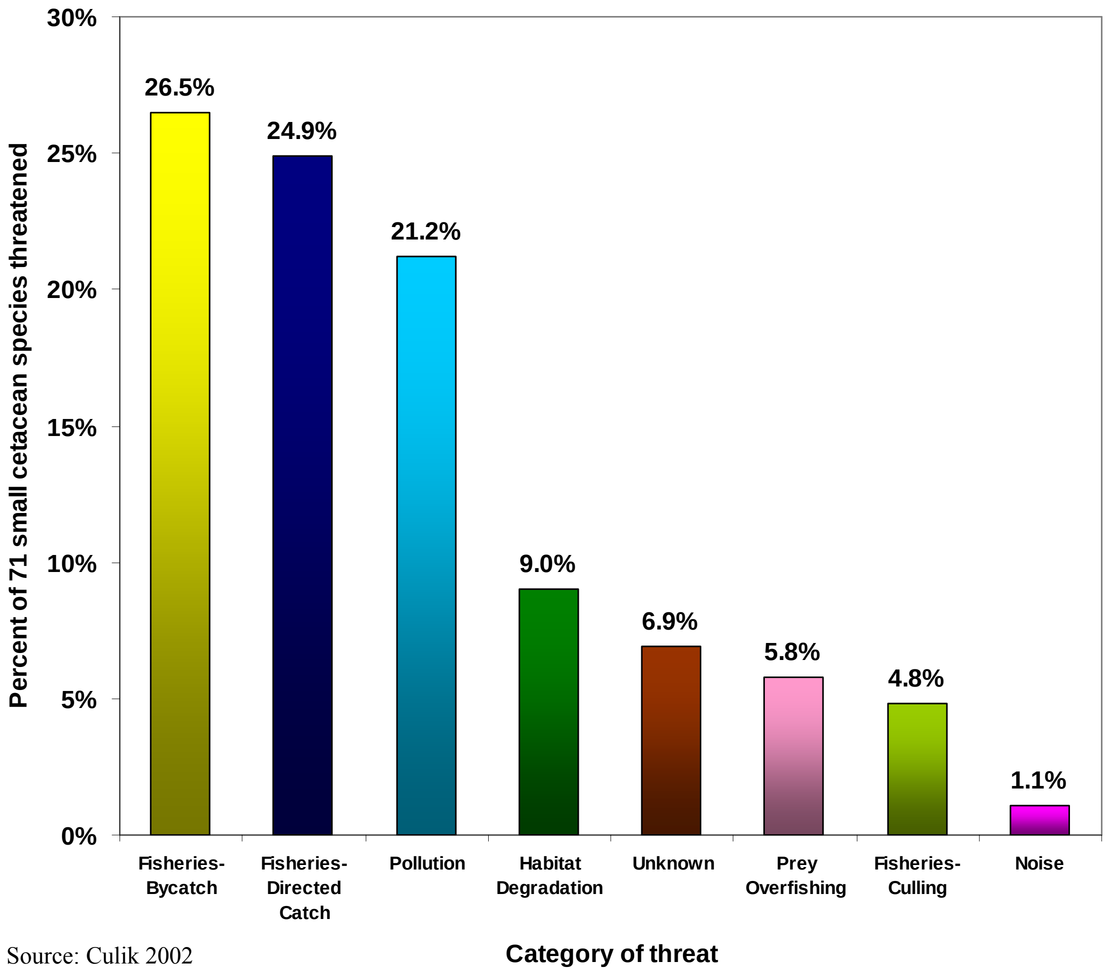
Echolocation Disruption in Shallow Water - Some researchers believe stranding may result from reductions in the effectiveness of echolocation within shallow water, especially with the pelagic species of odontocetes that may be less familiar with coastline (Dudok van Heel 1966; Chambers and James 2005). For an odontocete, echoes from echolocation signals contain important information on the location and identity of underwater objects and the shoreline. The authors postulate that the gradual slope of a beach may present difficulties to the navigational systems of some cetaceans, since it is common for live strandings to occur along beaches with shallow, sandy gradients (Brabyn and McLean, 1992; Mazzuca et al., 1999; Maldini et al., 2005; Walker et al., 2005). A contributing factor to echolocation interference in turbulent, shallow water is the presence of microbubbles from the interaction of wind, breaking waves, and currents. Additionally, ocean water near the shoreline can have an increased turbidity (e.g., floating sand or silt, particulate plant matter, etc.) due to the run-off of fresh water into the ocean, either from rainfall or from freshwater outflows (e.g., rivers and creeks). Collectively, these factors can reduce and scatter the sound energy within echolocation signals and reduce the perceptibility of returning echoes of interest.

Social Cohesion

Many pelagic species such as sperm whale, pilot whales, melon-head whales, and false killer whales, and some dolphins occur in large groups with strong social bonds between individuals. When one or more animals strand due to any number of causative events, then the entire pod may follow suit out of social cohesion (Geraci et al. 1999; Conner 2000; Perrin and Geraci 2002; NMFS 2007).

F.1.4.2 Anthropogenic Stranding Causes and Potential Risks

With the exception of historic whaling in the 19th and early part of the 20th century, over the past few decades there has been an increase in marine mammal mortalities associated with a variety of human activities (Geraci et al. 1999; NMFS 2007). These include fisheries interactions (bycatch and directed catch), pollution (marine debris, toxic compounds), habitat modification (degradation, prey reduction), direct trauma (vessel strikes, gunshots), and noise. Figure F-2 shows potential worldwide risk to small toothed cetaceans by source.



Source: Culik 2002

Figure F-2. Human Threats to World Wide Small Cetacean Populations

Fisheries Interaction: By-Catch, Directed Catch, and Entanglement

The incidental catch of marine mammals in commercial fisheries is a significant threat to the survival and recovery of many populations of marine mammals (Geraci et al.,1999; Baird 2002; Culik 2002; Carretta et al. 2004; Geraci and Lounsbury 2005; NMFS 2007). Interactions with fisheries and entanglement in discarded or lost gear continue to be a major factor in marine mammal deaths worldwide (Geraci et al. 1999; Nieri et al. 1999; Geraci and Lounsbury 2005; Read et al. 2006; Zeeber et al. 2006). For instance, baleen whales and pinnipeds have been found entangled in nets, ropes, monofilament line, and other fishing gear that has been discarded out at sea (Geraci et al. 1999; Campagna et al. 2007).

Bycatch - Bycatch is the catching of non-target species within a given fishing operation and can include non-commercially used invertebrates, fish, sea turtles, birds, and marine mammals (NRC 2006). Read et al. (2006) attempted to estimate the magnitude of marine mammal bycatch in U.S. and global fisheries. Data on marine mammal bycatch within the United States was obtained from fisheries observer programs, reports of entangled stranded animals, and fishery logbooks, and was then extrapolated to estimate global bycatch by using the ratio of U.S. fishing vessels to the total number of vessels within the world's fleet (Read et al., 2006). Within U.S. fisheries, between 1990 and 1999 the mean annual bycatch of marine mammals was 6,215 animals, with a standard error of +/- 448 (Read et al., 2006). Eight-four percent of cetacean bycatch occurred in gill-net fisheries, with dolphins and porpoises constituting most of the cetacean bycatch (Read et al., 2006). Over the decade there was a 40 percent decline in marine mammal bycatch, which was significantly lower from 1995-1999 than it was from 1990-1994 (Read et al., 2006). Read et al., (2006) suggests that this is primarily due to effective conservation measures that were implemented during this period.

Read et al. (2006) then extrapolated this data for the same time period and calculated an annual estimate of 653,365 of marine mammals globally, with most of the world's bycatch occurring in gill-net fisheries. With global marine mammal bycatch likely to be in the hundreds of thousands every year, bycatch in fisheries is the single greatest threat to many marine mammal populations around the world (Read et al., 2006).

Entanglement - Entanglement in active fishing gear is a major cause of death or severe injury among the endangered whales in the action area. Entangled marine mammals may die as a result of drowning, escape with pieces of gear still attached to their bodies, manage to be set free either of their own accord, or are set free by fishermen. Many large whales carry off gear after becoming entangled (Read et al., 2006). Many times when a marine mammal swims off with gear attached, the end result can be fatal. The gear may be become too cumbersome for the animal or it can be wrapped around a crucial body part and tighten over time. Stranded marine mammals frequently exhibit signs of previous fishery interaction, such as scarring or gear attached to their bodies, and the cause of death for many stranded marine mammals is often attributed to such interactions (Baird and Gorgone, 2005). Because marine mammals that die or are injured in fisheries may not wash ashore and because not all animals that do wash ashore exhibit clear signs of interactions, stranding data probably underestimate fishery-related mortality and serious injury (NMFS 2005a)

From 1993 through 2003, 1,105 harbor porpoises were reported stranded from Maine to North Carolina, many of which had cuts and body damage suggestive of net entanglement (NMFS 2005e). In 1999 it was possible to determine that the cause of death for 38 of the stranded porpoises was from fishery interactions, with one additional animal having been mutilated (right flipper and fluke cut off) (NMFS 2005e). In 2000, one stranded porpoise was found with monofilament line wrapped around its body (NMFS 2005e). In 2003, nine stranded harbor porpoises were attributed to fishery interactions, with an additional three mutilated animals (NMFS 2005e). An estimated 78 baleen whales were killed annually in the offshore Southern California/Oregon drift gillnet fishery during the 1980s (Heyning and Lewis 1990). From 1998-2005, based on observer records, five fin whales (CA/OR/WA stock), 12 humpback whales (ENP stock), and six sperm whales (CA/OR/WA stock) were either seriously injured or killed in fisheries off the mainland West Coast of the U.S. (California Marine Mammal Stranding Network Database 2006).

Ship Strike

Vessel strikes to marine mammals are another cause of mortality and stranding (Laist et al., 2001; Geraci and Lounsbury 2005; de Stephanis and Urquiola, 2006). An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or an animal just below the surface could be cut by a vessel's propeller. The severity of injuries typically depends on the size and speed of the vessel (Knowlton and Kraus, 2001; Laist et al., 2001; Vanderlaan and Taggart, 2007).

An examination of all known ship strikes from all shipping sources (civilian and military) indicates vessel speed is a principal factor in whether a vessel strike results in death (Knowlton and Kraus, 2001; Laist et al., 2001, Jensen and Silber, 2003; Vanderlaan and Taggart, 2007). In assessing records in which vessel speed was known, Laist et al. (2001) found a direct relationship between the occurrence of a whale strike and the speed of the vessel involved in the collision. The authors concluded that most deaths occurred when a vessel was traveling in excess of 13 knots although most vessels do travel greater than 15 knots. Jensen and Silber (2003) detailed 292 records of known or probable ship strikes of all large whale species from 1975 to 2002. Of these, vessel speed at the time of collision was reported for 58 cases. Of these cases, 39 (or 67 percent) resulted in serious injury or death (19 or 33 percent resulted in serious injury as determined by blood in the water, propeller gashes or severed tailstock, and fractured skull, jaw, vertebrae, hemorrhaging, massive bruising or other injuries noted during necropsy and 20 or 35% resulted in death). Operating speeds of vessels that struck various species of large whales ranged from 2 to 51 knots. The majority (79 percent) of these strikes occurred at speeds of 13 knots or greater. The average speed that resulted in serious injury or death was 18.6 knots. Pace and Silber (2005) found that the probability of death or serious injury increased rapidly with increasing vessel speed. Specifically, the predicted probability of serious injury or death increased from 45 percent to 75 % as vessel speed increased from 10 to 14 knots, and exceeded 90% at 17 knots. Higher speeds during collisions result in greater force of impact, but higher speeds also appear to increase the chance of severe injuries or death by pulling whales toward the vessel. Computer simulation modeling showed that hydrodynamic forces pulling whales toward the vessel hull increase with increasing speed (Clyne, 1999; Knowlton et al., 1995).

The growth in civilian commercial ports and associated commercial vessel traffic is a result in the globalization of trade. The Final Report of the NOAA International Symposium on “Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology” stated that the worldwide commercial fleet has grown from approximately 30,000 vessels in 1950 to more than 85,000 vessels in 1998 (NRC, 2003; Southall, 2005). Between 1950 and 1998, the U.S. flagged fleet declined from approximately 25,000 to fewer than 15,000 and currently represents only a small portion of the world fleet. From 1985 to 1999, world seaborne trade doubled to 5 billion tons and currently includes 90 percent of the total world trade, with container shipping movements representing the largest volume of seaborne trade. It is unknown how international shipping volumes and densities will continue to grow. However, current statistics support the prediction that the international shipping fleet will continue to grow at the current rate or at greater rates in the future. Shipping densities in specific areas and trends in routing and vessel design are as, or more, significant than the total number of vessels. Densities along existing coastal routes are expected to increase both domestically and internationally. New routes are also expected to develop as new ports are opened and existing ports are expanded. Vessel propulsion systems are also advancing toward faster ships operating in higher sea states for lower operating costs; and container ships are expected to become larger along certain routes (Southall 2005).

While there are reports and statistics of whales struck by vessels in U.S. waters, the magnitude of the risks of commercial ship traffic poses to marine mammal populations is difficult to quantify or estimate. In addition, there is limited information on vessel strike interactions between ships and marine mammals outside of U.S. waters (de Stephanis and Urquiola 2006). Laist et al. (2001) concluded that ship collisions may have a negligible effect on most marine mammal populations in general, except for regional based small populations where the significance of low numbers of collisions would be greater given smaller populations or populations segments.

U.S. Navy vessel traffic is a small fraction of the overall U.S. commercial and fishing vessel traffic. While U.S. Navy vessel movements may contribute to the ship strike threat, given the lookout and mitigation measures adopted by the U.S. Navy, probability of vessel strikes is greatly reduced. Furthermore, actions to avoid close interaction of U.S. Navy ships and marine mammals and sea turtles, such as maneuvering to keep away from any observed marine mammal and sea turtle are part of existing at-sea protocols and standard operating procedures. Navy ships have up to three or more dedicated and trained lookouts as well as two to three bridge watchstanders during at-sea movements who would be searching for any whales, sea turtles, or other obstacles on the water surface. Such lookouts are expected to further reduce the chances of a collision.

Commercial and Private Marine Mammal Viewing

In addition to vessel operations, private and commercial vessels engaged in marine mammal watching also have the potential to impact marine mammals in Southern California. NMFS has promulgated regulations at 50 CFR 224.103, which provide specific prohibitions regarding wildlife viewing activities. In addition, NMFS launched an education and outreach campaign to provide commercial operators and the general public with responsible marine mammal viewing guidelines. In January 2002, NMFS also published an official policy on human interactions with wild marine mammals which states: "NOAA Fisheries cannot support, condone, approve or authorize activities that involve closely approaching, interacting or attempting to interact with whales, dolphins, porpoises, seals, or sea lions in the wild. This includes attempting to swim, pet, touch or elicit a reaction from the animals."

Although considered by many to be a non-consumptive use of marine mammals with economic, recreational, educational, and scientific benefits, marine mammal watching is not without potential negative impacts. One concern is that animals become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle et al. 1993; Wiley et al. 1995). Another concern is that preferred habitats may be abandoned if disturbance levels are too high. A whale's behavioral response to whale watching vessels depends on the distance of the vessel from the whale, vessel speed, vessel direction, vessel noise, and the number of vessels (Amaral and Carlson 2005; Au and Green 2000; Cockeron 1995; Erbe 2002; Felix 2001; Magalhaes et al. 2002; Richter et al. 2003; Schedat et al. 2004; Simmonds 2005; Watkins 1986; Williams et al. 2002). The whale's responses changed with these different variables and, in some circumstances, the whales did not respond to the vessels, but in other circumstances, whales changed their vocalizations surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions. In addition to the information on whale watching, there is also direct evidence of pinniped haul out site (Pacific harbor seals) abandonment because of human disturbance at Strawberry Spit in San Francisco Bay (Allen 1991).

Ingestion of Plastic Objects and Other Marine Debris and Toxic Pollution Exposure

For many marine mammals, debris in the marine environment is a great hazard and can be harmful to wildlife. Not only is debris a hazard because of possible entanglement, animals may mistake plastics and other debris for food (NMFS, 2007g). U.S. Navy vessels have a zero-plastic discharge policy and return all plastic waste to appropriate disposition on shore.

There are certain species of cetaceans, along with Florida manatees, that are more likely to eat trash, especially plastics, which is usually fatal for the animal (Geraci et al. 1999). From 1990 through October 1998, 215 pygmy sperm whales stranded along the U.S. Atlantic Coast from New York through the Florida Keys (NMFS 2005a). Remains of plastic bags and other debris were found in the stomachs of 13 of these animals (NMFS 2005a). During the same period, 46 dwarf sperm whale strandings occurred along the U.S. Atlantic coastline between Massachusetts and the Florida Keys (NMFS 2005d). In 1987 a pair of latex examination gloves was retrieved from the stomach of a stranded dwarf sperm whale (NMFS 2005d). One hundred twenty-five pygmy sperm whales were reported stranded from 1999 to 2003 between Maine and Puerto Rico; in one pygmy sperm whale found stranded in 2002, red plastic debris was found in the stomach along with squid beaks (NMFS 2005a).

Sperm whales have been known to ingest plastic debris, such as plastic bags (Evans et al. 2003; Whitehead 2003). While this has led to mortality, the scale to which this is affecting sperm whale populations is unknown, but Whitehead (2003) suspects it is not substantial at this time.

High concentrations of potentially toxic substances within marine mammals along with an increase in new diseases have been documented in recent years. Scientists have begun to consider the possibility of a link between pollutants and marine mammal mortality events. NMFS takes part in a marine mammal bio-monitoring program not only to help assess the health and contaminant loads of marine mammals, but also to assist in determining anthropogenic impacts on marine mammals, marine food chains and marine ecosystem health. Using strandings and bycatch animals, the program provides tissue/serum archiving, samples for analyses, disease monitoring and reporting, and additional response during disease investigations (NMFS 2007).

The impacts of these activities are difficult to measure. However, some researchers have correlated contaminant exposure to possible adverse health effects in marine mammals. Contaminants such as organochlorines do not tend to accumulate in significant amounts in invertebrates, but do accumulate in fish and fish-eating animals. Thus, contaminant levels in planktivorous mysticetes have been reported to be one to two orders of magnitude lower compared to piscivorous odontocetes (Borell 1993; O'Shea and Brownell 1994; O'Hara and Rice 1996; O'Hara et al. 1999).

The manmade chemical PCB (polychlorinated biphenyl), and the pesticide DDT (dichlorodiphyenyltrichloroethane), are both considered persistent organic pollutants that are currently banned in the United States for their harmful effects in wildlife and humans (NMFS, 2007c). Despite having been banned for decades, the levels of these compounds are still high in marine mammal tissue samples taken along U.S. coasts (NMFS, 2007c). Both compounds are long-lasting, reside in marine mammal fat tissues (especially in the blubber), and can be toxic causing effects such as reproductive impairment and immunosuppression (NMFS, 2007c).

Both long-finned and short-finned pilot whales have a tendency to mass strand throughout their range. Short-finned pilot whales have been reported as stranded as far north as Rhode Island, and long-finned pilot whales as far south as South Carolina (NMFS 2005b). For U.S. East Coast stranding records, both species are lumped together and there is rarely a distinction between the two because of uncertainty in species identification (NMFS 2005b). Since 1980 within the Northeast region alone, between 2 and 120 pilot whales have stranded annually either individually or in groups (NMFS 2005b). Between 1999 and 2003 from Maine to Florida, 126 pilot whales were reported stranded, including a mass stranding of 11 animals in 2000 and another mass stranding of 57 animals in 2002, both along the Massachusetts coast (NMFS 2005b).

It is unclear how much of a role human activities play in these pilot whale strandings, and toxic poisoning may be a potential human-caused source of mortality for pilot whales (NMFS, 2005b). Moderate levels of PCBs and chlorinated pesticides (such as DDT, DDE, and dieldrin) have been found in pilot whale blubber (NMFS 2005b). Bioaccumulation levels have been found to be more similar in whales from the same stranding event than from animals of the same age or sex (NMFS 2005b). Numerous studies have measured high levels of toxic metals (mercury, lead, and cadmium), selenium, and PCBs in pilot whales in the Faroe Islands (NMFS 2005b). Population effects resulting from such high contamination levels are currently unknown (NMFS 2005b).

Habitat contamination and degradation may also play a role in marine mammal mortality and strandings. Some events caused by man have direct and obvious effects on marine mammals, such as oil spills (Geraci et al. 1999). But in most cases, effects of contamination will more than likely be indirect in nature, such as effects on prey species availability, or by increasing disease susceptibility (Geraci et al. 1999).

U.S. Navy vessel operation between ports and exercise locations has the potential for release of small amounts of pollutant discharges into the water column. U.S. Navy vessels are not a typical source, however, of either pathogens or other contaminants with bioaccumulation potential such as pesticides and

PCBs. Furthermore, any vessel discharges such as bilge water and deck runoff associated with the vessels would be in accordance with international and U.S. requirements for eliminating or minimizing discharges of oil, garbage, and other substances, and not likely to contribute significant changes to ocean water quality.

Deep Water Ambient Noise

Urick (1983) provided a discussion of the ambient noise spectrum expected in the deep ocean. Shipping, seismic activity, and weather, are the primary causes of deep-water ambient noise. The ambient noise frequency spectrum can be predicted fairly accurately for most deep-water areas based primarily on known shipping traffic density and wind state (wind speed, Beaufort wind force, or sea state) (Urick 1983). For example, for frequencies between 100 and 500 Hz, Urick (1983) estimated the average deep water ambient noise spectra to be 73 to 80 dB for areas of heavy shipping traffic and high sea states, and 46 to 58 dB for light shipping and calm seas.

Shallow Water Ambient Noise

In contrast to deep water, ambient noise levels in shallow waters (i.e., coastal areas, bays, harbors, etc.) are subject to wide variations in level and frequency depending on time and location. The primary sources of noise include distant shipping and industrial activities, wind and waves, marine animals (Urick 1983). At any give time and place, the ambient noise is a mixture of all of these noise variables. In addition, sound propagation is also affected by the variable shallow water conditions, including the depth, bottom slope, and type of bottom. Where the bottom is reflective, the sounds levels tend to be higher, than when the bottom is absorptive.

Noise from Aircraft and Vessel Movement

Surface shipping is the most widespread source of anthropogenic, low frequency (0 to 1,000 Hz) noise in the oceans and may contribute to over 75 percent of all human sound in the sea (Simmonds and Hutchinson 1996, ICES 2005b). Ross (1976) has estimated that between 1950 and 1975, shipping had caused a rise in ambient noise levels of 10 dB. He predicted that this would increase by another 5 dB by the beginning of the 21st century. The National Resource Council (1997) estimated that the background ocean noise level at 100 Hz has been increasing by about 1.5 dB per decade since the advent of propeller-driven ships. Michel et al. (2001) suggested an association between long-term exposure to low frequency sounds from shipping and an increased incidence of marine mammal mortalities caused by collisions with ships.

Sound from a low-flying helicopter or airplane may be heard by marine mammals and turtles while at the surface or underwater. Due to the transient nature of sounds from aircraft involved in at-sea operations, such sounds would not likely cause physical effects but have the potential to affect behaviors. Responses by mammals and turtles could include hasty dives or turns, or decreased foraging (Soto et al., 2006). Whales may also slap the water with flukes or flippers or swim away from the aircraft track.

Sound emitted from large vessels, particularly in the course of transit, is the principal source of noise in the ocean today, primarily due to the properties of sound emitted by civilian cargo vessels (Richardson et al., 1995; Arveson and Vendittis, 2000). Ship propulsion and electricity generation engines, engine gearing, compressors, bilge and ballast pumps, as well as hydrodynamic flow surrounding a ship's hull and any hull protrusions contribute to a large vessels' noise emission into the marine environment. Propeller-driven vessels also generate noise through cavitation, which accounts for much of the noise emitted by a large vessel depending on its travel speed. Military vessels underway or involved in naval operations or exercises, also introduce anthropogenic noise into the marine environment. Noise emitted by large vessels can be characterized as low-frequency, continuous, and tonal. The sound pressure levels at the vessel will vary according to speed, burden, capacity and length (Richardson et al. 1995; Arveson and Vendittis, 2000). Vessels ranging from 135 to 337 meters generate peak source sound levels from 169 to 200 dB between 8 Hz and 430 Hz, although Arveson and Vendittis (2000) documented components of higher frequencies (10-30 kHz) as a function of newer merchant ship engines and faster transit speeds.

Whales have variable responses to vessel presence or approaches, ranging from apparent tolerance to diving away. Unfortunately, it is not always possible to determine whether the whales are responding to the vessel itself or the noise generated by the engine and cavitation around the propeller. Apart from some disruption of behavior, an animal may be unable to hear other sounds in the environment due to masking by the noise from the vessel. Any masking of environmental sounds or conspecific sounds is expected to be temporary, as noise dissipates with a vessel transit through an area.

Vessel noise primarily raises concerns for masking of environmental and conspecific cues. However, exposure to vessel noise of sufficient intensity and/or duration can also result in temporary or permanent loss of sensitivity at a given frequency range, referred to as temporary or permanent threshold shifts (TTS or PTS). Threshold shifts are assumed to be possible in marine mammal species as a result of prolonged exposure to large vessel traffic noise due to its intensity, broad geographic range of effectiveness, and constancy.

Collectively, significant cumulative exposure to individuals, groups, or populations can occur if they exhibit site fidelity to a particular area; for example, whales that seasonally travel to a regular area to forage or breed may be more vulnerable to noise from large vessels compared to transiting whales. Any permanent threshold shift in a marine animal's hearing capability, especially at particular frequencies for which it can normally hear best, can impair its ability to perceive threats, including ships. Whales have variable responses to vessel presence or approaches, ranging from apparent tolerance to diving away from a vessel. It is not possible to determine whether the whales are responding to the vessel itself or the noise generated by the engine and cavitation around the propeller. Apart from some disruption of behavior, an animal may be unable to hear other sounds in the environment due to masking by the noise from the vessel.

Most observations of behavioral responses of marine mammals to human generated sounds have been limited to short-term behavioral responses, which included the cessation of feeding, resting, or social interactions. Nowacek et al. (2007) provide a detailed summary of cetacean response to underwater noise.

Given the sound propagation of low frequency sounds, a large vessel in this sound range can be heard 139 to 463 kilometers away (Ross, 1976 in Polefka, 2004). U.S. Navy vessels, however, have incorporated significant underwater ship quieting technology to reduce their acoustic signature (compared to a similarly sized vessel) in order to reduce their vulnerability to detection by enemy passive acoustics (Southall, 2005). Therefore, the potential for TTS or PTS from U.S. Navy vessel and aircraft movement is extremely low given that the exercises and training events are transitory in time, with vessels moving over large area of the ocean. A marine mammal or sea turtle is unlikely to be exposed long enough at high levels for TTS or PTS to occur. Any masking of environmental sounds or conspecific sounds is expected to be temporary, as noise dissipates with a U.S. Navy vessel transiting through an area. If behavioral disruptions result from the presence of aircraft or vessels, it is expected to be temporary. Animals are expected to resume their migration, feeding, or other behaviors without any threat to their survival or reproduction. However, if an animal is aware of a vessel and dives or swims away, it may successfully avoid being struck.

F.1.5 Stranding Events Associated with Navy Sonar

There are two classes of sonars employed by the U.S. Navy: active sonars and passive sonars. Most active military sonars operate in a limited number of areas, and are most likely not a significant contributor to a comprehensive global ocean noise budget (ICES, 2005b).

The effects of mid-frequency active naval sonar on marine wildlife have not been studied as extensively as the effects of air-guns used in seismic surveys (Madsen et al., 2006; Stone and Tasker, 2006; Wilson et al., 2006; Palka and Johnson, 2007; Parente et al., 2007). Maybaum (1989, 1993) observed changes in behavior of humpbacks during playback tapes of the M-1002 system (using 203 dB re 1 µPa-m for study); specifically, a decrease in respiration, submergence, and aerial behavior rates; and an increase in speed of travel and track linearity. Direct comparison of Maybaum's results, however, with U.S Navy mid-frequency active sonar are difficult to make. Maybaum's signal source, the commercial M-1002, operated differently from naval mid-frequency sonar. In addition, behavioral responses were observed during playbacks of a control tape, (i.e. a tape with no sound signal) so interpretation of Maybaum's results are inconclusive.

Research by Nowacek, et al. (2004) on North Atlantic right whales using a whale alerting signal designed to alert whales to human presence suggests that received sound levels of only 133 to 148 pressure level (decibel [dB] re 1 microPascals [µPa]) for the duration of the sound exposure may disrupt feeding behavior. The authors did note, however, that within minutes of cessation of the source, a return to normal behavior would be expected. Direct comparison of the Nowacek et al. (2004) sound source to MFA sonar, however, is not possible given the radically different nature of the two sources. Nowacek et al.'s source was a series of non-sonar like sounds designed to purposely alert the whale, lasting several minutes, and covering a broad frequency band. Direct differences between Nowacek et al. (2004) and MFA sonar is summarized below from Nowacek et al. (2004) and Nowacek et al. (2007):

(1) Signal duration: Time difference between the two signals is significant, 18-minute signal used by Nowacek et al. versus < 1 sec for MFA sonar.

(2) Frequency modulation: Nowacek et al. contained three distinct signals containing frequency modulated sounds:

1st - alternating 1-sec pure tone at 500 and 850 Hz

2nd - 2-sec logarithmic down-sweep from 4500 to 500 Hz

3rd - pair of low-high (1500 and 2000 Hz) sine wave tones amplitude modulated at 120 Hz

(3) Signal-to-noise ratio: Nowacek et al.'s signal maximized signal-to noise-ratio so that it would be distinct from ambient noise and resist masking.

(4) Signal acoustic characteristics: Nowacek et al.'s signal comprised of disharmonic signals spanning northern right whales' estimated hearing range.

Given these differences, therefore, the exact cause of apparent right whale behavior noted by the authors can not be attributed to any one component since the source was such a mix of signal types.

The effects of naval sonars on marine wildlife have not been studied as extensively as have the effects of airguns used in seismic surveys (Nowacek et al., 2007). In the Caribbean, sperm whales were observed to interrupt their activities by stopping echolocation and leaving the area in the presence of underwater sounds surmised to have originated from submarine sonar signals (Watkins and Schevill, 1975; Watkins et al., 1985). The authors did not report receive levels from these exposures, and also got a similar reaction from artificial noise they generated by banging on their boat hull. It was unclear if the sperm whales were reacting to the sonar signal itself or to a potentially new unknown sound in general. Madsen et al. (2006) tagged and monitored eight sperm whales in the Gulf of Mexico exposed to seismic airgun surveys. Sound sources were from approximately 2 to 7 nm (4 to 13 km) away from the whales and based on multipath propagation RLs were as high as 162 dB re 1 uPa with energy content greatest between 0.3

and 3.0 kHz. Sperm whales engaged in foraging dives continued the foraging dives throughout exposures to these seismic pulses. In the Caribbean Sea, sperm whales avoided exposure to mid-frequency submarine sonar pulses, in the range 1000 Hz to 10,000 Hz (IWC 2005). Sperm whales have also moved out of areas after the start of air gun seismic testing (Davis et al. 1995). In contrast, during playback experiments off the Canary Islands, André et al. (1997) reported that foraging sperm whales exposed to a 10 kHz pulsed signal did not exhibit any general avoidance reactions.

The Navy sponsored tests of the effects of low-frequency active (LFA) sonar source, between 100 Hz and 1000 Hz, on blue, fin, and humpback whales. The tests demonstrated that whales exposed to sound levels up to 155 dB did not exhibit significant disturbance reactions, though there was evidence that humpback whales altered their vocalization patterns in reaction to the noise. Given that the source level of the Navy's LFA is reported to be in excess of 215 dB, the possibility exists that animals in the wild may be exposed to sound levels much higher than 155 dB.

Acoustic exposures have been demonstrated to kill marine mammals and result in physical trauma, and injury (Ketten 2005). Animals in or near an intense noise source can die from profound injuries related to shock wave or blast effects. Acoustic exposures can also result in noise induced hearing loss that is a function of the interactions of three factors: sensitivity, intensity, and frequency. Loss of sensitivity is referred to as a threshold shift; the extent and duration of a threshold shift depends on a combination of several acoustic features and is specific to particular species (TTS or PTS, depending on how the frequency, intensity and duration of the exposure combine to produce damage). In addition to direct physiological effects, noise exposures can impair an animal's sensory abilities (masking) or result in behavioral responses such as aversion or attraction (see Section 3.19).

Acoustic exposures can also result in the death of an animal by impairing its foraging, ability to detect predators or communicate, or by increasing stress, and disrupting important physiological events. Whales have moved away from their feeding and mating grounds (Bryant *et al*., 1984; Morton and Symnods, 2002; Weller et al., 2002), moved away from their migration route (Richardson et al., 1995), and have changed their calls due to noise (Miller et al., 2000). Acoustic exposures such as MFA sonar tend to be infrequent and temporary in nature. In situations such as the alteration of gray whale migration routes in response to shipping and whale watching boats, those acoustic exposures were chronic over several years (Moore and Clarke 2002). This was also true of the effect of seismic survey airguns (daily for 39 days) on the use of feeding areas by gray whales in the western North Pacific although whales began returning to the feeding area within one day of the end of the exposure (Weller et al. 2002).

Below are evaluations of the general information available on the variety of ways in which cetaceans and pinnipeds have been reported to respond to sound, generally, and mid-frequency sonar, in particular.

The Navy is very concerned and coordinates with NMFS as they thoroughly investigate each marine mammal stranding potentially associated with Navy activities to better understand the events surrounding strandings (Norman 2006). Strandings can involve a single animal or several to hundreds. An event where animals are found out of their normal habitat may be considered a stranding even though animals do not necessarily end up beaching (such as the July 2004 "Hanalei Mass Stranding Event"; Southall et al., 2006). Several hypotheses have been given for the mass strandings which include the impact of shallow beach slopes on odontocete sonar, disease or parasites, geomagnetic anomalies that affect navigation, following a food source in close to shore, avoiding predators, social interactions that cause other cetaceans to come to the aid of stranded animals, and human actions. Generally, inshore species do not strand in large numbers but generally just as a single animal. This may be due to their familiarity with the coastal area whereas pelagic species that are unfamiliar with obstructions or sea bottom tend to strand more often in larger numbers (Woodings, 1995). The Navy has studied several stranding events in detail that may have occurred in association with Navy sonar activities. To better understand the causal factors in stranding events that may be associated with Navy sonar activities, the main factors, including bathymetry (i.e., steep drop offs), narrow channels (less than 35 nm), environmental conditions (e.g., surface ducting), and multiple sonar ships were compared between the different stranding events.

When a marine mammal swims or floats onto shore and becomes “beached” or stuck in shallow water, it is considered a “stranding” (MMPA section 410 (16 USC section 1421g); NMFS, 2007a). NMFS explains that “a cetacean is considered stranded when it is on the beach, dead or alive, or in need of medical attention while free-swimming in U.S. waters. A pinniped is considered to be stranded either when dead or when in distress on the beach and not displaying normal haul-out behavior” (NMFS, 2007b).

Over the past three decades, several “mass stranding” events [strandings involving two or more individuals of the same species (excluding a single cow-calf pair) and at times, individuals from different species] that have occurred have been associated with naval operations, seismic surveys, and other anthropogenic activities that introduce sound into the marine environment (Canary Islands, Greece, Vieques, U.S. Virgin Islands, Madeira Islands, Haro Strait, Washington State, Alaska, Hawaii, North Carolina).

Information was collected on mass stranding events (events in which two or more cetaceans stranded) that have occurred and for which reports are available, from the past 40 years. Any causal agents that have been associated with those stranding events were also identified. Major range events undergo name changes over the years, however, the equivalent of COMPTUEX and JTFEX have been conducted in southern California since 1934. Training involving sonar has been conducted since World War II and sonar systems described in the SOCAL EIS/OEIS since the 1970's (Jane’s 2005).

F.1.6 Stranding Analysis

Over the past two decades, several mass stranding events involving beaked whales have been documented. While beaked whale strandings have been reported since the 1800s (Geraci and Lounsbury, 1993; Cox et al., 2006; Podesta et al., 2006), several mass strandings since have been associated with naval operations that may have included mid-frequency sonar (Simmonds and Lopez-Jurado, 1991; Frantzis, 1998; Jepson et al., 2003; Cox et al., 2006). As Cox et al. (2006) concludes, the state of science can not yet determine if a sound source such as mid-frequency sonar alone causes beaked whale strandings, or if other factors (acoustic, biological, or environmental) must co-occur in conjunction with a sound source.

A review of historical data (mostly anecdotal) maintained by the Marine Mammal Program in the National Museum of Natural History, Smithsonian Institution reports 49 beaked whale mass stranding events between 1838 and 1999. The largest beaked whale mass stranding occurred in the 1870s in New Zealand when 28 Gray’s beaked whales (*Mesoplodon grayi*) stranded. Blainsville’s beaked whale (*Mesoplodon densirostris*) strandings are rare, and records show that they were involved in one mass stranding in 1989 in the Canary Islands. Cuvier’s beaked whales (*Ziphius cavirostris*) are the most frequently reported beaked whale to strand, with at least 19 stranding events from 1804 through 2000 (DoC and DoN, 2001; Smithsonian Institution, 2000).

The discussion below centers on those worldwide stranding events that may have some association with naval operations, and global strandings that the U.S. Navy feels are either inconclusive or can not be associated with naval operations.

F.1.6.1 Naval Association

In the following sections, specific stranding events that have been putatively linked to potential sonar operations are discussed. Of note, these events represent a small number of animals over an 11-year period (40 animals), and not all worldwide beaked whale strandings can be linked to naval activity (ICES

2005a; 2005b; Podesta et al., 2006). Four of the five events occurred during NATO exercises or events where U.S. Navy presence was limited (Greece, Portugal, Spain). One of the five events involved only U.S. Navy ships (Bahamas).

Beaked whale stranding events associated with potential naval operations.

1996 May	Greece (NATO)
2000 March	Bahamas (US)
2000 May	Portugal, Madeira Islands (NATO/US)
2002 September	Spain, Canary Islands (NATO/US)
2006 January	Spain, Mediterranean Sea coast (NATO/US)

Case Studies of Stranding Events (coincidental with or implicated with naval sonar)

1996 Greece Beaked Whale Mass Stranding (May 12 – 13, 1996)

Description: Twelve Cuvier's beaked whales (*Ziphius cavirostris*) stranded along a 38.2-kilometer strand of the coast of the Kyparissiakos Gulf on May 12 and 13, 1996 (Frantzis, 1998). From May 11 through May 15, the NATO research vessel Alliance was conducting sonar tests with signals of 600 Hz and 3 kHz and root-mean-squared (rms) sound pressure levels (SPL) of 228 and 226 dB re: 1µPa, respectively (D'Amico and Verboom, 1998; D'Spain et al., 2006). The timing and the location of the testing encompassed the time and location of the whale strandings (Frantzis, 1998).

Findings: Partial necropsies of eight of the animals were performed, including external assessments and the sampling of stomach contents. No abnormalities attributable to acoustic exposure were observed, but the stomach contents indicated that the whales were feeding on cephalopods soon before the stranding event. No unusual environmental events before or during the stranding event could be identified (Frantzis, 1998).

Conclusions: The timing and spatial characteristics of this stranding event were atypical of stranding in Cuvier's beaked whale, particularly in this region of the world. No natural phenomenon that might contribute to the stranding event coincided in time with the mass stranding. Because of the rarity of mass strandings in the Greek Ionian Sea, the probability that the sonar tests and stranding coincided in time and location, while being independent of each other, was estimated as being extremely low (Frantzis, 1998). However, because information for the necropsies was incomplete and inconclusive, the cause of the stranding cannot be precisely determined.

2000 Bahamas Marine Mammal Mass Stranding (March 15-16, 2000)

Description: Seventeen marine mammals - Cuvier's beaked whales, Blainville's beaked whales (*Mesoplodon densirostris*), minke whale (*Balaenoptera acutorostrata*), and one spotted dolphin (*Stenella frontalis*), stranded along the Northeast and Northwest Providence Channels of the Bahamas Islands on March 15-16, 2000 (Evans and England, 2001). The strandings occurred over a 36-hour period and coincided with U.S. Navy use of mid-frequency active sonar within the channel. Navy ships were involved in tactical sonar exercises for approximately 16 hours on March 15. The ships, which operated the AN/SQS-53C and AN/SQS-56, moved through the channel while emitting sonar pings approximately every 24 seconds. The timing of pings was staggered between ships and average source levels of pings varied from a nominal 235 dB SPL (AN/SQS-53C) to 223 dB SPL (AN/SQS-56). The center frequency of pings was 3.3 kHz and 6.8 to 8.2 kHz, respectively.

Seven of the animals that stranded died, while ten animals were returned to the water alive. The animals known to have died included five Cuvier's beaked whales, one Blainville's beaked whale, and the single spotted dolphin. Six necropsies were performed and three of the six necropsied animals (one Cuvier's beaked whale, one Blainville's beaked whale, and the spotted dolphin) were fresh enough to permit identification of pathologies by computerized tomography (CT). Tissues from the remaining three animals were in a state of advanced decomposition at the time of inspection.

Findings: The spotted dolphin demonstrated poor body condition and evidence of a systemic debilitating disease. In addition, since the dolphin stranding site was isolated from the acoustic activities of Navy ships, it was determined that the dolphin stranding was unrelated to the presence of Navy active sonar.

All five necropsied beaked whales were in good body condition and did not show any signs of external trauma or disease. In the two best preserved whale specimens, hemorrhage was associated with the brain and hearing structures. Specifically, subarachnoid hemorrhage within the temporal region of the brain and intracochlear hemorrhages were noted. Similar findings of bloody effusions around the ears of two other moderately decomposed whales were consistent with the same observations in the freshest animals. In addition, three of the whales had small hemorrhages in their acoustic fats, which are fat bodies used in sound production and reception (i.e., fats of the lower jaw and the melon). The best-preserved whale demonstrated acute hemorrhage within the kidney, inflammation of the lung and lymph nodes, and congestion and mild hemorrhage in multiple other organs. Other findings were consistent with stresses and injuries associated with the stranding process. These consisted of external scrapes, pulmonary edema and congestion.

Conclusions: The post-mortem analyses of stranded beaked whales lead to the conclusion that the immediate cause of death resulted from overheating, cardiovascular collapse and stresses associated with being stranded on land. However, subarachnoid and intracochlear hemorrhages were believed to have occurred prior to stranding and were hypothesized as being related to an acoustic event. Passive acoustic monitoring records demonstrated that no large scale acoustic activity besides the Navy sonar exercise occurred in the times surrounding the stranding event. The mechanism by which sonar could have caused the observed traumas or caused the animals to strand was undetermined. The spotted dolphin was in overall poor condition for examination, but showed indications of long-term disease. No analysis of baleen whales (minke whale) was conducted. Baleen whale stranding events have not been associated with either low-frequency or mid-frequency sonar use (ICES 2005a, 2005b).

2000 Madeira Island, Portugal Beaked Whale Strandings (May 10 – 14, 2000)

Description: Three Cuvier's beaked whales stranded on two islands in the Madeira Archipelago, Portugal, from May 10 to 14, 2000 (Cox et al., 2006). A joint NATO amphibious training exercise, named "Linked Seas 2000," which involved participants from 17 countries, took place in Portugal during May 2 to 15, 2000. The timing and location of the exercises overlapped with that of the stranding incident.

Findings: Two of the three whales were necropsied. Two heads were taken to be examined. One head was intact and examined grossly and by CT; the other was only grossly examined because it was partially flensed and had been seared from an attempt to dispose of the whale by fire (Ketten, 2005).

No blunt trauma was observed in any of the whales. Consistent with prior CT scans of beaked whales stranded in the Bahamas 2000 incident, one whale demonstrated subarachnoid and peribullar hemorrhage and blood within one of the brain ventricles. Post-cranially, the freshest whale demonstrated renal congestion and hemorrhage, which was also consistent with findings in the freshest specimens in the Bahamas incident.

Conclusions: The pattern of injury to the brain and auditory system were similar to those observed in the Bahamas strandings, as were the kidney lesions and hemorrhage and congestion in the lungs (Ketten, 2005). The similarities in pathology and stranding patterns between these two events suggested a similar causative mechanism. Although the details about whether or how sonar was used during "Linked Seas 2000" is unknown, the presence of naval activity within the region at the time of the strandings suggested a possible relationship to Navy activity.

2002 Canary Islands Beaked Whale Mass Stranding (September 24, 2002)

Description: On September 24, 2002, 14 beaked whales stranded on Fuerteventura and Lanzaote Islands in the Canary Islands (Jepson et al., 2003). Seven of the 14 whales died on the beach and the 7 were returned to the ocean. Four beaked whales were found stranded dead over the next three days either on the coast or floating offshore (Fernández et al., 2005). At the time of the strandings, an international naval exercise (Neo-Tapon 2002) that involved numerous surface warships and several submarines was being conducted off the coast of the Canary Islands. Tactical mid-frequency active sonar was utilized during the exercises, and strandings began within hours of the onset of the use of mid-frequency sonar (Fernández et al., 2005).

Findings: Eight Cuvier's beaked whales, one Blainville's beaked whale, and on Gervais' beaked whale were necropsied; six of them within 12 hours of stranding (Fernández et al. 2005). The stomachs of the whales contained fresh and undigested prey contents. No pathogenic bacteria were isolated from the whales, although parasites were found in the kidneys of all of the animals. The head and neck lymph nodes were congested and hemorrhages were noted in multiple tissues and organs, including the kidney, brain, ears, and jaws. Widespread fat emboli were found throughout the carcasses, but no evidence of blunt trauma was observed in the whales. In addition, the parenchyma of several organs contained macroscopic intravascular bubbles and lesions, putatively associated with nitrogen off-gassing.

Conclusions: The association of NATO mid-frequency sonar use close in space and time to the beaked whale strandings, and the similarity between this stranding event and previous beaked whale mass strandings coincident with sonar use, suggests that a similar scenario and causative mechanism of stranding may be shared between the events. Beaked whales stranded in this event demonstrated brain and auditory system injuries, hemorrhages, and congestion in multiple organs, similar to the pathological findings of the Bahamas and Madeira stranding events. In addition, the necropsy results of the Canary Islands stranding event lead to the hypothesis that the presence of disseminated and widespread gas bubbles and fat emboli were indicative of nitrogen bubble formation, similar to what might be expected in decompression sickness (Jepson et al., 2003; Fernández et al., 2005). Whereas gas emboli would develop from the nitrogen gas, fat emboli would enter the blood stream from ruptured fat cells (presumably where nitrogen bubble formation occurs) or through the coalescence of lipid bodies within the blood stream.

The possibility that the gas and fat emboli found by Fernández et al. (2005) was due to nitrogen bubble formation has been hypothesized to be related to either direct activation of the bubble by sonar signals or to a behavioral response in which the beaked whales flee to the surface following sonar exposure. The first hypothesis is related to rectified diffusion (Crum and Mao, 1996), the process of increasing the size of a bubble by exposing it to a sound field. This process is facilitated if the environment in which the ensonified bubbles exist is supersaturated with gas. Repetitive diving by marine mammals can cause the blood and some tissues to accumulate gas to a greater degree than is supported by the surrounding environmental pressure (Ridgway and Howard, 1979). Deeper and longer dives of some marine mammals, such as those conducted by beaked whales, are theoretically predicted to induce greater levels of supersaturation (Houser et al., 2001). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue supersaturation could theoretically speed the rate and increase the size of bubble growth. Subsequent effects due to tissue trauma and emboli would presumably mirror those observed in humans suffering from decompression sickness. It is unlikely that the brief duration of sonar pings would be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. However, an alternative but related hypothesis has also been suggested: stable bubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of the tissues. In such a scenario the marine mammal would need to be in a gas-supersaturated state long enough for bubbles to become of a problematic size. The second hypothesis speculates that rapid ascent to the surface following exposure to a startling sound might produce tissue gas saturation sufficient for the evolution of nitrogen bubbles (Jepson et al. 2003; Fernández et al. 2005). In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation. Tyack et al. (2006) showed that beaked whales often make rapid ascents from deep dives suggesting that it is unlikely that beaked whales would suffer from decompression sickness. Zimmer and Tyack (2007) speculated that if repetitive shallow dives that are used by beaked whales to avoid a predator or a sound source, they could accumulate high levels of nitrogen because they would be above the depth of lung collapse (above about 210 feet) and could lead to decompression sickness. There is no evidence that beaked whales dive in this manner in response to predators or sound sources and other marine mammals such as Antarctic and Galapagos fur seals, and pantropical spotted dolphins make repetitive shallow dives with no apparent decompression sickness (Kooyman and Trillmich, 1984; Kooyman et al., 1984; Baird et al., 2001).

Although theoretical predictions suggest the possibility for acoustically mediated bubble growth, there is considerable disagreement among scientists as to its likelihood (Piantadosi and Thalmann, 2004). Sound exposure levels predicted to cause in vivo bubble formation within diving cetaceans have not been evaluated and are suspected as needing to be very high (Evans, 2002; Crum et al., 2005). Moore and Early (2004) reported that in analysis of sperm whale bones spanning 111 years, gas embolism symptoms were observed indicating that sperm whales may be susceptible to decompression sickness due to natural diving behavior. Further, although it has been argued that traumas from recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson et al. 2003), there is no conclusive evidence supporting this hypothesis and there is concern that at least some of the pathological findings (e.g., bubble emboli) are artifacts of the necropsy. Currently, stranding networks in the United States have agreed to adopt a set of necropsy guidelines to determine, in part, the possibility and frequency with which bubble emboli can be introduced into marine mammals during necropsy procedures (Arruda et al., 2007).

2006 Spain, Gulf of Vera Beaked Whale Mass Stranding (26-27 January 2006)

Description: The Spanish Cetacean Society reported an atypical mass stranding of four beaked whales that occurred January 26 to 28, 2006, on the southeast coast of Spain near Mojacar (Gulf of Vera) in the Western Mediterranean Sea. According to the report, two of the whales were discovered the evening of January 26 and were found to be still alive. Two other whales were discovered on January 27, but had already died. A following report stated that the first three animals were located near the town of Mojacar and were examined by a team from the University of Las Palmas de Gran Canarias, with the help of the stranding network of Ecologistas en Acción Almería-PROMAR and others from the Spanish Cetacean Society. The fourth animal was found dead on the afternoon of January 27, a few kilometers north of the first three animals.

From January 25-26, 2006, a NATO surface ship group (seven ships including one U.S. ship under NATO operational command) conducted active sonar training against a Spanish submarine within 50 nm of the stranding site.

Findings: Veterinary pathologists necropsied the two male and two female beaked whales (*Z. cavirostris*).

Conclusions: According to the pathologists, a likely cause of this type of beaked whale mass stranding event may have been anthropogenic acoustic activities. However, no detailed pathological results confirming this supposition have been published to date, and no positive acoustic link was established as a direct cause of the stranding.

Even though no causal link can be made between the stranding event and naval exercises, certain conditions may have existed in the exercise area that, in their aggregate, may have contributed to the marine mammal strandings (Freitas, 2004):

- Operations were conducted in areas of at least 1000 meters in depth near a shoreline where there is a rapid change in bathymetry on the order of 1000 to 6000 meters occurring a cross a relatively short horizontal distance (Freitas, 2004).

- Multiple ships, in this instance, five MFA sonar equipped vessels, were operating in the same area over extended periods (20 hours) in close proximity.

- Exercises took place in an area surrounded by landmasses, or in an embayment. Operations involving multiple ships employing mid-frequency active sonar near land may produce sound directed towards a channel or embayment that may cut off the lines of egress for marine mammals (Freitas, 2004).

F.1.6.2 Other Global Stranding Discussions

In the following sections, stranding events that have been linked to U.S. Navy activity in popular press are presented. As detailed in the individual case study conclusions, the U.S. Navy believes there is enough evidence available to refute allegations of impacts from mid-frequency sonar, or at least indicate a substantial degree of uncertainty in time and space that precludes a meaningful scientific conclusion.

Case Studies of Stranding Events

2003 Washington State Harbor Porpoise Strandings (May 2 – June 2 2003)

Description: At 1040 hours on May 5, 2003, the USS SHOUP began the use of mid-frequency tactical active sonar as part of a naval exercise. At 1420, the USS SHOUP entered the Haro Strait and terminated active sonar use at 1438, thus limiting active sonar use within the strait to less than 20 minutes. Between May 2 and June 2, 2003, approximately 16 strandings involving 15 harbor porpoises (*Phocoena phocoena*) and one Dall's porpoise (*Phocoenoides dalli*) were reported to the Northwest Marine Mammal Stranding Network. A comprehensive review of all strandings and the events involving USS SHOUP on May 5, 2003 were presented in U.S. Department of Navy (2004). Given that the USS SHOUP was known to have operated sonar in the strait on May 5, and that supposed behavioral reactions of killer whales (*Orcinus orca*) had been putatively linked to these sonar operations (NMFS Office of Protected Resources, 2005), NMFS undertook an analysis of whether sonar caused the strandings of the harbor porpoises.

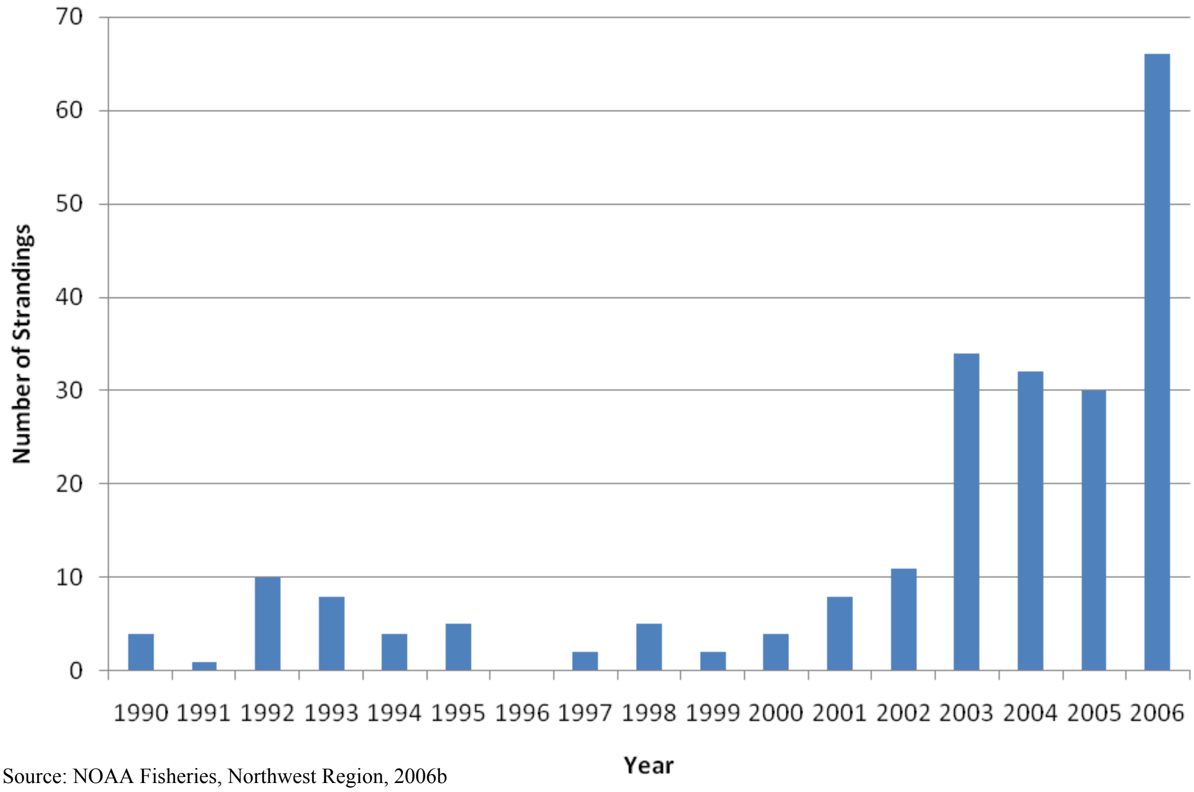
Whole carcasses of ten harbor porpoises and the head of an additional porpoise were collected for analysis. Necropsies were performed on ten of the porpoises and six whole carcasses, and two heads were selected for CT imaging. Gross examination, histopathology, age determination, blubber analysis, and various other analyses were conducted on each of the carcasses (Norman et al., 2004).

Findings: Post-mortem findings and analysis details are found in Norman et al. (2004). All of the carcasses suffered from some degree of freeze-thaw artifact that hampered gross and histological evaluations. At the time of necropsy, three of the porpoises were moderately fresh, whereas the remainder of the carcasses was considered to have moderate to advanced decomposition. None of the 11 harbor porpoises demonstrated signs of acoustic trauma. In contrast, a putative cause of death was determined for five of the porpoises; two animals had blunt trauma injuries and three animals had indication of disease processes (fibrous peritonitis, salmonellosis, and necrotizing pneumonia). A cause of death could not be determined in the remaining animals, which is consistent with expected percentage of marine mammal necropsies conducted within the Northwest region. It is important to note, however, that these determinations were based only on the evidence from the necropsy to avoid bias with regard to determinations of the potential presence or absence of acoustic trauma. The result was that other potential causal factors, such as one animal (Specimen 33NWR05005) found tangled in a fishing net, was unknown to the investigators in their determination regarding the likely cause of death.

Conclusions: NMFS concluded from a retrospective analysis of stranding events that the number of harbor porpoise stranding events in the approximate month surrounding the USS SHOUP use of sonar was higher than expected based on annual strandings of harbor porpoises (Norman et al., 2004). In this regard, it is important to note that the number of strandings in the May-June timeframe in 2003 was also higher for the outer coast indicating a much wider phenomena than use of sonar by USS SHOUP in Puget Sound for one day in May. The conclusion by NMFS that the number of strandings in 2003 was higher is also different from that of The Whale Museum, which has documented and responded to harbor porpoise strandings since 1980 (Osborne, 2003). According to The Whale Museum, the number of strandings as of May 15, 2003, was consistent with what was expected based on historical stranding records and was less than that occurring in certain years. For example, since 1992 the San Juan Stranding Network has documented an average of 5.8 porpoise strandings per year. In 1997 there were 12 strandings in the San Juan Islands with more than 30 strandings throughout the general Puget Sound area. Disregarding the discrepancy in the historical rate of porpoise strandings and its relation to the USS SHOUP, NMFS acknowledged that the intense level of media attention focused on the strandings likely resulted in an increased reporting effort by the public over that which is normally observed (Norman et al., 2004). NMFS also noted in its report that the “sample size is too small and biased to infer a specific relationship with respect to sonar usage and subsequent strandings.”

Seven of the porpoises collected and analyzed died prior to SHOUP departing to sea on May 5, 2003. Of these seven, one, discovered on May 5, 2003, was in a state of moderate decomposition, indicating it died before May 5; the cause of death was determined, most likely, to be salmonella septicemia. Another porpoise, discovered at Port Angeles on May 6, 2003, was in a state of moderate decomposition, indicating that this porpoise also died prior to May 5. One stranded harbor porpoise discovered fresh on May 6 is the only animal that could potentially be linked in time to the USS SHOUP’s May 5 active sonar use. Necropsy results for this porpoise found no evidence of acoustic trauma. The remaining eight strandings were discovered one to three weeks after the USS SHOUP’s May 5 transit of the Haro Strait, making it difficult to causally link the sonar activities of the USS SHOUP to the timing of the strandings. Two of the eight porpoises died from blunt trauma injury and a third suffered from parasitic infestation, which possibly contributed to its death (Norman et al. 2004). For the remaining five porpoises, NMFS was unable to identify the causes of death.

Additionally, it has become clear that the number of harbor porpoise strandings in the Northwest increased beginning in 2003 and through 2006. Figure F-3 shows the number of strandings documented in the Northwest for harbor porpoises. On November 3, 2006, a UME in the Pacific Northwest was declared. In 2006, a total of 66 harbor porpoise strandings were reported in the Outer Coast of Oregon and Washington and Inland waters of Washington (NOAA Fisheries, 2006; NOAA Fisheries, Northwest Region, 2006a).



Source: NOAA Fisheries, Northwest Region, 2006b

Figure F-3. Northwest Region Harbor Porpoise Strandings 1990 – 2006

The speculative association of the harbor porpoise strandings to the use of sonar by the USS SHOUP is inconsistent with prior stranding events linked to the use of mid-frequency sonar. Specifically, in prior events, the stranding of whales occurred over a short period of time (less than 36 hours), stranded individuals were spatially co-located, traumas in stranded animals were consistent between events, and active sonar was known or suspected to be in use. Although mid-frequency active sonar was used by the USS SHOUP, the distribution of harbor porpoise strandings by location and with respect to time surrounding the event do not support the suggestion that mid-frequency active sonar was a cause of harbor porpoise strandings. Rather, a complete lack of evidence of any acoustic trauma within the harbor porpoises, and the identification of probable causes of stranding or death in several animals, further supports the conclusion that harbor porpoise strandings were unrelated to the sonar activities of the USS SHOUP.

Additional allegations regarding USS SHOUP use of sonar having caused behavioral effects to Dall’s porpoise, orca, and a minke whale also arose in association with this event (see U.S. Department of Navy 2004 for a complete discussion).

Dall’s porpoise: Information regarding the observation of Dall’s porpoise on May 5, 2003 came from the operator of a whale watch boat at an unspecified location. This operator reported the Dall’s porpoise were seen “going north” when the SHOUP was estimated by him to be 10 miles away. Potential reasons for the Dall’s movement include the pursuit of prey, the presence of harassing resident orca or predatory transient orca, vessel disturbance from one of many whale watch vessels, or multiple other unknowable reasons including the use of sonar by SHOUP. In short, there was nothing unusual in the observed behavior of the Dall’s porpoise on May 5, 2003 and no way to assess if the otherwise normal behavior was in reaction to the use of sonar by USS SHOUP, any other potential causal factor or a combination of factors.

Orca: Observer opinions regarding orca J-Pod behaviors on 5 May 2003 were inconsistent, ranging from the orca being "at ease with the sound" or "resting" to their being "annoyed." One witness reported observing "low rates of surface active behavior" on behalf of the orca J-Pod, which is in conflict with that of another observer who reported variable surface activity, tail slapping and spyhopping. Witnesses also expressed the opinion that the behaviors displayed by the orca on 5 May 2003 were "extremely unusual," although those same behaviors are observed and reported regularly on the Orca Network Website, are behaviors listed in general references as being part of the normal repertoire of orca behaviors. Given the contradictory nature of the reports on the observed behavior of the J-Pod orca, there is no way to assess if any unusual behaviors were present or if present they were in reaction to vessel disturbance from one of many nearby whale watch vessels, use of sonar by SHOUP, any other potential causal factor, or a combination of factors.

Minke whale: A minke whale was reported porpoising in Haro Strait on May 5, 2003, which is a rarely observed behavior. The cause of this behavior is indeterminate given multiple potential causal factors including but not limited to the presence of predatory Transient orca, possible interaction with whale watch boats, other vessels, or SHOUP's use of sonar. Given the existing information, there is no way to be certain if the unusual behavior observed was in reaction to the use of sonar by SHOUP, any other potential causal factor or a combination of factors.

2004 Alaska Beaked Whale Strandings (Northern Edge Exercise, 7-16 June 2004)

Description: Between 27 June and 19 July 2004, five beaked whales were discovered at various locations along 1,600 miles of the Alaskan coastline and one was found floating (dead) at sea. These whales included three Baird's beaked whales and two Cuvier's beaked whales. Questions and comments posed on previous Navy environmental documents have alleged that sonar use may have been the cause of these strandings in association with the Navy Alaska Shield/Northern Edge exercise, which occurred June 7 to June 16, 2004 (within the approximate timeframe of these strandings).

Findings: Information regarding the strandings is incomplete as the whales had been dead for some time before they were discovered. The stranded beaked whales were in moderate to advanced states of decomposition and necropsies were not performed. Additionally, prior to the Navy conducting the Alaska Shield/Northern Edge exercise, two Cuvier's beaked whales were discovered stranded at two separate locations along the Alaskan coastline (February 26 at Yakutat and June 1 at Nuka Bay).

Zimmerman (1991) reported that between 1975 and 1987, 11 species of cetaceans were found stranded in Alaska seven or more times, including 29 Stejneger's beaked whales, 19 Cuvier's beaked whales, and 8 Baird's beaked whales. Cuvier's beaked whales have been found stranded from the eastern Gulf of Alaska to the western Aleutians. Baird's beaked whales were found stranded as far north as the area between Cape Pierce and Cape Newenham, east near Kodiak, and along the Aleutian Islands. (Zimmerman, 1991). In short, however, the stranding of beaked whales in Alaska is a relatively uncommon occurrence (as compared to other species).

Conclusions: The at-sea portion of the Alaska Shield/Northern Edge 2004 exercise consisted mainly surface ships and aircraft tracking a vessel of interest followed by a vessel boarding search and seizure event. There was no ASW component to the exercise, no use of mid-frequency sonar, and no use of explosives in the water. There were no events in the Alaska Shield/Northern Edge exercise that could have caused or been related to any of the strandings over this 33 day period along 1,600 miles of coastline.

2004 Hawai'i Melon-Headed Whale Unusual Milling Event (July 3-4 2004)

Description: The majority of the following information is taken from the NMFS report (which referred to the event as a "mass stranding event"; Southall et al., 2006) but includes additional and new information not presented in the NMFS report. On the morning of July 3, 2004, between 150 and 200 melon-headed whales (*Peponocephala electra*) entered Hanalei Bay, Kauai. Individuals attending a canoe blessing ceremony observed the animals entering the bay at approximately 7:00 a.m. The whales were reported entering the bay in a "wave as if they were chasing fish" (Braun 2006). At 6:45 a.m. on July 3, 2004, approximately 25 nm north of Hanalei Bay, active sonar was tested briefly prior to the start of an anti-submarine warfare exercise.

The whales stopped in the southwest portion of the bay, grouping tightly, and displayed spy-hopping and tail-slapping behavior. As people went into the water among the whales, the pod separated into as many as four groups, with individual animals moving among the clusters. This continued through most of the day, with the animals slowly moving south and then southeast within the bay. By about 3 p.m., police arrived and kept people from interacting with the animals. The Navy believes that the abnormal behavior by the whales during this time is likely the result of people and boats in the water with the whales rather than the result of sonar activities taking place 25 or more miles off the coast. At 4:45 p.m. on July 3, 2004, the RIMPAC Battle Watch Captain received a call from a National Marine Fisheries representative in Honolulu, Hawaii, reporting the sighting of as many as 200 melon-headed whales in Hanalei Bay. At 4:47 p.m. the Battle Watch Captain directed all ships in the area to cease active sonar transmissions.

At 7:20 p.m. on July 3, 2004, the whales were observed in a tight single pod 75 yards from the southeast side of the bay. The pod was circling in a group and displayed frequent tail slapping and whistle vocalizations and some spy hopping. No predators were observed in the bay and no animals were reported as having fresh injuries. The pod stayed in the bay through the night of July 3, 2004. On the morning of July 4, 2004, the whales were observed to still be in the bay and collected in a tight group. A decision was made at that time to attempt to herd the animals out of the bay. A 700-to-800-foot rope was constructed by weaving together beach morning glory vines. This vine rope was tied between two canoes and with the assistance of 30 to 40 kayaks, was used to herd the animals out of the bay. By approximately 11:30 a.m. on July 4, 2004, the pod was coaxed out of the bay.

A single neonate melon-headed whale was observed in the bay on the afternoon of July 4, after the whale pod had left the bay. The following morning on July 5, 2004, the neonate was found stranded on Lumahai Beach. It was pushed back into the water but was found stranded dead between 9 and 10 a.m. near the Hanalei pier. NMFS collected the carcass and had it shipped to California for necropsy, tissue collection, and diagnostic imaging.

Following the unusual milling event, NMFS undertook an investigation of possible causative factors of the event. This analysis included available information on environmental factors, biological factors, and an analysis of the potential for sonar involvement. The latter analysis included vessels that utilized mid-frequency active sonar on the afternoon and evening of July 2. These vessels were to the southeast of Kauai, on the opposite side of the island from Hanalei Bay.

Findings: NMFS concluded from the acoustic analysis that the melon-headed whales would have had to have been on the southeast side of Kauai on July 2 to have been exposed to sonar from naval vessels on that day (Southall et al. 2006). There was no indication whether the animals were in that region or whether they were elsewhere on July 2. NMFS concluded that the animals would have had to swim from 1.4-4.0 m/s for 6.5 to 17.5 hours after sonar transmissions ceased to reach Hanalei Bay by 7:00 a.m. on July 3. Sound transmissions by ships to the north of Hanalei Bay on July 3 were produced as part of exercises between 6:45 a.m. and 4:47 p.m. Propagation analysis conducted by the 3rd Fleet estimated that the level of sound from these transmissions at the mouth of Hanalei Bay could have ranged from 138-149 dB re: 1 μPa.

NMFS was unable to determine any environmental factors (e.g., harmful algal blooms, weather conditions) that may have contributed to the stranding. However, additional analysis by Navy investigators found that a full moon occurred the evening before the stranding and was coupled with a squid run (Mobley 2007). One of the first observations of the whales entering the bay reported the pod came into the bay in a line "as if chasing fish" (Braun, 2005). In addition, a group of 500 to700 melon-headed whales were observed to come close to shore and interact with humans in Sasanhaya Bay, Rota, on the same morning as the whales entered Hanalei Bay (Jefferson et al. 2006). Previous records further indicated that, though the entrance of melon-headed whales into the shallows is rare, it is not unprecedented. A pod of melon-headed whales entered Hilo Bay in the 1870s in a manner similar to that which occurred at Hanalei Bay in 2004.

The necropsy of the melon-headed whale calf suggested that the animal died from a lack of nutrition, possibly following separation from its mother. The calf was estimated to be approximately one week old. Although the calf appeared not to have eaten for some time, it was not possible to determine whether the calf had ever nursed after it was born. The calf showed no signs of blunt trauma or viral disease and had no indications of acoustic injury.

Conclusions: Although it is not impossible, it is unlikely that the sound level from the sonar caused the melon-headed whales to enter Hanalei Bay. This conclusion is based on a number of factors:

1. The speculation that the whales may have been exposed to sonar the day before and then fled to the Hanalei Bay is not supported by reasonable expectation of animal behavior and swim speeds. The flight response of the animals would have had to persist for many hours following the cessation of sonar transmissions. Such responses have not been observed in marine mammals and no documentation exists that such persistent flight response after the cessation of a frightening stimulus has been observed in other mammals. The swim speeds, though feasible for the species, are highly unlikely to be maintained for the durations proposed, particularly since the pod was a mixed group containing both adults and neonates. Whereas adults may maintain a swim speed of 4.0 m/s for some time, it is improbable that a neonate could achieve the same for a period of many hours.

2. The area between the islands of Oahu and Kauai and the Pacific Missile Range Facility training range have been used in RIMPAC exercises for more than 30 years, and are used year-round for ASW training with mid frequency active sonar. Melon-headed whales inhabiting the waters around Kauai are likely not naive to the sound of sonar and there has never been another stranding event associated in time with ASW training at Kauai. Similarly, the waters surrounding Hawaii contain an abundance of marine mammals, many of which would have been exposed to the same sonar operations that were speculated to have affected the melon-headed whales. No other strandings were reported coincident with the RIMPAC exercises. This leaves it uncertain as to why melon-headed whales, and no other species of marine mammal, would respond to the sonar exposure by stranding.

3. At the nominal swim speed for melon-headed whales, the whales had to be within 1.5 to 2 nm of Hanalei Bay before sonar was activated on July 3. The whales were not in their open ocean habitat but had to be close to shore at 6:45 a.m. when the sonar was activated to have been observed inside Hanalei Bay from the beach by 7 a.m. (Hanalei Bay is very large area). This observation suggests that other potential factors could have caused the event (see below).

4. The simultaneous movement of 500 to 700 melon-headed whales and Risso's dolphins into Sasanhaya Bay, Rota, in the Northern Marianas Islands on the same morning as the 2004 Hanalei stranding (Jefferson et al., 2006) suggests that there may be a common factor which prompted the melon-headed

whales to approach the shoreline. A full moon occurred the evening before the stranding and a run of squid was reported concomitant with the lunar activity (Mobley et al. 2007). Thus, it is possible that the melon-headed whales were capitalizing on a lunar event that provided an opportunity for relatively easy prey capture (Mobley et al. 2007). A report of a pod entering Hilo Bay in the 1870s indicates that on at least one other occasion, melon-headed whales entered a bay in a manner similar to the occurrence at Hanalei Bay in July 2004. Thus, although melon-headed whales entering shallow embayments may be an infrequent event, and every such event might be considered anomalous, there is precedent for the occurrence.

5. The received noise sound levels at the bay were estimated to range from roughly 95 to 149 dB re: 1 μPa. Received levels as a function of time of day have not been reported, so it is not possible to determine when the presumed highest levels would have occurred and for how long. However, received levels in the upper range would have been audible by human participants in the bay. The statement by one interviewee that he heard "pings" that lasted an hour and that they were loud enough to hurt his ears is unreliable. Received levels necessary to cause pain over the duration stated would have been observed by most individuals in the water with the animals. No other such reports were obtained from people interacting with the animals in the water.

Although NMFS concluded that sonar use was a "plausible, if not likely, contributing factor in what may have been a confluence of events (Southall et al. 2006)," this conclusion was based primarily on the basis that there was an absence of any other compelling explanation. The authors of the NMFS report on the incident were unaware, at the time of publication, of the simultaneous event in Rota. In light of the simultaneous Rota event, the Hanalei event does not appear as anomalous as initially presented and the speculation that sonar was a causative factor is weakened. The Hanalei Bay incident does not share the characteristics observed with other mass strandings of whales coincident with sonar activity (e.g., specific traumas, species composition, etc.). In addition, the inability to conclusively link or exclude the impact of other environmental factors makes a causal link between sonar and the melon-headed whale event highly speculative at best.

1980- 2004 Beaked Whale Strandings in Japan (Brownell et al. 2004)

Description: Brownell et al. (2004) compare the historical occurrence of beaked whale strandings in Japan (where there are U.S. Naval bases), with strandings in New Zealand (which lacks a U.S. Naval base) and concluded the higher number of strandings in Japan may be related to the presence of the US. Navy vessels using mid-frequency sonar. While the dates for the strandings were well documented, the authors of the study did not attempt to correlate the dates of any navy activities or exercises with those stranding dates.

To fully investigate the allegation made by Brownell et al. (2004), the Center for Naval Analysis (CNA) in an internal Navy report, looked at past U.S. Naval exercise schedules from 1980 to 2004 for the water around Japan in comparison to the dates for the strandings provided by Brownell et al. (2004). None of the strandings occurred during or soon (within weeks) after any U.S. Navy exercises. While the CNA analysis began by investigating the probabilistic nature of any co-occurrences, the strandings and sonar use were not correlated by time. Given that there was no instance of co-occurrence in over 20 years of stranding data, it can be reasonably postulated that sonar use in Japan waters by U.S. Navy vessels did not lead to any of the strandings documented by Brownell et al. (2004).

2005 North Carolina Marine Mammal Mass Stranding Event (January 15-16, 2005)

Description: On January 15 and 16, 2005, 36 marine mammals consisting of 33 short-finned pilot whales, one minke whale, and two dwarf sperm whales stranded alive on the beaches of North Carolina (Hohn et al., 2006a). The animals were scattered across a 111-km area from Cape Hatteras northward. Because of the live stranding of multiple species, the event was classified as a UME. It is the only stranding on record for the region in which multiple offshore species were observed to strand within a two- to three-day period.

The U.S. Navy indicated that from January 12-14 some unit level training with mid-frequency active sonar was conducted by vessels that were 93 to 185 km from Oregon Inlet. An expeditionary strike group was also conducting exercises to the southeast, but the closest point of active sonar transmission to the inlet was 650 km away. The unit level operations were not unusual for the area or time of year and the vessels were not involved in antisubmarine warfare exercises. Marine mammal observers on board the vessels did not detect any marine mammals during the period of unit level training. No sonar transmissions were made on January 15-16.

The National Weather Service reported that a severe weather event moved through North Carolina on January 13 and 14. The event was caused by an intense cold front that moved into an unusually warm and moist air mass that had been persisting across the eastern United States for about a week. The weather caused flooding in the western part of the state, considerable wind damage in central regions of the state, and at least three tornadoes that were reported in the north central part of the state. Severe, sustained (one to four days) winter storms are common for this region.

Over a two-day period (January 16-17), two dwarf sperm whales, 27 pilot whales, and the minke whale were necropsied and tissue samples collected. Twenty-five of the stranded cetacean heads were examined; two pilot whale heads and the heads of the dwarf sperm whales were analyzed by CT.

<u>Findings</u>: The pilot whales and dwarf sperm whale were not emaciated, but the minke whale, which was believed to be a dependent calf, was emaciated. Many of the animals were on the beach for an extended period of time prior to necropsy and sampling, and many of the biochemical abnormalities noted in the animals were suspected of being related to the stranding and prolonged time on land. Lesions were observed in all of the organs, but there was no consistency across species. Musculoskeletal disease was observed in two pilot whales and cardiovascular disease was observed in one dwarf sperm whale and one pilot whale. Parasites were a common finding in the pilot whales and dwarf sperm whales but were considered consistent with the expected parasite load for wild odontocetes. None of the animals exhibited traumas similar to those observed in prior stranding events associated with mid-frequency sonar activity. Specifically, there was an absence of auditory system trauma and no evidence of distributed and widespread bubble lesions or fat emboli, as was previously observed (Fernández et al., 2005).

Sonar transmissions prior to the strandings were limited in nature and did not share the concentration identified in previous events associated with mid-frequency active sonar use (Evans and England, 2001). The operational/environmental conditions were also dissimilar (e.g., no constrictive channel and a limited number of ships and sonar transmissions). NMFS noted that environmental conditions were favorable for a shift from up-welling to down-welling conditions, which could have contributed to the event. However, other severe storm conditions existed in the days surrounding the strandings and the impact of these weather conditions on at-sea conditions is unknown. No harmful algal blooms were noted along the coastline.

<u>Conclusions</u>: All of the species involved in this stranding event are known to occasionally strand in this region. Although the cause of the stranding could not be determined, several whales had preexisting conditions that could have contributed to the stranding. Cause of death for many of the whales was likely due to the physiological stresses associated with being stranded. A consistent suite of injuries across species, which was consistent with prior strandings where sonar exposure is expected to be a causative mechanism, was not observed.

NMFS was unable to determine any causative role that sonar may have played in the stranding event. The acoustic modeling performed, as in the Hanalei Bay incident, was hampered by uncertainty regarding the location of the animals at the time of sonar transmissions. However, as in the Hanalei Bay incident, the response of the animals following the cessation of transmissions would imply a flight response that persisted for many hours after the sound source was no longer operational. In contrast, the presence of a severe weather event passing through North Carolina during January 13 and 14 is a possible, if not likely, contributing factor to the North Carolina UME of January 15. Hurricanes may have been responsible for mass strandings of pygmy killer whales in the British Virgin Islands and Gervais' beaked whales in North Carolina (Mignucci-Giannoni et al. 2000; Norman and Mead 2001).

F.1.6.3 Causal Associations for Stranding Events

Several stranding events have been associated with Navy sonar activities but relatively few of the total stranding events that have been recorded occurred spatially or temporally with Navy sonar activities. While sonar may be a contributing factor under certain rare conditions, the presence of sonar it is not a necessary condition for stranding events to occur. In established range areas such as those in Hawaii and Southern California where sonar use has been routine for decades, there is no evidence of impacts from sonar use on marine mammals.

A review of past stranding events associated with sonar suggest that the potential factors that may contribute to a stranding event are steep bathymetry changes, narrow channels, multiple sonar ships, surface ducting and the presence of beaked whales that may be more susceptible to sonar exposures. The most important factors appear to be the presence of a narrow channel (e.g. Bahamas and Madeira Island, Portugal) that may prevent animals from avoiding sonar exposure and multiple sonar ships within that channel. There are no narrow channels (less than 35 nm wide and 10 nm in length) in the MAA and the ships would be spread out over a wider area allowing animals to move away from sonar activities if they choose. In addition, beaked whales may not be more susceptible to sonar but may favor habitats that are more conducive to sonar effects. There have been no mass strandings in GOA attributed to Navy sonar during any of the prior Northern Edge exercises or as the result of ay Navy sonar use.

F.1.7 Stranding Section Conclusions

Marine mammal strandings have been a historic and ongoing occurrence attributed to a variety of causes. Over the last 50 years, increased awareness and reporting has lead to more information about species effected and raised concerns about anthropogenic sources of stranding. While there has been some marine mammal mortalities potentially associated with mid-frequency sonar effects to a small number of species (primarily limited numbers of certain species of beaked whales), the significance and actual causative reason for any impacts is still subject to continued investigation.

By comparison and as described previously, potential impacts to all species of cetaceans worldwide from fishery related mortality can be orders of magnitude more significant (100,000s of animals versus tens of animals) (Culik, 2002; ICES, 2005b; Read et al., 2006). This does not negate the influence of any mortality or additional stressor to small, regionalized sub-populations which may be at greater risk from human related mortalities (fishing, vessel strike, sound) than populations with larger oceanic level distribution or migrations. ICES (2005a) noted, however, that taken in context of marine mammal populations in general, sonar is not a major threat, nor is it a significant portion of the overall ocean noise budget.

In conclusion, a constructive framework and continued research based on sound scientific principles is needed in order to avoid speculation as to stranding causes, and to further our understanding of potential effects or lack of effects from military mid-frequency sonar (Bradshaw et al., 2005; ICES, 2005b; Barlow and Gisiner, 2006; Cox et al., 2006).

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Appendix G

Public Scoping Summary

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G PUBLIC SCOPING SUMMARY

G.1 GENERAL SUMMARY OF THE SCOPING PERIOD

The scoping period for the Navy Training Activities in the Gulf of Alaska (GOA) Environmental Impact Statement (EIS)/Overseas EIS (OEIS) began with publication of a Notice of Intent in the Federal Register on March 17, 2008. The scoping period began on this date and lasted 45 days, concluding on April 30, 2008. Three public scoping meetings were held on April 1, 2 and 3 in the cities of Kodiak, Anchorage, and Cordova, Alaska, respectively. The scoping meetings were held in an open house format, with informational posters and written information provided to participants and Navy staff and project experts were available to answer participants' questions. Additionally, a tape recorder was available to record participants' oral comments. The interaction during the information sessions was productive and helpful to the Navy.

Scoping participants could submit comments in five ways:

- Oral statements at the public meetings (as recorded by the tape recorder);
- Written comments at the public meetings;
- Written letters (received any time during the public comment period);
- Electronic mail (received any time during the public comment period); and
- Comments submitted directly on the project website (received any time during the public comment period).

In total, the Navy received comments from 77 individuals or organizations. These comments included 52 comments via the website, 18 comments via mail, and 7 comments made in person during the public scoping meetings. This summary gives an overview of comments received during the scoping period. Comments are organized by issue area.

G.2 AIR QUALITY

Comments in this category expressed concern about the effects of military activities on air quality, specifically from carbon dioxide (CO_2) and greenhouse gases and their effects on global warming. Additional commenters expressed concerns with black carbon exhaust emissions from Navy vessels and their warming impact in the Arctic. Compliance with the Clean Air Act (CAA) was also mentioned. Commenters noted that the EIS/OEIS should discuss which areas do not meet National Ambient Air Quality Standards.

G.3 ALTERNATIVES

Comments regarding alternatives suggested that the Navy consider other sites to conduct its activities. Several commenters expressed that, of the three alternatives, they could only support the No Action Alternative. Additional comments expressed general disappointment with use of the term "No Action Alternative" to refer to continuing activities at current levels.

G.4 BIOLOGICAL RESOURCES – MARINE MAMMALS, FISH, BIRDS AND MARINE HABITAT

The majority of comments received in this focus area expressed concerns about impacts to marine life. Many of these comments specifically raised concerns about the effect of Navy sonar on marine life, such as marine mammals, fish, sea turtles, sea invertebrates and zooplankton. Numerous comments were made about the number of endangered species in the GOA, particularly whales (seven whale species in total) and the North Pacific Right Whale specifically, and the presence of North Pacific Right Whale critical habitat in the GOA. Participants frequently requested that the EIS/OEIS consider alternative technologies to mid-frequency active (MFA) sonar, while others stated that MFA and other forms of sonar are not required for training and should not be used within the GOA based upon "common knowledge" of the effects of sonar. Other commenters quoted previous EIS/OEIS's such as the Hawaii Range Complex Supplemental Draft EIS to state that the Navy, in this EIS, "…found that the use of MFA sonar and high-frequency active (HFA) sonar was harassment to a variety of whale species which included the endangered blue whale, fin whale, humpback and sperm, also Stellar Sea Lion." Several comments addressed protective and mitigation measures that are used now and that could be used for marine mammals when sonar is in use. Still, other comments voiced concern over the effects of all forms of sonar on migration patterns of whales, marine mammals, fish, and birds. A few comments expressed concern about potential negative impacts from sonar, both short- and long-term, to fish and the developing eggs/embryos of salmon and other commercial species (halibut, herring, haddock, pollock and crab). Other comments concerned sonar effects on the marine mammal food chain, including fish and zooplankton.

Several comments expressed general concern about Navy impacts, other than sonar, such as habitat quality and water quality, on marine life, while others identified specific policies that must be considered in the Navy's analysis, such as the Marine Mammal Protection Act, the Endangered Species Act, the Coastal Zone Management Act, the Magnuson-Stevens Fisheries Conservation Management Act, the Migratory Bird Treaty Act, and Executive Order 13158.

G.5 BIOLOGICAL RESOURCES—ONSHORE

A few comments suggested that the EIS/OEIS should also evaluate impacts on plant species and habitats, and indirect impacts outside the defined project boundary. Several comments addressed the protection of birds, including shorebirds, seabirds and migratory birds. Potential stressors to birds mentioned in the comments included noise disturbance. Among other terrestrial issues were general concerns about impacts to Alaska's ecosystem and resources.

G.6 CULTURAL RESOURCES

Participants commenting on cultural resources were primarily concerned with preserving the integrity of sport and subsistence activities to include native subsistence. A few comments also addressed the issue of pollution and potential damage to ancestral homelands.

G.7 CUMULATIVE IMPACTS

Comments in this category expressed concern about the overall impact of past and present military activity in the GOA. One specific commenter asked "how the cumulative impact of noise from other sources (military, fisheries, ship traffic and other commercial and industrial sources) can be measured and monitored while the Navy sonar exercises are going on." Another commenter asked that the "…cumulative impacts on local communities, subsistence, endangered species, marine mammals, fish, birds, and the ecosystem, among others, to include the EXXON Valdez oil spill, be fully evaluated and presented to the public". Finally, one commenter noted that cumulative impacts should include the consideration of how Navy actions may impact climatic changes, given concerns about how climate change may already be stressing many species.

G.8 ENVIRONMENTAL JUSTICE

Commenters requested that the EIS/OEIS disclose what efforts were taken to meet environmental justice requirements consistent with Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low-Income/Populations. These commenters also requested information describing the methodology and criteria for identifying low-income and minority populations as well as sources and references used within the DEIS analysis. Comments were also made in reference to making a complete analysis of impacts, including cumulative impacts, to low-income and minority communities, as well as methods of input for low-income populations and the means of outreach to these potentially affected communities.

G.9 HAZARDOUS MATERIALS/HAZARDOUS WASTE

Of the comments regarding hazardous materials and waste, the primary concerns articulated were over spills, specifically fuel oil, other toxic liquids, wastewater ballast and other bilge water discharges. Another area of concern was the effects of depleted uranium use in munitions on the environment in general. Other comments were in regard to chemical composition of the munitions that would be released. Additionally, a few individuals commented on World War II dump sites that are designated on some marine charts. These individuals want these areas to be re-identified, the types and quantities of materials and containers revealed to the public, and this information factored in to the DEIS analysis as previous military impacts on top of present and future proposed activities, as well as used to establish a baseline for cumulative impacts analysis.

G.10 HEALTH AND SAFETY

One comment expressed concern about safety implications to recreational swimmers and divers from mid-frequency active sonar.

G.11 NOISE

Several commenters expressed concern about noise from ordnance, mid-frequency sonar, sonar jamming signals, low-frequency communication and surveillance sonar, mid- and high- frequency communication sonars and mechanical noises associated with warfare exercises, to include engine noises, explosions and munitions firing. Another commenter wanted to know what the seismic and sonic noise impacts will be to marine mammals, especially whales, walrus, and seals, and to fish and birds. Another commenter stated that the EIS should describe the impacts of noise on human and wildlife health and behavior, as well as the measures that will be employed to mitigate those impacts, such as physical controls, operations plans and flight corridors. Commenters stated that noise analysis methodologies should be explained and the single-event and cumulative noise metrics utilized in the analysis should be defined. One commenter was concerned about air or noise pollution in ancestral homelands – on or off shore.

G.12 MISCELLANEOUS

Several comments were received that stated that the Navy was, in effect, moving to Alaska to conduct training, specifically sonar training, because "Court orders and lawsuits ran the Navy out of both California and Hawaii for similar tests and now you are making (a) move on our Alaskan waters." One commenter wanted to inform the Navy of vital telecommunication cables on the seafloor and indicated that Navy activities must be conducted away from these cables.

G.13 MITIGATION MEASURES

Most comments regarding mitigation measures focused on marine mammals. For example, several comments expressed concern that spotting marine mammals is extremely difficult for even expert observers, and those commenters doubted that shipboard lookouts could detect animals in adverse sea conditions and especially at night. One commenter proposed that the Navy should use infrared imaging devices at night. Other commenters expressed concern about the effectiveness of the Navy's training program for spotting animals. One commenter believed that it would be impossible to avoid encounters with whales and other marine animals no matter how many lookouts the Navy utilizes or what time of the year training is conducted. Others questioned how the Navy is going to mitigate sonar's possible adverse impacts on marine mammals. Additionally, others asked that the Navy aggressively consider ways to expand, improve, and employ better protective measures in future sonar exercises, such as conducting more monitoring and enforcing larger safety zones around ships. Finally, comments were made that the

Navy needs to better identify clear monitoring goals and objectives with specific parameters for measuring success and provide a feedback mechanism for the public to view information on mitigation effectiveness and monitoring results.

G.14 MEETINGS/NATIONAL ENVIRONMENTAL POLICY ACT PROCESS

Comments on the National Environmental Policy Act (NEPA) process included several that felt the information available during the scoping process was inadequate to provide informed comments or that the “poster” session was not the best format. Other commenters desired a more open forum type format, where all questions voiced could be heard by all. One commenter was disappointed that the Navy chose to hold scoping sessions in only three Alaska communities. Another requested that an additional scoping meeting be held in Homer, Alaska. Still other commenters desired the Navy to shift its meetings to later in the year (August), when there is less activity in the various fisheries.

G.15 RECREATION

One comment expressed concern about preserving the integrity of commercial, sport and subsistence activities, including fishing and traditional harvesting of animals. Another comment concerned the possibility of being subjected to sonar while diving. Still others mentioned whale watching activities and how Navy activities might affect them.

G.16 SOCIOECONOMICS

Comments regarding socioeconomic concerns included questions about the effects and impacts on commercial fishing, tourism, and the economy in general.

G.17 SONAR AND UNDERWATER DETONATIONS

Many comments mentioned concerns about the effect of Navy sonar on marine life, such as marine mammals, fish, sea turtles, and invertebrates. Others mentioned recent reports that fish suffer from hearing loss and widespread disorientation following loud noise intrusions and that catch rates of commercial species of fish have plummeted in the vicinity of noise sources. Some specific references to additional studies were received via comments. Others said that noise has been shown in several cases to kill, disable or disrupt the behavior of invertebrates and that little is known about the effects of MFAS on lower marine trophic levels such as phytoplankton and zooplankton. Participants frequently requested that the EIS/OEIS consider alternative technologies to sonar. Many felt that sonar activity is not necessary or appropriate for Alaska waters and that training could be accomplished through simulation and/or use of alternate technologies. Several comments addressed protective and mitigation measures for marine mammals when sonar is used. A few comments specifically mentioned concerns about possible acute and/or chronic effects on benthic and pelagic marine life from munitions discharges and explosions. Some commenters also discussed that analysis of possible impacts to the seafloor from expended materials during training exercises would need to be discussed.

G.18 WATER RESOURCES

Comments regarding water resources included general concerns about the potential effects on quality of both fresh and marine waters, not only in the designated training areas, but also in the land-based areas utilized for logistical support of the exercises, and areas adjacent to the training areas to be affected by military activities. Of specific concern were graywater (waste water from sinks, baths, showers, laundry, etc) and blackwater (waste water from human body wastes) that will be discharged from all vessels engaged in Northern Edge exercises, to include ballast water drawn from areas that may contain invasive species. A few of these comments quoted specific provisions of the Clean Water Act.

G.19 SUMMARY OF COMMENTS

Table G-1 provides a breakdown of areas of concern based on comments received during scoping. Because most commenters provided comments on several issues, and because some commenters chose to comment via multiple means, with only slight variations in their comments, the total count well exceeds the total number of 77 comments received.

Table G-1: Breakdown of Scoping Comments by Resource Area

Resource Area	Count	Percent of Total
Biological Resources - Marine Mammals	88	19.04%
Sonar and Underwater Detonations	74	16.01%
Biological Resources - Fish & Marine Habitat	45	9.74%
Mitigation	36	7.79%
Policy/NEPA	31	6.70%
Threatened and Endangered Species	30	6.49%
Commercial Fishing	27	5.84%
Alternatives	26	5.62%
Hazardous Materials / Hazardous Waste	24	5.19%
Socioeconomics	15	3.24%
Cumulative Impacts	11	2.38%
Water Resources	10	2.16%
Air Quality	8	1.73%
Biological Resources - Onshore	7	1.51%
Noise	6	1.29%
Miscellaneous	6	1.29%
Cultural Resources	5	1.08%
Proposed Action	5	1.08%
Coastal Zone Management Act	3	0.64%
Recreation	2	0.43%
Health and Safety	2	0.43%
Environmental Justice	1	0.21%
TOTAL	462	

Table G-2: Notice of Intent/Notice of Scoping Meeting Advertisements

Newspaper	Publish Date
Anchorage Daily News	Tuesday, March 18th 2008
	Wednesday, March 19th 2008
	Thursday, March 20th 2008
	Tuesday, April 1st 2008
	Wednesday, April 2nd 2008 (Day of Meeting)
Peninsula Clarion	Tuesday, March 18th 2008
	Wednesday, March 19th 2008
	Thursday, March 20th 2008
	Tuesday, April 1st 2008
	Wednesday, April 2nd 2008 (Day of Meeting)
Kodiak Daily Mirror	Tuesday, March 18th 2008
	Wednesday, March 19th 2008
	Thursday, March 20th 2008
	Monday, March 31st 2008
	Tuesday, April 1st 2008 (Day of Meeting)
Cordova Times	Tuesday, March 18th 2008
	Wednesday, March 19th 2008
	Thursday, March 20th 2008
	Thursday, March 27th 2008
	Thursday, April 3rd 2008 (Day of Meeting)

Appendix H

Acoustic Systems Descriptions

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H ACOUSTIC SYSTEMS DESCRIPTIONS

H.1 GENERAL SUMMARY OF ACOUSTIC SYSTEMS

Various active acoustic sources that may or may not affect the local marine mammal population are deployed by platforms during various training activities, exercises and maintenance events. The following sections discuss the acoustic sources that could be present during such training activities, exercises, and maintenance events.

H.1.1 Surface Ship Sonars

- AN/SQS-53 – a computer-controlled, hull-mounted surface-ship sonar that has both active and passive operating capabilities, providing precise information for anti-submarine warfare (ASW) weapons control and guidance. The system is designed to perform direct-path ASW search, detection, localization, and tracking from a hull-mounted transducer array. The AN/SQS-53 (Figure H-1) is characterized as a mid-frequency active (MFA) sonar, operating from 1 to 10 kilohertz (kHz); however, the exact frequency is classified. The AN/SQS-53 sonar is the major component to the AN/SQQ-89 sonar suite, and it is installed on Arleigh Burke Class guided missile destroyers (DDGs), and Ticonderoga Class guided missile cruisers (CGs).

Figure H-1: Arleigh Burke Class DDG equipped with AN/SQS-53 (L); Ticonderoga Class CG showing AN/SQS-53 (R)

- AN/SQS-53 Kingfisher – a modification to the AN/SQS-53 sonar system that provides the surface ship with an object detection capability. The system uses MFA sonar, although the exact frequency range is classified. This sonar system is installed on Arleigh Burke Class DDGs, and Ticonderoga Class CGs.
- AN/SQS-56 – a hull-mounted sonar that features digital implementation, system control by a built-in mini computer, and an advanced display system. The sonar is an active/passive, preformed beam, digital sonar providing panoramic active echo ranging and passive digital multibeam steering (DIMUS) surveillance. The sonar system is characterized as MFA sonar, although the exact frequency range is classified. The AN/SQS-56 (Figure H-2) is the major component of the AN/SQQ-89 sonar suite and is installed on Oliver Hazard Perry Class frigates (FFGs).

Figure H-2: Oliver Hazard Perry Class FFG equipped with AN/SQS-56

- AN/SQR-19 – a tactical towed array sonar (TACTAS) that is able to passively detect adversary submarines at a very long range. The AN/SQR-19, which is a component of the AN/SQQ-89 sonar suite, is a series of passive hydrophones towed from a cable several thousand feet behind the ship. This sonar system is a passive sensing device; therefore, it is not analyzed in this Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS). The AN/SQR-19 (Figure C-3) can be deployed by Arleigh Burke Class DDGs, Ticonderoga Class CGs, and Oliver Hazard Perry Class FFGs.

Figure H-3: AN/SQR-19

H.1.2 Surface Ship Fathometer

The surface ship fathometer (AN/UQN-4) is used to measure the depth of water from the ship's keel to the ocean floor for safe operational navigation. Fathometers are operated from all classes of United States (U.S.) Navy surface ships and are considered MFA sonar, although the exact frequency range is classified.

H.1.3 Submarine Sonars

- AN/BQQ-5 – a bow- and hull-mounted passive and active search and attack sonar system. The system includes the TB-16 and TB-23 or TB-29 towed arrays and Combat Control System (CCS) MK 2. This sonar system is characterized as MFA, although the exact frequency range is classified. The AN/BQQ-5 (Figure H-4) sonar system is installed on Los Angeles Class nuclear attack submarines (SSNs) and Ohio Class ballistic missile nuclear submarines (SSBNs), although the AN/BQQ-5 systems installed on Ohio Class SSBNs do not have an active sonar capability. The AN/BQQ-5 system is being phased out on all submarines in favor of the AN/BQQ-10 sonar. The operating parameters of both systems with regard to sound output in the ocean are almost identical. For these reasons, these systems will be referred to as AN/BQQ-10 in this EIS.

Figure H-4: AN/BQQ-5

- AN/BQQ-10 (also known as Advanced Rapid Commercial-Off-the-Shelf Insertion [ARCI]) – a four-phase program for transforming existing submarine sonar systems (i.e., AN/BQQ-5) from legacy systems to more capable and flexible active and passive systems with enhanced processing using commercial-off-the-shelf (COTS) components. The system is characterized as MFA, although the exact frequency range is classified. The AN/BQQ-10 (Figure H-5) is installed on Seawolf Class SSNs, Virginia Class SSNs, Los Angeles Class SSNs, and Ohio Class SSBN/nuclear guided missile submarines (SSGNs). The BQQ-10 systems installed on Ohio Class SSBNs do not have an active sonar capability.

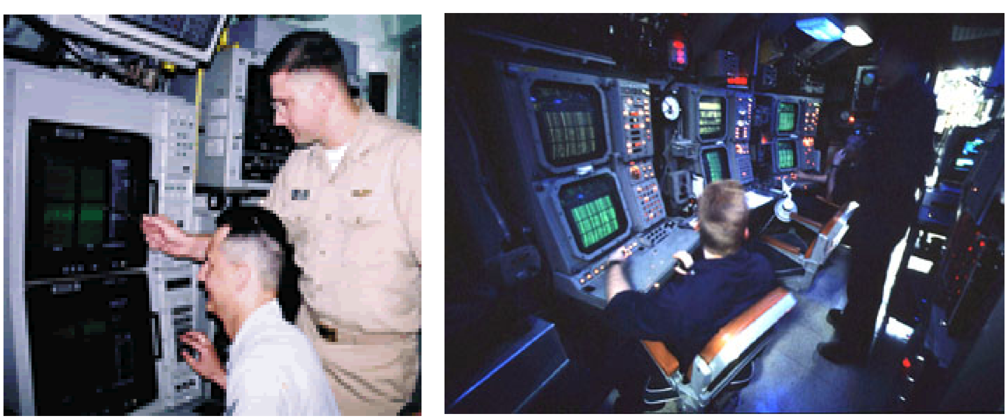

Figure H-5: Sailors operating AN/BQQ-10

H.1.4 Submarine Auxiliary Sonar Systems

- AN/BQS-15 – an under-ice navigation and mine-hunting sonar (Figure H-6) that uses both mid- and high-frequency (i.e., greater than 10 kHz) active sonar, although the exact frequencies are classified. Later versions of the AN/BQS-15 are also referred to as Submarine Active Detection Sonar (SADS). The Advanced Mine Detection System (AMDS) is being phased in on all ships and will eventually replace the AN/BQS-15 and SADS. These systems are installed on Seawolf Class SSNs, Virginia Class SSNs, Los Angeles Class SSNs, and Ohio Class SSGNs.

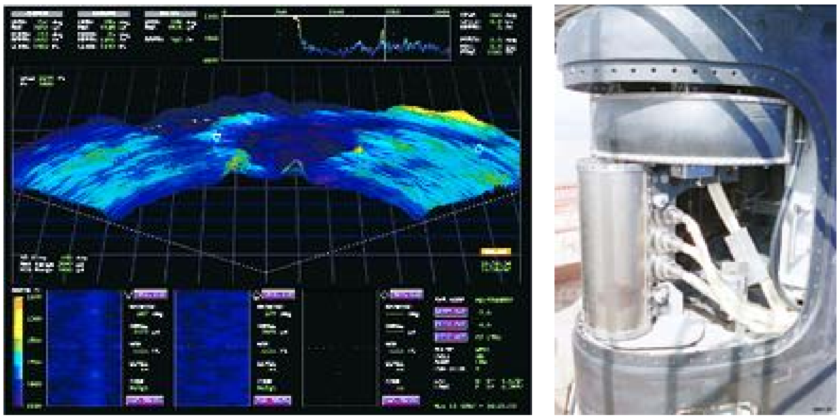

Figure H-6: AN/BQS-15 display (L), and sensor components (R)

- AN/WQC-25 – an MFA sonar underwater communications system that can transmit either voice or signal data in two bands, 1.5 to 3.1 kHz or 8.3 to 11.1 kHz. The AN/WQC-2 (Figure H-7), also referred to as the "underwater telephone" (UWT), is on all submarines and most surface ships, and allows voice and tonal communications between ships and submarines.

Figure H-7: AN/WQC-2 transducer (L), and control unit (R)

H.1.5 Aircraft Sonar Systems

Aircraft sonar systems that could be deployed during active sonar events include sonobuoys (tonal [active], listening [passive], and extended echo ranging [EER] or improved extended echo ranging [IEER]) and dipping sonar (AN/AQS-13/22 or AN/AOS-22). Sonobuoys may be deployed by Marine Patrol Aircraft (MPA) or MH-60R helicopters. A sonobuoy is an expendable device used by aircraft for the detection of underwater acoustic energy and for conducting vertical water column temperature measurements. Most sonobuoys are passive, but some can generate active acoustic signals as well as listen passively. Dipping sonars are used by MH-60R helicopters. Dipping sonar is an active or passive sonar device lowered on cable by helicopters to detect or maintain contact with underwater targets. A description of various types of sonobuoys and dipping sonar is provided below.

- AN/AQS-13 Helicopter Dipping Sonar – an active scanning sonar that detects and maintains contact with underwater targets through a transducer lowered into the water from a hovering helicopter. It operates at mid-frequency, although the exact frequency is classified. The AN/AQS-13 (Figure H-8) is operated by MH-60R helicopters.

Figure H-8: AN/AQS-13 being deployed by a Navy helicopter

- AN/AQS-22 Airborne Low-Frequency Sonar (ALFS) – the U.S. Navy's dipping sonar system for the MH-60R helicopter Light Airborne Multi-Purpose System III (LAMPS III), which is deployed from aircraft carriers, cruisers, destroyers, and frigates. It operates at mid-frequency, although the exact frequency is classified. The AN/AQS-22 (Figure H-9) employs both deep- and shallow-water capabilities.

Figure H-9: AN/AQS-22 being deployed by a Navy helicopter

- AN/SSQ-62C Directional Command Activated Sonobuoy System (DICASS) – sonobuoy that operates under direct command from ASW fixed-wing aircraft or MH-60R helicopters (Figure H-10). The system can determine the range and bearing of the target relative to the sonobuoys position and can deploy to various depths within the water column. The active sonar operates at mid-frequency, although the exact frequency range is classified. After water entry, the sonobuoy transmits sonar pulses (continuous waveform [CW] or linear frequency modulation [LFM]) upon command from the aircraft. The echoes from the active sonar signal are processed in the buoy and transmitted to the receiving station onboard the launching aircraft.

Figure H-10: AN/SQS-62 (L); MPA equipped with AN/SQS-62 sonobuoys (R)

- AN/SSQ-110A Explosive Source Sonobuoy – a commandable, air-dropped, high source level explosive sonobuoy. The AN/SSQ-110A explosive source sonobuoy (Figure H-11) is composed of two sections, an active (explosive) section and a passive section. The upper section is called the "control buoy" and is similar to the upper electronics package of the AN/SSQ-62 DICASS sonobuoy. The lower section consists of two signal underwater sound (SUS) explosive payloads of Class A explosive weighing 1.9 kg (4.2 lbs) each. The arming and firing mechanism is hydrostatically armed and detonated. Once in the water, the SUS charges explode, creating a loud acoustic signal. The echoes from the explosive charge are then analyzed on the aircraft to determine a submarine's position. The AN/SSQ-110A explosive source sonobuoy is deployed by MPA.

Figure H-11: MPA deploying AN/SSQ-110A

- AN/SSQ-53D/E Directional Frequency Analysis and Recording (DIFAR) – a passive sonobuoy deployed by MPA aircraft and MH-60R helicopters. The DIFAR sonobuoy (Figure H-12) provides acoustic signature data and bearing of the target of interest to the monitoring unit(s) and can be used for search, detection, and classification. The buoy uses a hydrophone with directional detection capabilities in the very low frequency, low frequency, and mid-frequency ranges, as well as an omnidirectional hydrophone for general listening purposes.

Figure H-12: AN/SSQ-53 (L); AN/SSQ-53 being loaded onto MPA (R)

H.1.6 Torpedoes

Torpedoes are the primary ASW weapon used by surface ships, aircraft, and submarines. When torpedoes operate actively, they transmit an active acoustic signal to ensonify the target and use the received echoes for guidance.

- MK 48 and MK 48 Advanced Capability (ADCAP) (Figure H-13) are heavyweight torpedoes deployed on all classes of Navy submarines. MK 48 and MK 48 ADCAP torpedoes are inert and considered HF sonar, but the frequency ranges are classified. Due to the fact that both torpedoes are essentially identical in terms of environmental interaction, they will be referred to collectively as the MK48 in this EIS.

Figure H-13: MK 48/MK 48 ADCAP (L); Seawolf Class SSN launching MK-48/MK-48 ADCAP (R)

- MK 46 Lightweight Torpedo (Figure H-14) are ASW torpedoes. They are less than half the size of the MK 48 and can be launched from surface ships, helicopters, and fixed wing aircraft. When used in training, the MK 46 is inert and considered HF sonar, but the exact frequency range is classified. When dropped from an aircraft, the MK 46 may have a parachute, which is jettisoned when it enters the water. The MK 46 torpedo also carries a small sea dye marker (Fluorescein) that is marks the torpedo's position on the surface to facilitate recovery. The MK 46 is planned to remain in service until 2015.

Figure H-14: MK 46 Torpedo at launch (L), and recovery (R)

H.1.7 Exercise Training Targets

There are two types of training targets, the MK 30 Acoustic Target and the MK 39 Expendable Mobile ASW Training Target (EMATT) (Figure H-15). ASW training targets simulate submarines as an ASW target in the absence of participation by a submarine in an exercise. They are equipped with acoustic projectors emanating sounds to simulate submarine acoustic signatures, and echo repeaters to simulate the characteristics of the reflection of a sonar signal from a submarine.

Figure H-15: MK 39 EMATT (L) and MK 30 (R)

In addition, surface targets such as "sleds" (aluminum catamarans), seaborne powered targets (radio-controlled high-speed boats), and target drone units (TDUs) could also be deployed during training exercises.

H.1.8 Tracking Pingers, Transponders, and Acoustical Communications (ACOMs)

Tracking pingers are installed on training platforms to track the position of underwater vehicles. The pingers generate a precise, preset, acoustic signal for each target to be tracked. ACOMs and transponders provide the communication link between sensor packages and base platform allowing information to be exchanged.

- MK 84 Pinger Signal, Underwater Sound (SUS) – an air or surface dropped noisemaking device (Figure H-16) that emits one of five mid-frequency tonal patterns using two MFA sonars with frequencies at 3.1 and 3.5 kHz; it is used to provide prearranged signal communications to submerged submarines.

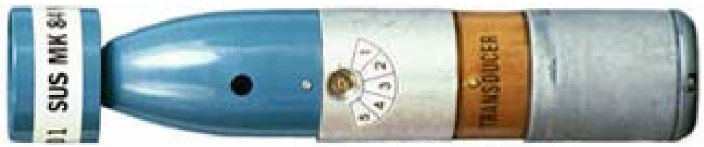

Figure H-16: MK 84

H.1.9 Portable Undersea Training Range (PUTR)

The Portable Undersea Training Range (PUTR) is a self-contained, portable, undersea tracking capability that employs modern technologies to support coordinated USW training for Forward Deployed Naval Forces (FDNF). PUTR will be available in two variants to support both shallow and deep water remote operations in keeping with Navy requirements to exercise and evaluate weapons systems and crews in the environments that replicate the potential combat area.

PUTR-D, shown below in Figure H-17, consists of a set of transponders which will be deployed by a ship of opportunity and anchored to the ocean bottom. Once deployed a survey is conducted by a range vessel to determine the transponder locations and to test tracking accuracy. The transponder is activated by utilizing an acoustic command signal during operations and commanded into sleep mode when not in use. Operational lifetime, due to transponder battery life, will meet the key performance parameters, including the operating objective of actual tracking time. The transponders can remain deployed for up to 12 months in a dormant state. Transponders will be recovered for battery/buoy maintenance or for range recovery by transmitting an acoustic command which releases the transponder electronics/floatation buoy package from the anchor. The ship of opportunity will then retrieve the transponders leaving the anchor *in-situ*.

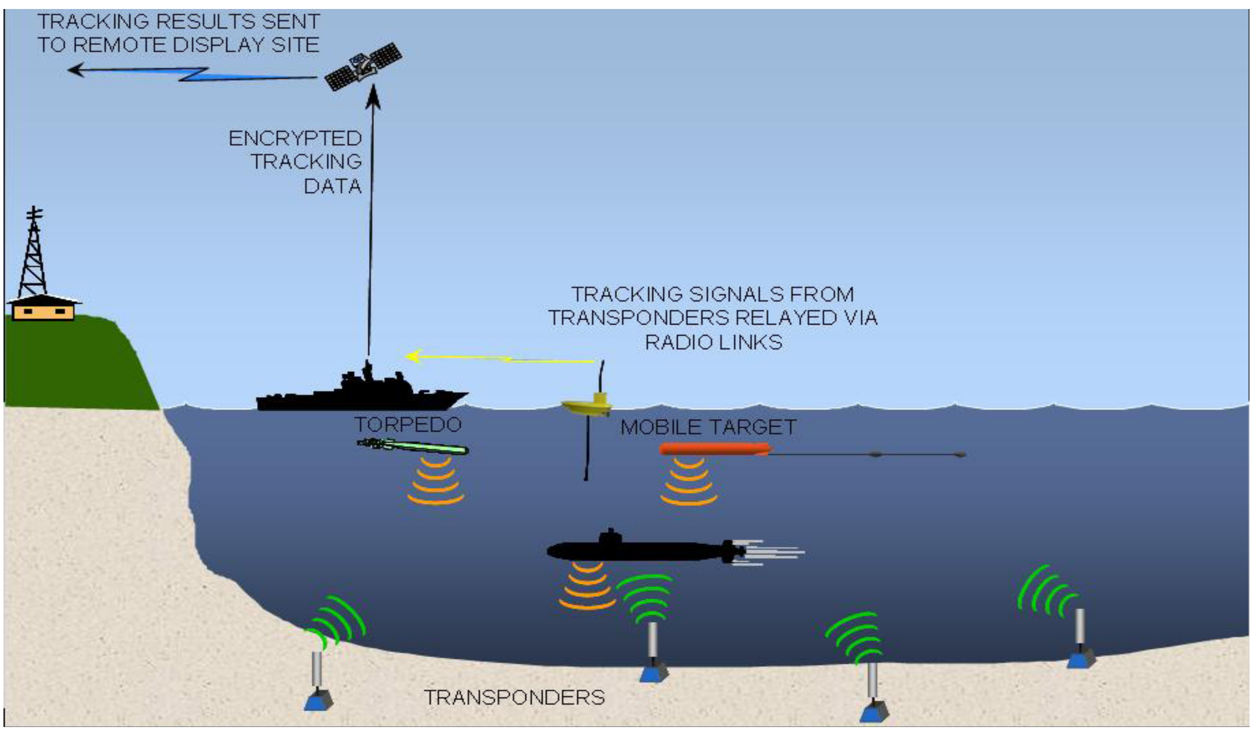

Figure H-17: Portable Undersea Training Range Deep (PUTR-D) Transponder Configuration

H.1.10 Advanced Extended Echo Ranging (AEER)

The Advance Extended Echo Ranging program examines improvements in both long-range shallow and deep water ASW search using active sources (Air Deployable Low Frequency Projector (ADLFP), Advance Ranging Source (ARS)) and passive sonobuoy receivers (Air Deployable Active Radar Receiver (ADAR)). The signal processing is provided by research conducted under Advanced Multi-static Processing Program (AMSP).

The AEER system is similar to the IEER system in that it uses the AN/SSQ-101 Air Deployed Active Receiver (ADAR) sonobuoy. But instead of the SSQ-110A Extended Echo Range Sonobuoy it is coupled with the SSQ-125 Air Deployable Coherent Source Sonobuoy. The SSQ-125 system is in the R&D stage with two types of sensor technology being considered (the ADLFP and ARS). The buoy is intended to provide the user with a sonobuoy with an improved bi-static acoustic source and better signal processing for harsh water environments. Table H-1 below is a comparison of the echo ranging systems.

Table H-1: Echo Ranging Systems

	Current System	Current System	Future System
Aircraft System =	EER	IEER	AEER
Buoys = (Source)	SSQ-110 (EER)	SSQ-110 (EER)	SSQ-125 (ADLFP)
Buoys = (Receiver)	SSQ-77 (VLAD)	SSQ-101 (ADAR)	SSQ-101 (ADAR)
Area of use =	Deep Water Only	Littoral &Deep Water	Enhanced Littoral & Deep Water
Used by	P-3C	P-3C (IOC)	P-3C/MH-60R