National Marine Fisheries Service
Endangered Species Act Section 7 Consultation Biological Opinion

Agencies:	National Marine Fisheries Service Office of Protected Resources – Permits, Conservation, and Education Division with the U.S. Navy as Action Agency and Applicant for a Federal Authorization
Activities Considered:	Military readiness activities on the Mariana Islands Range Complex from August 2011 to August 2012 NMFS' 2011 Letter of Authorization for the U.S. Navy to "take" marine mammals incidental to the conduct of military readiness activities on the Mariana Islands Range Complex from August 2011 to August 2012
Consultation Conducted by:	Endangered Species Division of the Office of Protected Resources, National Marine Fisheries Service

Approved by: _____ Date: AUG 9 2011

This document constitutes the National Marine Fisheries Service's (NMFS) Biological Opinion (Opinion) on (1) the United States Navy – Pacific Fleet (hereafter, the U.S. Navy), as the executive agent responsible for the Mariana Islands Range Complex, which proposes to undertake training and research, development, test, and evaluation activities, and make range enhancements on the Mariana Islands Range Complex and (2) NMFS' proposed issuance of a letter of authorization to the U.S. Navy that would authorize the U.S. Navy to "take" marine mammals incidental to those military readiness activities. The consulting agency for these proposals is NMFS' Office of Protected Resources - Endangered Species Division. This Opinion has been prepared in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

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1 INTRODUCTION

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1539(a)(2)) requires each Federal agency to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a Federal agency's action "may affect" a protected species, that agency is required to consult formally with the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service, depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR §402.14(a)). Federal agencies are exempt from this general requirement if they have concluded that an action "may affect, but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat and NMFS or the U.S. Fish and Wildlife Service concurs with that conclusion (50 CFR §402.14(b)).

For the actions described in this document, there are two action agencies: (1) the United States Navy – Pacific Fleet (hereafter, the U.S. Navy), as the executive agent responsible for the Mariana Islands Range Complex, which proposes to undertake training and research, development, test, and evaluation activities, and make range enhancements on the Mariana Islands Range Complex and (2) the National Marine Fisheries Service's Office of Protected Resources – Permits, Conservation, and Education Division (Permits Division), which proposes to issue a Letter of Authorization under the Marine Mammal Protection Act (MMPA) that would authorize the U.S. Navy to "take" marine mammals incidental to those military readiness activities. The consulting agency for these proposals is NMFS' Office of Protected Resources - Endangered Species Division.

This Opinion has been prepared in accordance with section 7 of the ESA and is based on information provided in the U.S. Navy's *Environmental Impact Statement/Overseas Environmental Impact Statement, Mariana Islands Range Complex* (Navy 2010b), the U.S. Navy's biological assessment for the Mariana Islands Range Complex (2009), the application for the proposed Marine Mammal Protection Act permit, published and unpublished scientific information on the biology and ecology of threatened and endangered marine mammals and endangered and threatened sea turtles that occur off the coasts of Mariana Islands and published information.

This Opinion is also based on information contained in consultation records developed for a series of consultations on SURTASS LFA, including the January 2001 *Final Overseas Environmental Impact Statement and Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar* (Navy 2001b), the *Biological Assessment for the Employment of the Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar* (Navy 2006); a February 1999 report on Marine Vertebrates and Low Frequency Sound: Technical Report for LFA EIS prepared by the Marine Mammal and Seabird Ecology Group of the University of California, Santa Cruz, Institute of Marine Sciences (Croll et al. 1999b);

NMFS' May 30, 2002, biological opinion on the U.S. Navy's proposed use of SURTASS LFA sonar; NMFS' regulations to authorize the Navy to take marine mammals incidental to its employment of SURTASS LFA sonar; a series of biological opinions on the U.S. Navy's annual missions with SURTASS LFA sonar; and the U.S. Navy's annual reports from the operations of SURTASS LFA sonar (Navy 2005; Navy 2007) (Navy 2008a) (Navy 2009; Navy 2010a).

The Opinion and Incidental Take Statement (ITS) portions of this consultation were prepared by NMFS Endangered Species Division in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531, et seq.), and implementing regulations at 50 CFR §402. This document represents NMFS' final Biological Opinion on the effects of these actions on endangered and threatened species and critical habitat that has been designated for those species.

1.1 Background

In August 2008, the U.S. Navy submitted an application requesting authorization to "take" marine mammals under the MMPA incidental to military readiness activities on the Mariana Islands Range Complex to NMFS' Permits Division. That original request was intended to address military readiness activities the U.S. Navy planned to conduct on the Mariana Island Range Complex from January 2010 through December 2014. The Navy provided MMPA updates to the proposed action in February 2009, April 2009, June 2009 and November 2009.

Prior to NMFS' Permits Division publishing new regulations pursuant to the MMPA that would affect marine mammals protected under the ESA, NMFS' Permits Division requested consultation under section 7 of the ESA.

On 28 June 2010, the NMFS Endangered Species Division issued a programmatic biological opinion that assessed the probable direct and indirect effects of the U.S. Navy's military readiness activities on the Mariana Islands Range Complex and NMFS Permits Division's proposal to issue regulations that would allow it to authorize the "take" of marine mammals incidental to military readiness activities on the Mariana Islands Range Complex on ESA listed species under NMFS jurisdiction. The five year time period of the consultation was adjusted from the U. S. Navy's requested time period to incorporate the Navy requested updates and coincide with the biological opinion and MMPA regulations issuance dates.

On 3 August 2010, the NMFS' Permits Division published final regulations to govern the unintentional taking of marine mammals incidental to activities conducted in the Mariana Islands Range Complex for the period of August 2010 through August 2015. The final regulations allow for the issuance of annual ''Letters of Authorization'' (LOAs) for the incidental take of marine mammals during the described activities and specified timeframes, prescribe the permissible methods of taking and other means of effecting the least practicable adverse impact on marine mammal species or stocks and their habitat, as

well as requirements pertaining to the monitoring and reporting of such taking (75 FR 45527).

On 4 August 2010, the Permits Division provided NMFS' Endangered Species Division with a copy of the draft annual LOA it intended to issue to the U.S. Navy to authorize the "take" of marine mammals beginning in August 2010 through August 2011.

On 16 August 2010, NMFS Endangered Species Division completed the biological opinion on that annual LOA. This biological opinion evaluated the U.S. Navy's proposal to conduct military readiness activities on the Mariana Islands Range Complex and NMFS' Permits Division's proposal to issue the annual LOA to authorize the "take" of marine mammals incidental to military readiness activities on the Mariana Islands Range Complex from August 2010 to August 2011.

1.2 Consultation History

On 12 July 2011, the Permits Division provided NMFS' Endangered Species Division with a copy of the draft annual LOA it intended to issue to the U.S. Navy to authorize the "take" of marine mammals for the period of August 2011 to August 2012.

On 28 July 2011, the National Marine Fisheries Service's Endangered Species Division provided the U.S. Navy and the Permits Division with copies of its draft biological opinion on the proposed letters of authorization for the Mariana Islands Range Complex. On August 4, 2011 and August 5, 2011, the Endangered Species Division received the U.S. Navy's and the Permits Division's comments on the draft Opinion, respectively. Those comments have been incorporated, as appropriate, in this version of the Opinion.

2 DESCRIPTION OF THE PROPOSED ACTION

This Opinion addresses two separate, but related activities: (1) a proposal by the U.S. Navy (as the executive agent for the Mariana Islands Range Complex) to continue military readiness activities on the Mariana Islands Range Complex over a 12-month period beginning on or about August 2011 and ending on or about August 2012; (2) NMFS' Permits Division proposal to issue a LOA that would authorize the Navy to "take" marine mammals incidental to military readiness activities on the Mariana Islands Range Complex from August 2011 through August 2012. The U.S. Navy is the lead agency for this consultation and, in most cases, will be referred to as the Action Agency in this Opinion.

The purpose of the proposed readiness activities is to meet the requirements of the U.S. Navy's Fleet Response Training Plan and allow U.S. military personnel to remain proficient in anti-submarine warfare and mine warfare skills. The purpose of the Permits Division's regulations is to establish a framework whereby, pursuant to the MMPA, the U.S. Navy may obtain authorizations to "take" marine mammals incidental to military readiness activities on the Mariana Islands Range Complex.

2.1 Activities That Are Not Likely to Adversely Affect Listed Resources

The 28 June 2010 biological opinion concluded that several of the activities the U.S. Navy plans to conduct on the range complex are not likely to adversely affect listed species or designated critical habitat because (1) the activities are not likely to produce stimuli that would represent potential stressors for endangered or threatened species or designated critical habitat under NMFS' jurisdiction; (2) the activities are likely to produce stimuli that would represent potential stressors for endangered or threatened species or designated critical habitat under NMFS' jurisdiction, but those species or critical habitat are not likely to be exposed to stressors; or (3) endangered or threatened species or designated critical habitat under NMFS' jurisdiction are likely to be exposed to potential stressors associated with the activities, but they are not likely to respond given that exposure. Specifically, endangered or threatened species or designated critical habitat under NMFS' jurisdiction are not likely to be exposed to physical, chemical, or biotic stressors that might be associated with the following activities:

1) The Expeditionary Warfare training exercises the U.S. Navy proposes to conduct on the Mariana Islands Range Complex, which consist of military operations in urban terrain (MOUT) training (see Table 1), would occur at primary and secondary locations that are terrestrial (on Guam; Andersen Airforce Base South; Finegayan Communication Annex; Barrigada Housing; Northwest Field, Tinian; Rota; or Saipan). These exercises are not likely to directly or indirectly produce potential stressors that would reach the marine or coastal environment where endangered or threatened species under NMFS' jurisdiction might be exposed to those stressors.
2) The Anti-terrorism and Force Protection training exercises the U.S. Navy proposes to conduct on the Mariana Islands Range Complex would occur at primary and secondary locations that are terrestrial (Northwest Field, Northern Land Navigation Area; and Barrigada Annex, Orote Point Airfield, Polaris Point airfield, or Tinian North Field). These exercises are not likely to directly or indirectly produce potential stressors that would reach the marine or coastal environment where endangered or threatened species under NMFS' jurisdiction might be exposed to those stressors.
3) The Marine Air Ground Task Force Exercise – Humanitarian Assistance Disaster Relief/ Noncombatant Evacuation Operation (HADR/NEO) the U.S. Navy proposes to conduct on the Mariana Islands Range Complex would occur at primary and secondary locations that are terrestrial (Guam with Tinian, Saipan, or Farallon de Medinilla). These exercises are not likely to directly or indirectly produce potential stressors that would reach the marine or coastal environment where endangered or threatened species under NMFS' jurisdiction might be exposed to those stressors.
4) The Urban Warfare Exercise the U.S. Navy proposes to conduct on the Mariana Islands Range Complex would occur at primary and secondary locations that are terrestrial (Finegayan Housing, Andersen South, Barrigada Housing, and Northwest Field, Tinian or Rota). These exercises are not likely to directly or indirectly produce potential stressors that would reach the marine or coastal environment where

endangered or threatened species under NMFS' jurisdiction might be exposed to those stressors.

5) The Special Warfare training exercises the U.S. Navy proposes to conduct on the Mariana Islands Range Complex, including breaching, direct action, hydrographic reconnaissance, insertion/extraction, parachute insertion, or urban warfare training activities would occur at primary and secondary locations that are terrestrial. These exercises are not likely to directly or indirectly produce potential stressors that would reach the marine or coastal environment where endangered or threatened species under NMFS' jurisdiction might be exposed to those stressors.

6) The Special Warfare-Expeditionary Warfare training exercises the U.S. Navy proposes to conduct on the Mariana Islands Range Complex, including specific training exercises for Airfield Expeditionary, Field Training Exercise, Humanitarian Assistance/Disaster Relief Operation, Intelligence, Surveillance, Reconnaissance, Land Demolitions, Maneuver, Non-Combatant Evacuation Operation, and Airfield Seizure would occur at primary and secondary locations that are terrestrial. These exercises are not likely to directly or indirectly produce potential stressors that would reach the marine or coastal environment where endangered or threatened species under NMFS' jurisdiction might be exposed to those stressors.

7) Air Combat Maneuvers which include basic flight maneuvers in which aircraft engage in offensive and defensive maneuvering against each other. Air Combat Maneuvers activities on the Mariana Islands Range Complex primarily consist of unit-level training that typically involves two aircraft, operating at altitudes from 5,000 to 30,000 ft and airspeeds range from very low (less than 100 kts) to high subsonic (less than 600 kts). These maneuvers typically last for about one hour and no ordnance is released during sorties. The U.S. Navy plans to conduct about 720 of these sorties each year in the Mariana Islands Range Complex (an increase from the 360 sorties that are conducted each year under current training schedules). These events would occur primarily off Guam in W-517, with maritime areas off the Mariana Islands greater than 12nm from land and Air Traffic Control Assigned Airspaces as secondary sites (see Figures 1 and 2).

8) Air Intercept Control Exercises involving air intercept controllers that are embarked in ships, aircraft, or on the ground, use air search radars to track "friendly" strike fighter interceptor and "threat" aircraft which typically travel at altitudes substantially higher than 15,000 ft. When a "threat" aircraft is detected by a controller's air search radar, "friendly" strike fighters intercept and engage the "threat" aircraft; the aircraft involved in these exercises may travel at speeds greater than 450 kts. No high explosive ordnance is used during these exercises, but Combat Arms and Training Maintenance may be used when strike fighters participate (which complete air-to-air missile exercises or air-to-air gunnery exercises). These events typically consist of several intercepts, with 2 – 4 aircraft per sortie, conducted over one to two hours. The U.S. Navy proposes to conduct about 40 events and 80 sorties on W-517; in airspace

beyond 12 nm of Guam or the Commonwealth of the Mariana Islands, or in Air Traffic Control Assigned Airspaces.

Because these activities are not likely to adversely affect endangered or threatened species under NMFS' jurisdiction, they will not be considered further in this document.

2.2 Activities That Are Likely to Adversely Affect Listed Resources

The following narratives summarize the remaining training operations the U.S. Navy plans to conduct on the Mariana Islands Range Complex. Table 1 identifies the specific training activities, number of events for each activity, and the locations of the different events while Chapter 2 and Appendix D of the U.S. Navy's Environmental Impact Statement/Overseas Environmental Impact Statement, Mariana Islands Range Complex (Navy 2010b; Navy 2010c) and our 28 June 2010 programmatic biological opinion on the Mariana Islands Range Complex (NMFS 2010b) provide more detailed narratives of these training operations and specific ordnance that might be involved in particular training operations.

1) Air-To-Air Missile or Gunnery Exercises, which consist of missiles fired from aircraft against unmanned aerial target drones such as BQM-34s, BQM-74s, or Tactical Air Launched Decoys that are dropped by supporting aircraft. Typically, about half of the missiles fired have live warheads and half have telemetry packages.

2) Surface-to-Air Missile Exercises, in which surface ships engage incoming missiles and aircraft with defensive missiles off Guam in W-517, with maritime areas off the Mariana Islands greater than 12nm from land and Air Traffic Control Assigned Airspaces as secondary sites (see Figures 1 and 2 for maps depicting these areas).

3) Amphibious Warfare, which consist of amphibious assault U.S. Marine air ground task force operations, amphibious assault operations, and firing exercises (see Table 1).

4) Anti-Submarine Warfare, which consists of Torpedo Exercises (Maritime Patrol Aircraft – Helicopter); Torpedo Exercises (Surface Ship); Torpedo Exercises (Submarine); Tracking Exercise (Helicopters); Tracking Exercise (Maritime Patrol Aircraft); Tracking Exercise (Surface Ship); Tracking Exercise (Submarine). All of these exercises are designed to train U.S. Navy personnel to detect, classify, localize, track, and neutralize submarines (see Table 1).

5) Electronic Combat Operations, which consist of chaff exercises and flare exercises (see Table 1). The U.S. Navy typically conducts chaff exercises with flare exercises or other exercises rather than as a stand alone exercise (see Table 1).

6) Expeditionary Warfare, which consist of military operations in theater training, specifically military operations in urban terrain (MOUT) training (see Table 1).

7) Major Training Exercises, which consist of Joint Expeditionary Exercises, Joint Multi-Strike Group Exercises, Marine Air Ground Task Force Exercises, Urban

Warfare Exercises, and Special Purpose Marine Air Ground Task Force Exercises. Joint Multi-Strike Group Exercises involve up to three Carrier Strike Groups working with other Services while engaging in battle scenarios that pit United States forces against an opposition force. These exercises can include sinking exercises and the U.S. Navy's Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) sonar platform (see Table 1 and Figures 5, 7, 8, and 9).

8) Mine Warfare consist of floating mine neutralization, underwater demolition, and mine laying exercises. Floating mine neutralization and underwater demolition events typically occur at Agat Bay on Guam, Apra Harbor, or Piti Point, (see Table 1 and Figure 6).

9) Special Warfare, which involves platoons or squads of U.S. Navy SEALS or Explosive Ordnance Detonation, U.S. Army, U.S. Marine Corps, U.S. Air Force, or U.S. Navy Expeditionary Combat Command personnel engaged in breaching, direct action, hydrographic reconnaissance, insertion/extraction, parachute insertion, or urban warfare training activities (see Table 1).

10) Special Warfare-Expeditionary Warfare involve specific training exercises for Airfield Expeditionary, Field Training Exercise, Humanitarian Assistance/Disaster Relief Operation, Intelligence, Surveillance, Reconnaissance, Land Demolitions, Maneuver, Non-Combatant Evacuation Operation, and Airfield Seizure (see Table 1 and Figures 5, 6, 7, 8, and 9).

11) Strike Warfare involve bombing exercises (land-based targets), air-to-ground missile exercises, and combat search and rescue exercises (see Table 1 for a list of the aircraft involved in these exercises and Figure 4 for locations).

12) Surface Warfare involve Gunnery Exercises (Surface-to-Surface – small arms), Gunnery Exercises (Surface-to-Surface Ship), Gunnery Exercises (Air to Surface), Bombing Exercises (Air to Surface), Sinking Exercises, and Visit, Board, Search, and Seizure or Maritime Interception Operations (see Table 1 and Figures 1, 2, and 3).

Table 1. Activities the U.S. Navy proposes to conduct in the Mariana Islands Range Complex from August 2011 through August 2012 (adapted from Table 2-6 and Appendix D of (Navy 2010c).

Range Operation	Platform(s)	System or Ordnance	Proposed Action	Location
AIR WARFARE				
Air Combat Maneuvers	FA-18; AV-8B; F-15; F16; F-35	Captive Air Training Missile (Combat Arms and Training Maintenance) or Telemetry Pod	720 sorties (2-4 aircraft per sortie)	Primary Site(s): W-517 Secondary Site(s):: MI Maritime, >12nm from land; Air Traffic Control Assigned Airspaces
Air Intercept Control Exercise	FA-18, F-15	Search and fire control radars	80 sorties (2-4 aircraft per sortie) in 40 training events	Primary Site(s): W-517 Secondary Site(s):: MI Maritime, >12nm from land; Air Traffic Control Assigned Airspaces
Missile Exercise/Gunnery Exercise Air to Air	FA-18; EA-18; AV-8B; F-3, Tactical Air-Launched Decoy Target	AIM-7 Sparrow (Non Explosive).20mm or 25 mm cannon.	6 sorties (2-4 aircraft) (6 missiles; 1,500 rounds)	Primary Site(s): W-517 Secondary Site(s):: MI Maritime, >12nm from land; Air Traffic Control Assigned Airspaces
		AIM-9 Sidewinder (HE)/AIM-120 (HE or Inert). 20mm or 25 mm cannon	6 sorties (2-4 aircraft) (6 missiles; 1,500 rounds)	
MISSILEX (Ship to Air)	Multi-purpose Aircraft Carrier (Nuclear), Amphibious Assault Ship (multipurpose), Guided Missile Cruiser, Guided Missile Destroyer; Aerial Target Drone (BQM-74E)	RIM-7 Sea Sparrow RIM-116 RAM RIM-67 SM-II ER	2 (2 missiles)	Primary Site(s): W-517 Secondary Site(s):: MI Maritime, >12nm from land; Air Traffic Control Assigned Airspaces
AMPHIBIOUS WARFARE				
Amphibious Assault Marine Air Ground Task Force	1 Amphibious Assault Ship (general purpose) or Amphibious Assault Ship (multipurpose), 1 Amphibious Transport Dock, 1 Dock Landing Ship, 1 Guided Missile Cruiser or Guided Missile Destroyer, and 2 Guided Missile Frigate, Includes temporary Fuel and Armament Replenishment Point	4-14 AAV/EFV or LAV/LAR; 3-5 LCAC; 1-2 LCU; 4 H-53; 12 H-46 or 10 MV-22; 2 UH-1; 4 AH-1; 4 AV-8, includes FARP construction	4 Events (assault, offload, `backload)	Primary Site(s): Tinian Military Leased Area; Unai Chulu, Dankulo and Babui (beach) and Tinian Harbor; North Field. Secondary Site(s): Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Sumay Cove and MWR Ramp; Tipalao Cove and Dadi Beach
Amphibious Raid Special Purpose Marine Air Ground Task Force	1 Amphibious Assault Ship (general purpose) or Amphibious Assault Ship (multipurpose); 1 Amphibious Transport Dock; and 1 Dock Landing Ship. Tailored Marine Air Ground Task Force	4-14 AAV/EFV or LAV/LAR; 0-5 LCAC; 0-2 LCU; 4 H-53; 12 H-46 or 10 MV-22; 2 UH-1; 4 AH-1; 4 AV-8	2 Events (raid, offload, backload)	Primary Site(s): Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Field; Sumay Cove and MWR Marina Ramp; Tipalao Cove and Dadi Beach Secondary Site(s): Tinian Military Leased Area; Unai Chulu, Dankulo, and Babui (beach) and Tinian Harbor; North Field
Firing Exercise (Land)	Guided Missile Cruiser, Guided Missile Destroyer	5" Guns and High Explosive shells	8 Events (800 rounds)	Farallon de Medinilla (R-7201)
ANTI-SUBMARINE WARFARE				
Tracking Exercise (Helicopters)	SH-60B, SH-60F SUB/ MK-30/ EMATT	AQS-22, SSQ-62 DICASS sonobuoy	18 Events; 2 hours per helicopter	Primary Site(s): W-517 Secondary Site(s):: MI Maritime, >3 nm from land
Tracking Exercise (Maritime Patrol Aircraft)	Fixed Wing Maritime Patrol Aircraft Submarine/MK-30/ EMATT	SSQ-62 DICASS EER/IEER/AEER	8 Events; 4 hours per Maritime Patrol Aircraft	Primary Site(s): W-517 Secondary Site(s):: MI Maritime, >3 nm from land
Tracking Exercise (Surface Ship)	Guided Missile Cruiser/ Guided Missile Destroyer / Guided Missile Frigate SUB/ MK-30/ EMATT	SQS-53 SQS-56 sonar	30 Events 4 hours per ship	Primary Site(s): W-517 Secondary Site(s):: MI Maritime, >3 nm from land
Tracking Exercise (Submarine)	Submarine (nuclear propulsion); Submarine (Guided Missile) MK-30	BQQ sonar	10 Events 4 hours per submarine	Primary Site(s): Guam Maritime, >3 nm from land Secondary Site(s):: W-517
Torpedo Exercise (Maritime Patrol Aircraft – Helicopter)	Maritime Patrol Aircraft / SH-60B/F, SUB/ MK-30/ EMATT TRB / MH-60S/ RHIB	AQS-22 / DICASS sonobuoy Recoverable Exercise Torpedo	4 Events 2 hours per event	Primary Site(s): Guam Maritime, >3 nm from land Secondary Site(s):: W-517
Torpedo Exercise (Surface Ship)	Guided Missile Cruiser/ Guided Missile Destroyer / Guided Missile Frigate SUB/ MK-30/ EMATT TRB / MH-60S/ RHIB	SQS-53 SQS-56 sonar Recoverable Exercise Torpedo	3 Events 4 hours per event	Primary Site(s): Guam Maritime, >3 nm from land Secondary Site(s):: W-517

Range Operation	Platform(s)	System or Ordnance	Proposed Action	Location
Torpedo Exercise (Submarine)	Submarine (nuclear propulsion); Submarine (Guided Missile) MK-30 TRB / MH-60S	BQQ sonar MK-48 Exercise Torpedo	10 Events; 4 hours per event	Primary Site(s): Guam Maritime, >3 nm from land Secondary Site(s):: W-517
ELECTRONIC COMBAT				
Chaff Exercises	SH-60; MH-60; HH-60; MH-53	RR-144A/AL	14 sorties (420 rounds)	Primary Site(s): W-517 Secondary Site(s):: MI Maritime, >12nm from land; Air Traffic Control Assigned Airspaces
	FA-18; EA-18; AV-8B; Maritime Patrol Aircraft; EA-6	RR-144A/AL	32 sorties (320 rounds)	
	F-15; F-16; F-35; C-130	RR-188	500 sorties (5,000 rounds)	
	Guided Missile Cruiser, Guided Missile Destroyer, Guided Missile Frigate, Amphibious Assault Ship (general purpose), Amphibious Assault Ship (multipurpose), Amphibious Transport Dock, Dock Landing Ship	MK 214 (seduction); MK 216 (distraction)	16 (90 canisters)	
Flare Exercise	SH-60; MH-60; HH-60; MH-53	MK 46 MOD 1C; MJU-8A/B; MJU- 27A/B; MJU-32B; MJU-53B; SM- 875/ALE	14 sorties (420 rounds)	Primary Site(s): W-517 Secondary Site(s):: MI Maritime, >12nm from land; Air Traffic Control Assigned Airspaces
	FA-18; EA-18; AV-8B; Maritime Patrol Aircraft; EA-6		32 sorties (320 rounds)	
	F-15; F-16; F-35; C-130	MJU-7; MJU-10; MJU-206	500 sorties (5,000 rounds)	
EXPEDITIONARY WARFARE				
Military Operations In Urban Terrain (mout)	Marine Corps Infantry Company: AH-1, UH-1; H-46 or MV- 22; H-53; AAV, LAV, HMMWV, Truck	5.56 mm blanks/Simulations	5 events 7-21 days per event	Primary Site(s): Guam; AAFB South; Finegayan Communication Annex; Barrigada Housing; Northwest Field Secondary Site(s):: Tinian; Rota; Saipan
	Air Force RED HORSE SQUADRON: Truck, HMMWV; MH-53; H-60		4 events 3-5 days per event	
	Navy Naval Expeditionary Combat Command Company, HMWWV, Truck		4 events 3-5 days per event	
	Army Reserve/GUARNG Company; HMWWV, Truck		4 events 3-5 days per event	
FORCE PROTECTION AND ANTI-TERRORISM				
Anti-terrorism	Navy Base Security Air Force Security Squadron Marine Corps FAST Platoon Trucks; HMMWV; MH-60	5.56 mm blanks/Simulations	80 events 1day per event	Primary Site(s): Tarague Beach Shoot House and Combat Arms and Training Maintenance Range; Polaris Pt.; Northwest Field. Secondary Site(s):: Kilo Wharf; Finegayan Comm. Annex; Navy Munitions Site; AAFB Munitions Site, Rota Municipality
Embassy Reinforcement Exercise	SEAL or Army Platoon, Marine Corps Company or Platoon, Trucks, HMMWV, C-130, H-60, H-53	5.56 mm blanks/Simulations	50 events 2 -3 days per event	Primary Site(s): Orote Pt.Airfield, apra Harbor, Northern and Southern Land Navigation Area; Secondary Site(s): Orote Pt. Triple Spot, Orote Pt. CQC, Kilo Wharf, Rota Municipality
Force Protection	Air Force Squadron or Platoon; Naval Expeditionary Combat Command SEABEE Company or Platoon; USAR Engineer Company or Platoon Tents; Trucks; HMMWV; Generators	5.56 mm blanks/Simulations	75 Events 1-2 days per event	Primary Site(s): Guam, Northwest Field; Northern Land Navigation Area; Barrigada Annex Secondary Site(s):: Orote Pt. Airfield; Polaris Pt. Field; Tinian North Field, Rota Municipality
MAJOR TRAINING EXERCISES				
Joint Expeditionary Exercise (Carrier and Expeditionary Strike Groups)	**Vessels:** Aircraft Carrier - nuclear, CG, Guided Missile Frigate, Guided Missile Destroyer, Amphibious Assault Ship (general or multipurpose), Dock Landing Ship, and Amphibious Transport Dock, TAOE, submarines, T-AGO	Numerous (see text)	1 Event per year 10 days per event	Primary Site(s): Tinian; Secondary Site(s): Guam, Rota, Saipan, Farallon de Medinilla, nearshore to over-the-horizon

Range Operation	Platform(s)	System or Ordnance	Proposed Action	Location
	Fixed-Wing Aircraft: FA-18; EA-6B, F-35, E-2, P3-P8, AV-8B; C-130, Air Force bomber, F-15/16/22, A-10, E-3, KC-10/135/130 **Rotary Aircraft**: SH-60; MH-60; HH-60; MH-53; CH-53; ch-46, ah-1, UH-1, MV-22 **Unmanned Aerial Systems**: Ship-based; Ground-based **Landing Craft**: Landing Craft- Air Cushion, Landing Craft - Utility, Combat Rubber Raiding Craft **Ground Combat Elements**: Amphibious Assault Vehicle, Light armored vehicle, HMMWV, Ground Personnel **Logistics Combat Elements**: Trucks, Dozer, Forklifts, Reverse Osmosis Purification Unit, Rigid Hull Inflatable Boat, Ground Personnel			
Joint Multi-strike Group Exercise (3 Carrier Strike Groups + Air Force)	**Vessels:** Aircraft Carrier - nuclear, CG, Guided Missile Frigate, Guided Missile Destroyer, TAOE, submarines, T-AGO **Fixed-Wing Aircraft:** FA-18; EA-6B, E-2, P3-P8, Air Force bomber, F-15/16/22, E-3, KC-10/135/130 **Rotary Aircraft**: SH-60; MH-60; HH-60; MH-53; **Unmanned Aerial Systems**: Ship-based; Ground-based	Numerous (see text)	1 Event per year 10 days per event	Primary Site(s): Mariana Islands > 12 km offshore ; Secondary Site(s): Farallon de Medinilla
Marine Air Ground Task Force Exercise (STOM/ NEO)	**Vessels:** Guided Missile Frigate, Guided Missile Destroyer, Amphibious Assault Ship (general or multipurpose), Dock Landing Ship, and Amphibious Transport Dock, TAOE, submarines **Fixed-Wing Aircraft:** FA-18; F-35, EA-6B, E-2, P3-P8, AV-8B; C-130, Air Force bomber, F-15/16/22, A-10, E-3, KC-10/135/130 **Rotary Aircraft**: SH-60; MH-60; CH-53; CH-46, AH-1, UH-1, MV-22 **Unmanned Aerial Systems**: Ship-based; Ground-based **Landing Craft**: Landing Craft- Air Cushion, Landing Craft-Utility, Combat Rubber Raiding Craft **Ground Combat Elements**: Amphibious Assault Vehicle, Light armored vehicle, HMMWV, Ground Personnel **Logistics Combat Elements**: Trucks, Dozer, Forklifts, Reverse Osmosis Purification Unit, Rigid Hull Inflatable Boat, Ground Personnel	Numerous (see text)	4 Events per year 10 days per event	Primary Site(s): Tinian; Secondary Site(s): Guam, Saipan, Farallon de Medinilla, nearshore to –over-the-horizon
Special Purpose Marine Air Ground Task Force Exercise (HADR/ NEO)	**Vessels:** Amphibious Assault Ship (general or multipurpose), Dock Landing Ship, and Amphibious Transport Dock, **Fixed-Wing Aircraft:** C-130 **Rotary Aircraft**: CH-53; CH-46, AH-1, UH-1, MV-22 **Unmanned Aerial Systems**: Ground-based **Landing Craft**: Landing Craft- Air Cushion, Landing Craft - Utility, Combat Rubber Raiding Craft **Ground Combat Elements**: Amphibious Assault Vehicle, Light armored vehicle, HMMWV, Ground Personnel **Logistics Combat Elements**: Trucks, Dozer, Forklifts, Reverse Osmosis Purification Unit, Rigid Hull Inflatable Boat, Ground Personnel	Numerous (see text)	2 Events per year 10 days per event	Primary Site(s): Guam; Secondary Site(s): Tinian, Rota, Saipan
Urban Warfare Exercise	**Vessels:** Aircraft Carrier - nuclear, CG, Guided Missile Frigate, Guided Missile Destroyer, Amphibious Assault Ship (general or multipurpose), Dock Landing Ship, and Amphibious Transport Dock, **Fixed-Wing Aircraft:** C-130	Numerous (see text)	5 Events per year 7-21 days per event	Primary Site(s): Guam; Secondary Site(s): Tinian, Rota, Saipan

Range Operation	Platform(s)	System or Ordnance	Proposed Action	Location
	Rotary Aircraft: CH-53; ch-46, ah-1, UH-1, MV-22 **Unmanned Aerial Systems**: Ship-based; Ground-based **Ground Combat Elements**: Amphibious Assault Vehicle, Light armored vehicle, HMMWV, Ground Personnel **Logistics Combat Elements**: Trucks, Dozer, Forklifts, Reverse Osmosis Purification Unit, Rigid Hull Inflatable Boat, Ground Personnel			
MINE WARFARE				
Floating mine neutralization	EOD Personnel, RHIB, CRRC, Small craft	Floating mine shape, 5 – 10 lb new	20 events (2 – 8 hours each)	Primary Site(s): Agat Bay, Secondary Site(s): – Piti
Mine Laying Exercise	Fighter, Bomber, Maritime Patrol Aircraft (B-1, B-2, B-52, FA-18, P-3, P-8A)	Mk-62, Mk-56 (inert)	3 events	Primary Site(s) W-517; Secondary Site(s): MI Maritime, >12 nm from land
Underwater demolition	EOD Personnel, RHIB, CRRC, Small Craft	Bottom/mid-moored mine shape 5 – 20 lb new	30 Events (2 – 8 hours each)	Primary Site(s): Agat Bay, Secondary Site(s):: Apra Harbor (10lb new maximum
SPECIAL WARFARE				
Breaching	SEAL, EOD, Army, or Marine Corps platoon or squad	Breach house (1.5 lbs new; C4 maximum per door)	20 Events (2 – 8 hours each, 30 lbs new or C4)	Navy munitions site Breacher House
Direct Action	SEAL Tactical Air Control Party; RHIB; Small Craft.	M-16, M-4, M-249 SAW, M-240G, .50 cal, M-203 (5.56 /7.62 mm/ .50 cal round/ 40mm HE)	3; events 1 day (3,000 rounds)	Farallon de Medinilla (R-7201)
	SEAL, NECC, Marine Corps, Army, or Air Force platoon or squad	5.56 mm blanks/Simunitions 9mm (Orote Pt. Combat Qualification Center) 1.5 lb NEW C4 (Navy Munitions Site Breaching House)	40 Events 2-8 hours; (15,000 9mm; 15 lb NEW C4)	Primary Site(s): Orote Pt. Combat Qualification Center and Navy Munitions Site Breacher House Secondary Site(s):: Tarague Beach CQC and Navy Munitions Site Breacher House.
Hydrographic Surveys	SEAL, EOD, or Marine Corps Platoon/Squad; Small Craft; RHIB; CRRC; H-60	scuba	6	Farallon de Medinilla; Tinian; Tipalao Cove Secondary Site(s):: Haputo Beach; Gab Gab Beach; Dadi Beach
Insertion/Extraction	SEAL, EOD, Army, Air Force, or Marine Corps Platoon/Squad; Small Craft; RHIB; CRRC; H-60 H-46 or MV-22	Square Rig or Static Line; Fastrope; Rappel; scuba	150 Events 2 to 8 hours per event	Primary Site(s): Orote Pt. Airfield; Northwest Field; Orote Pt. Triple Spot; Apra Harbor; Gab Gab Beach Secondary Site(s):: Orote Pt. CQC; Finegayan DZ; Haputo Beach; Munitions Site Breacher House; Polaris Pt. Field; Orote Point. KD Range
Military Operations In Theater (mout) Training	SEAL or EOD platoon or squad; HMWWV, Truck	5.56 mm blanks/Simunitions	8 Events (3-5 days per event)	Primary Site(s): Guam; AAFB South; Finegayan Communication Annex; Barrigada Housing; Navy Munitions Site Breaching House Secondary Site(s):: Tinian; Rota; Saipan
Parachute Insertion	SEAL, EOD, Army, or Air Force platoon or squad, C-130, CH-46, H-60	Square Rig or Static Line	12 Events (2 to 8 hours per event)	Primary Site(s): Orote Point Airfield; Northwest Airfield; Orote Point Triple Spot Secondary Site(s):: Finegayan DZ; Apra Harbor; Navy Munitions Site Breacher House
SPECIAL/EXPEDITIONARY WARFARE				
Airfield Expeditionary	Air Force RED HORSE Squadron; Naval Expeditionary Combat Command SEABEE Company. Marine Corps Combat Engineer Company USAR Engineer Dozer, Truck, Crane, Forklift, Earth Mover, HMMWV. C-130; H-53. Includes temporary Fuel and Armament Replenishment Point	Expeditionary Airfield Repair and Operation	12 events	Primary Site(s): Northwest Field Secondary Site(s):: Orote Pt. Airfield; Tinian North Airfield
Field Training Exercise	Army or Naval Expeditionary Combat Command SEABEE Company/Platoon	Tents; Trucks; HMMWV; Generators	100 events 2-3 days per event	Primary Site(s): Guam, Northwest Field; Northern Land Navigation Area Secondary Site(s):: Orote Pt. Airfield; Polaris Pt. Field; Tinian North Field.
Humanitarian Assistance/Disaster Relief Operation (HADR)	Amphibious Shipping (1-Amphibious Assault Ship (multipurpose); 1-Amphibious Transport Dock; 1-Dock	HMMWV; Trucks; Landing Craft (LCAC/ LCU); AAV/	2 events	Primary Site(s): Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Northwest

Range Operation	Platform(s)	System or Ordnance	Proposed Action	Location
	Landing Ship); Marine Corps Special Purpose Marine Air Ground Task Force	LAV; H-46 or MV-22		Field; Sumay Cove and MWR Marina Ramp Secondary Site(s):: Tinian Military Leased Area; Unai Chulu (beach) and Tinian Harbor; North Field.Rota Airfield/West Harbor
Intelligence, Surveillance, Reconnaissance	U.S. Navy seal, Army, Marine Corps, or Air Force Platoon/Squad	Night Vision; Combat camera; 5.56 mm blanks/Simunition	16 events 8– 24 hours per event	Primary Site(s): Guam; Northwest Field; Barrigada Housing; Finegayan Comm. Annex; Orote Pt. Airfield.Secondary Site(s):: Tinian, Rota, Saipan
Land Demolitions (IED Discovery/Disposal)	NECC, Marine Corps or Air Force EOD, platoon or squad; HMWWV	Improvised Explosive Device (IED) Shapes	120 events (2 – 8 hours each)	Primary Site(s): Guam, Orote Point Airfield, Orote Point cqc; Polaris Point Field; Andersen South; Northwest Field sec; Northern or Southern Land Navigation Area; Munitions Site Breacher House; Tinian mla
Land Demolitions (UXO Discovery/Disposal)	NECC, Marine Corps or Air Force EOD, platoon or squad; HMWWV, Truck	Unexploded Ordnance (UXO)	200 events	Primary Site(s): Navy Munitions Site, EOD Disposal Site (limit 3,000lbs NEW per event); Secondary Site(s): AAFB EOD Disposal Site (limit100 lbs per event) and Northwest Field (limit20 lbs NEW per event)
Maneuver (Convoy; Land Navigation)	Marine Corps or Army Company or Platoon	Trucks; HMWWV;AAV/LAV	16 events 8–24 hours	Primary Site(s): Northwest Field; AAFB South; Northern and Southern Land Navigation Area; Tinian MLA Secondary Site(s):: Finegayan Annex; Barrigada Annex; Orote Pt. Airfield
Non-Combatant Evacuation Operation	Amphibious Shipping (1-Amphibious Assault Ship (multipurpose); 1-Amphibious Transport Dock; 1-Dock Landing Ship); Marine Corps Special Purpose Marine Air Ground Task Force	HMMWV; Trucks; Landing Craft (LCAC/ LCU); AAV/ LAV; H- 46 or MV-22	2 events	Primary Site(s): Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Northwest Field; Sumay Cove and MWR Marina Ramp Secondary Site(s):: Tinian Military Leased Area; Unai Chulu (beach) and Tinian Harbor; North Field, Rota Airfield/West Harbor
Seize Airfield	SEAL, Marine Corps, or Army Company or Platoon; Air Force Squadron; C-130; MH-53; H-60; HMWWV; Truck	5.56 mm blanks/Simunitions	12 Events (1-3 day per event)	Primary Site(s): Northwest Field; Secondary Site(s):: Orote Pt. Airfield; Tinian North Field, Rota Airfield
STRIKE WARFARE				
Bombing Exercise (Land)	FA-18; AV-8B; B-1; B-2; B-52; F-15; F- 16; F-22; F-35, A-10	High Explosive Bombs 500 lbs	500 annually	Farallon de Medinilla (R-7201)
		High Explosive Bombs: 750 / 1,000 lbs / 2,000 lbs	1,650 annually	
		Inert Bomb Training Rounds □ 2,000 lbs	2,800 annually	
		Total Sorties (1 aircraft per sortie):	1,300 sorties	
Gunnery Exercise (Air to Ground)	FA-18; AV-8B; F-15; F-16; F-22; F-35, A-10; MH-60R/S; SH- 60B; HH-60H; AH-1, AC-130	20- or 25-mm cannon	20,000 rounds	
		30-mm cannon (A-10)	1,500 rounds	
		40-mm or 105-mm cannon (AC-130)	200 rounds	
Missile Exercise (Air to Ground)	FA-18; AV-8B; F-15; F-16; F-22; F-35, A-10; MH-60R/S; SH- 60B; HH-60H; AH-1	TOW; MAVERICK; HELLFIRE	60 annually	
Combat Search and Rescue	SH-60; MH-60; HH-60; MH-53; CH-53; C-17; C-130; V-22	Night Vision	60 sorties	Tinian North Field: Guam Northwest Field Secondary Site(s):: Orote Point Airfield; Rota Airport
SURFACE WARFARE				
Bombing Exercise (Air to Surface – Inert Only)	Fixed Wing Fighter/Bomber/Maritime Patrol Aircraft (MK 58 Smoke target or towed sled or small hull target)	MK 82 I; BDU-45; MK 76 (Inert Rounds)	24 events 1 – 2 hours (72 rounds)	Primary Site(s): W-517 Secondary Site(s):: MI Maritime, >12 nm from land; Air Traffic Control Assigned Airspaces
Bombing Exercise (Air to Surface – Live Rounds)	Fixed Wing Fighter/Bomber/Maritime Patrol Aircraft (MK 58 Smoke target or towed sled)	MK 82/83/84 series and JDAM (Live Rounds)	4 events	Primary Site(s): W-517 Secondary Site(s):: MI Maritime, >12 nm from land; Air Traffic Control Assigned Airspaces
Gunnery Exercise (Surface-to-Surface – small arms)	Ship, RHIB, small craft. Barrel or Inflatable target	M-16, M-4, M-249 SAW, M-240G, .50 cal, M-203 (5.56 /7.62 mm/ .50 cal. round/	32 events (16,000 rounds)	Primary Site(s): MI Maritime, >3 nm from land Secondary Site(s):: W-517

Range Operation	Platform(s)	System or Ordnance	Proposed Action	Location
		40mm TP)		
Gunnery Exercise (Surface-to-Surface Ship)	Ships and Maritime Patrol Aircraft, Barrel, Inflatable Targets	.50 cal machine gun	5 events (12,000 rounds)	Primary Site(s): W-517; Secondary Site(s):: MI Maritime, >12 nm from land
		.25 mm machine gun	5 events (8,000 rounds)	
	Guided Missile Cruiser and Guided Missile Destroyer. Barrel or Inflatable target or towed sled	5" gun	8 events (320 rounds)	
	Guided Missile Frigate Barrel or Inflatable target or towed sled	76 mm	4 events (120 rounds)	
Gunnery Exercise (Air to Surface)	SH-60; HH-60; MH-60R/S; UH-1; CH-53; FA-18; AH-1W; F-15; F16; F-22; F-35, AV-8B; A-10 (Barrel or MK-58 smoke target)	7.62 mm machine gun	200 (40,000 rounds)	Primary Site(s): W-517 Secondary Site(s):: MI Maritime, >12 nm from land; Air Traffic Control Assigned Airspaces
		.50 cal machine gun	20 (4,000 rounds)	
		20 mm cannon	100 (10,000 rounds)	
		25 mm cannon	40 (4,000 rounds)	
		30 mm cannon	15 (1,500 rounds)	
Missile Exercise (Air to surface)	Fixed Wing Fighter/Bomber/Maritime Patrol Aircraft (MK 58 Smoke target or towed sled or small hull target)	HELLFIRE (Live Rounds)	2 rounds	Primary Site(s): W-517 Secondary Site(s):: MI Maritime, >50 nm from land; Air Traffic Control Assigned Airspaces
Missile Exercise (Air to surface CATMEX Inert Only)	Fixed Wing Fighter/Bomber/Maritime Patrol Aircraft (MK 58 Smoke target or towed sled or small hull target)	Laser Designation and Tracking with Captive Air Training Missile	60 events	Primary Site(s): W-517 Secondary Site(s):: MI Maritime, >50 nm from land; Air Traffic Control Assigned Airspaces
Sinking Exercise	Ship hulk or barge	HARM [2]; SLAM-ER [4] HARPOON [5]; 5" Rounds (400); HELLFIRE [2]; MAVERICK [8]; GBU-12 [10]; GBU-10 [4]; MK-48 [1]; Underwater Demolitions [2 - 100lb]	2	Primary Site(s): W-517 Secondary Site(s):: MI Maritime, >50 nm from land; Air Traffic Control Assigned Airspaces
Visit, Board, Search, and Seizure or Maritime Interception Operations	RHIB, Small craft, Ship, H-60	not applicable	6 Events (2 – 3 hours each)	Primary Site(s): Apra Harbor; Secondary Site(s):: MI Maritime

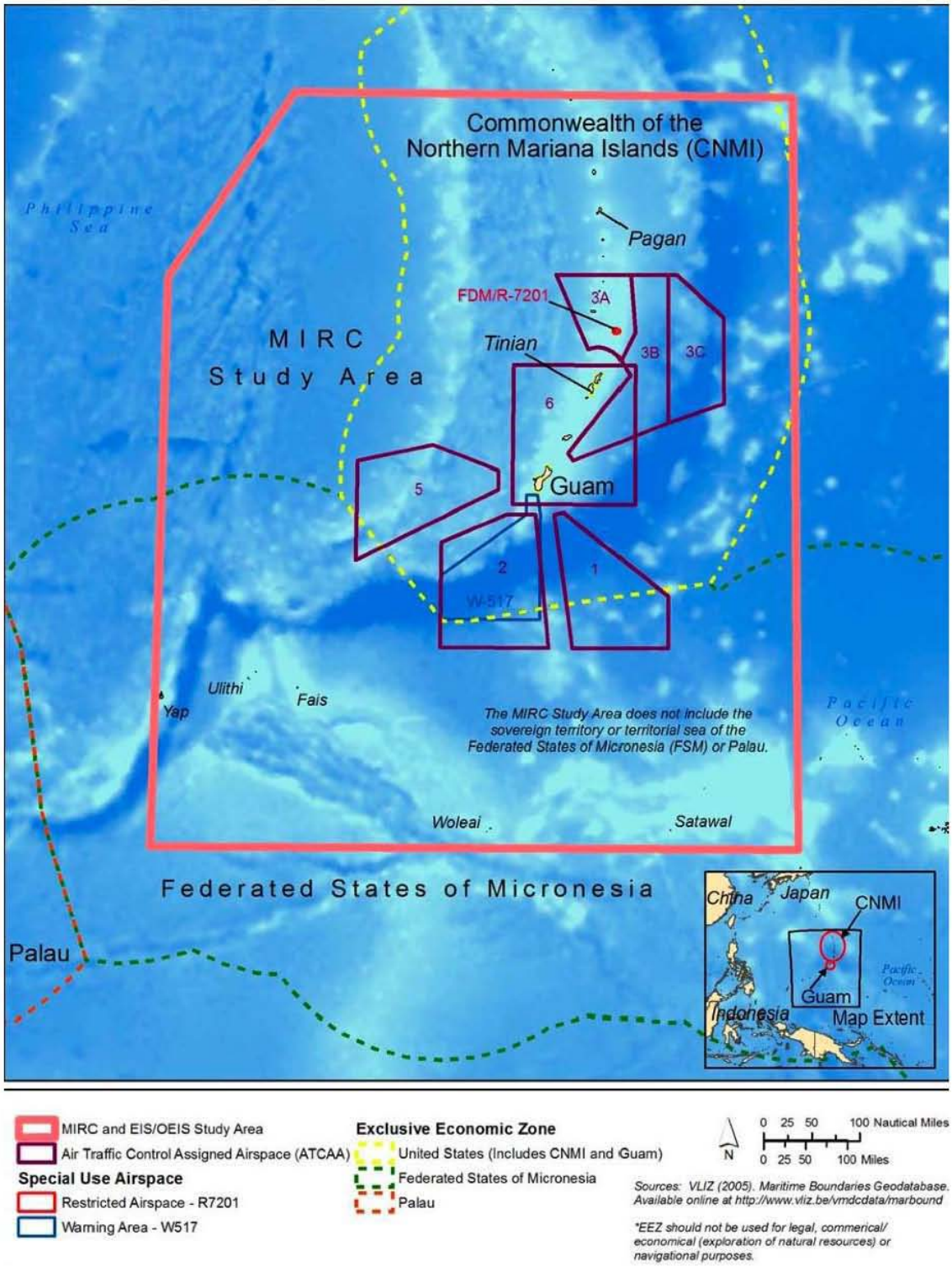

Figure 1. Overview of the Mariana Islands Range Complex (Navy 2010b).

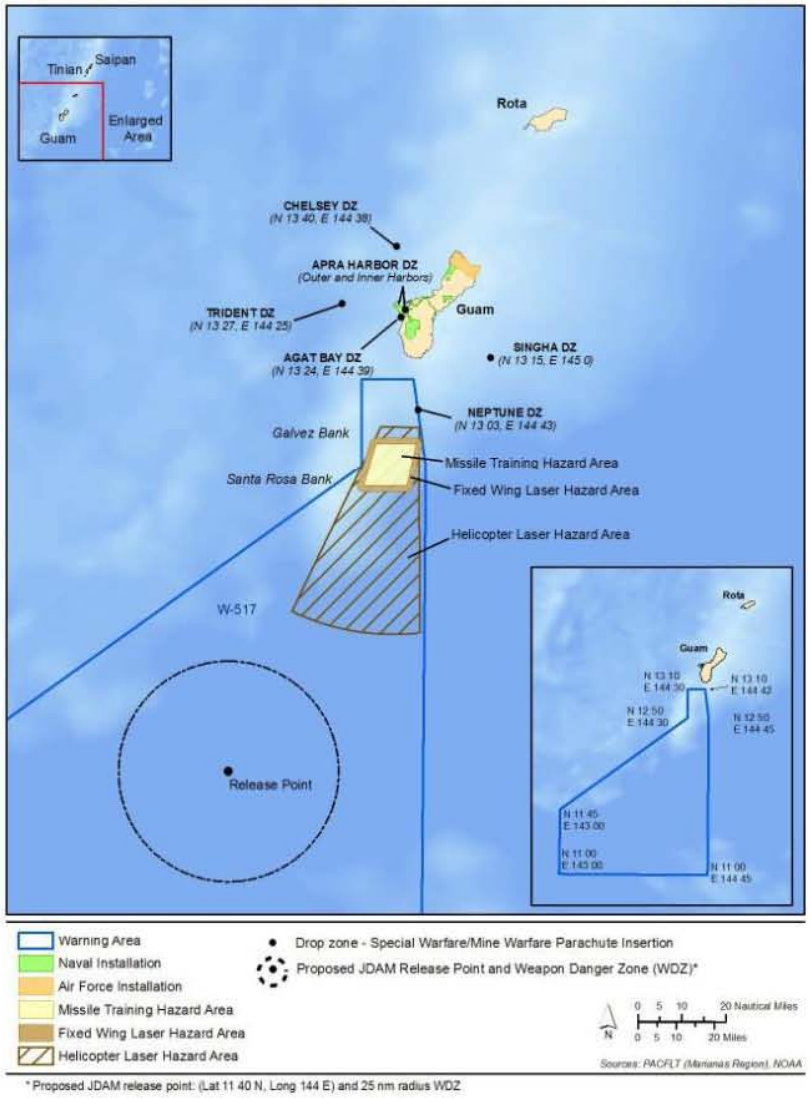

Figure 2. Warning Area W-517(Navy 2010b).

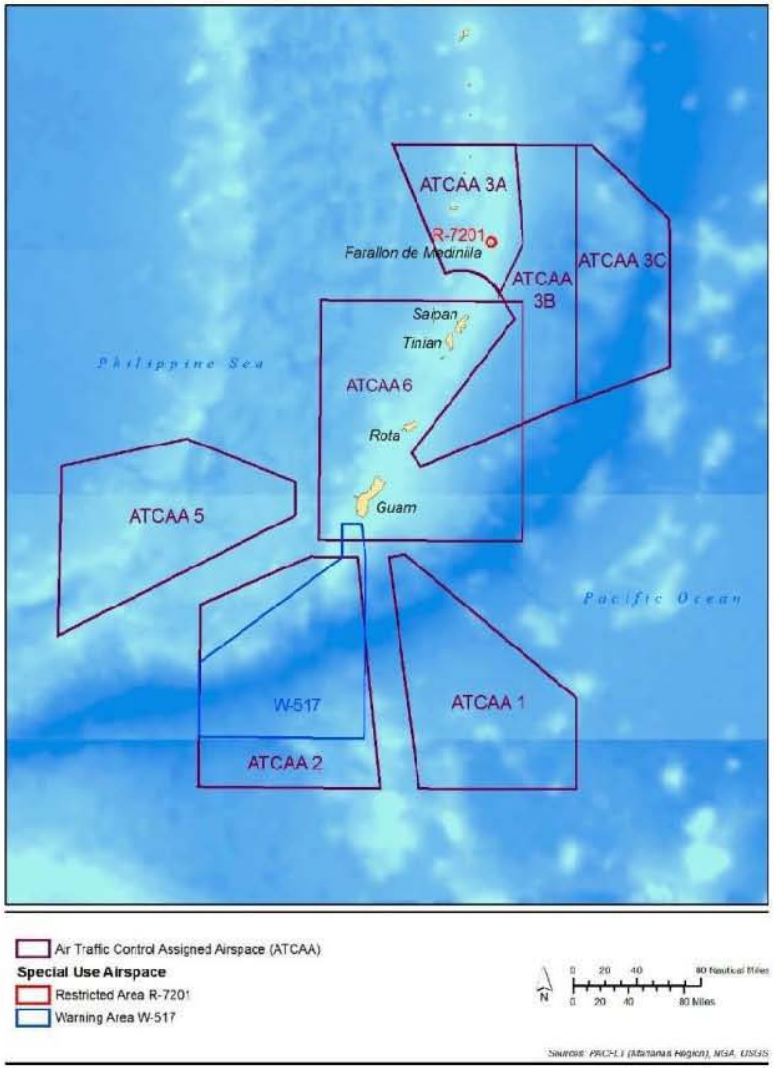

Figure 3. The Air Traffic Control Assigned Airspace (ATCAAS) (Navy 2010b).

Figure 4. Farallon de Medinilla (Navy 2010b).

Figure 5. Saipan and Tinian (Navy 2010b).

Figure 6. Apra Harbor and nearshore training areas (Navy 2010b).

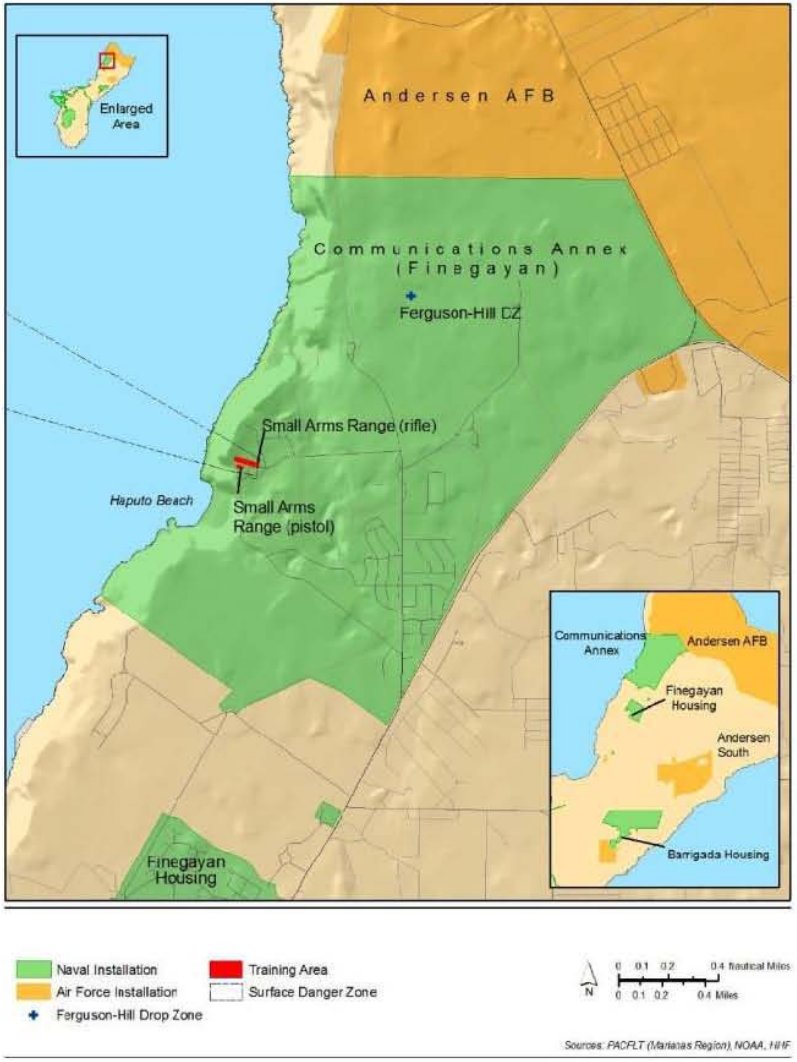

Figure 7. Finegayan communications annex training areas(Navy 2010b) .

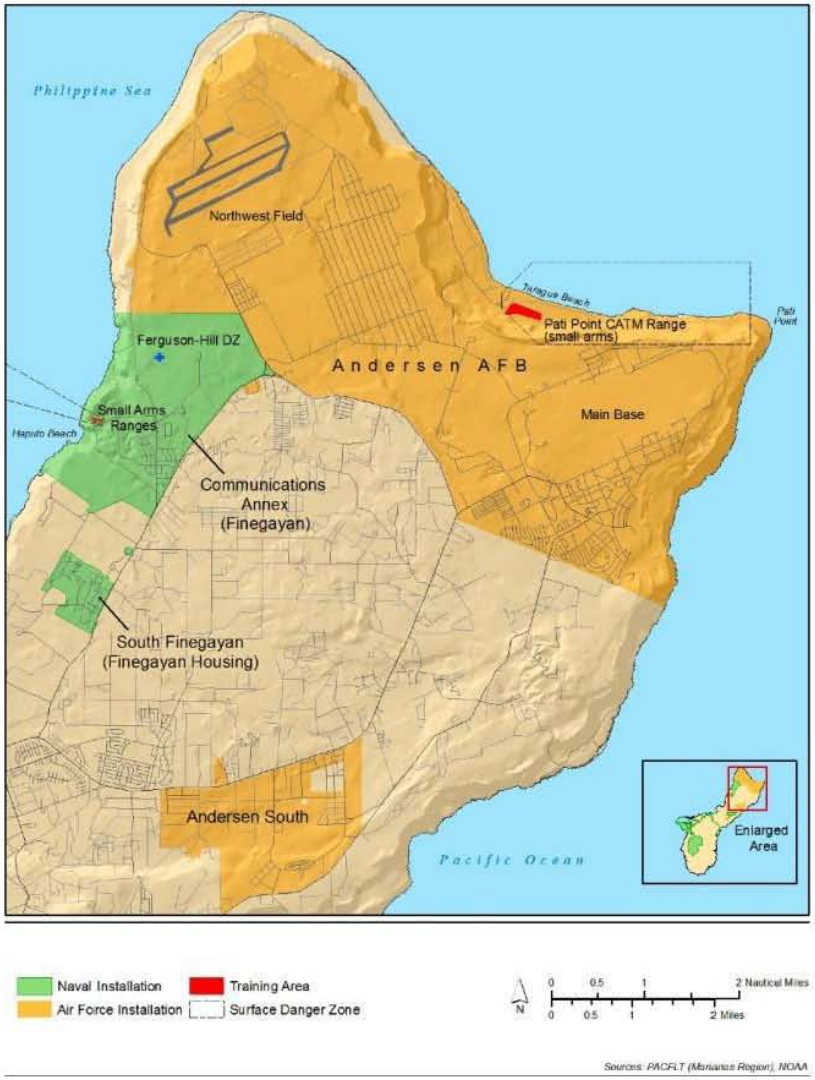

Figure 8. Andersen Airforce Base training areas (Navy 2010b).

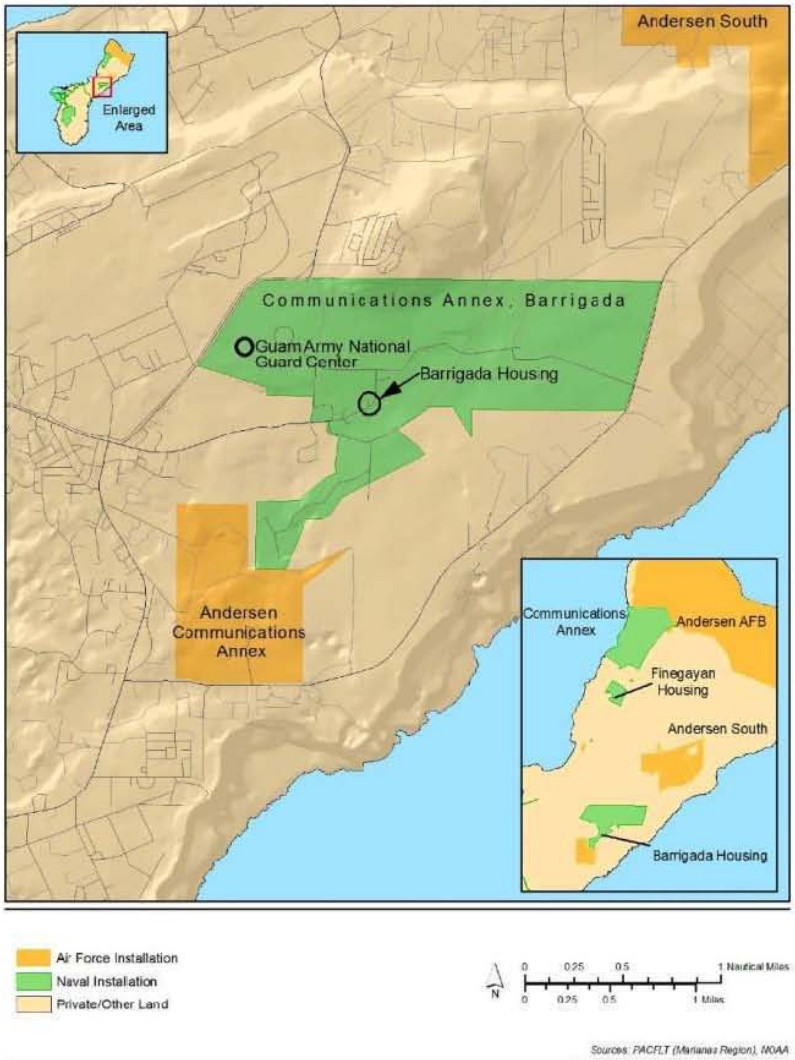

Figure 9. Barrigada communications annex (Navy 2010b).

Acoustic Systems Associated with Anti-Submarine Warfare Training

Tactical military sonars are designed to search for, detect, localize, classify, and track submarines. The Navy typically employs two types of sonars during anti-submarine warfare exercises:

1) 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.
2) Active sonars generate and emit acoustic energy specifically for the purpose of obtaining information concerning a distant object from the received and processed reflected sound energy.

The simplest active sonars emit omnidirectional pulses or "pings" and calculate the length of time the reflected echoes return from the target object to determine the distance between the sonar source and a target. More sophisticated active sonar emits an omnidirectional ping and then scans a steered receiving beam to calculate the direction and distance of a target. More advanced sonars transmit multiple preformed beams, listening to echoes from several directions simultaneously and providing efficient detection of both direction and range. The types of sound sources that would be used in the Valiant Shield exercise include:

Sonar Systems Associated With Surface Ships

A variety of surface ships participate in Navy training exercises, including guided missile cruisers, destroyers, guided missile destroyers, and frigates. Some ships (e.g., aircraft carriers) do not have any onboard active sonar systems, other than fathometers. Others, like guided missile cruisers, are equipped with active as well as passive sonars for submarine detection and tracking. The primary surface ship sonars considered are:

1) The AN/SQS-53 which is a large, active-passive, bow-mounted sonar that has been operational since 1975. AN/SQS-53 is the U.S. Navy's most powerful surface ship sonar and is installed on Ticonderoga (22 units) and Arleigh Burke I/II/IIIa (51 units) class vessels in the U.S. Navy (D'Spain et al. 2006a; Polmar 2001). This sonar typically transmits at a center frequency of 3.5 kHz at source levels of 235 dBrms re: 1 µPa at 1 m[1]. The sonar has pulse durations between 1 and 2 seconds, with about 24-second intervals between pulses. AN/SQS-53 operates at depths of about 7 m.

   The AN/SQS-53 is a computer-controlled, hull-mounted surface-ship sonar that has both active and passive operating capabilities, providing precise information for anti-submarine warfare weapons control and guidance. The system is designed to perform direct-path anti-submarine warfare search, detection, localization, and tracking from a hull-mounted transducer array. The AN/SQS-53 sonar is installed on Arleigh Burke Class guided missile

[1] All underwater intensities in dB are re: 1 micro Pascal at 1 meter (µPa at 1m).

destroyers and Ticonderoga Class guided missile cruisers. The AN/SQS-53 Kingfisher is a modification that provides a surface ship with the ability to detect mine-like objects.

2) The AN/SQS-56 system is an active-passive bow-mounted sonar that has been operational since 1977. AN/SQS-56 is installed on FFG-7 (33 units) class guided missile frigates in the U.S. Navy (D'Spain et al. 2006a; Polmar 2001). This sonar typically transmits at a center frequency of 7.5 kHz and a source level of 225 dBrms re: 1 µPa at 1 m source level. This sonar also has pulse durations between 1 and 2 seconds, with about 24-second intervals between pulses. AN/SQS-56 operates at depths of about 6 m.

   The duration, rise times, and wave form of sounds sonar transmitted from these sonar systems are classified; however, the characteristics of the transmissions that were used during the Bahamas exercises might help illustrate attributes of the transmissions from these two sonar sources. During the Bahamas exercises, these two sonars transmitted 1 – 2 second pulses once every 24 seconds (D'Spain et al. 2006a). Pulses had rise times of 0.1 – 0.4 seconds and typically consisted of three waveforms with nominal bandwidths up to 100 Hz (D'Spain et al. 2006a). Both sonars create acoustic fields that are omnidirectional in azimuth, although AN/SQS-53 also can create beams covering 120˚ azimuthal sectors that can be swept from side to side during transits (D'Spain et al. 2006a). Waveforms of both sonar systems are frequency modulated with continuous waves (D'Spain et al. 2006a).

Sonar Systems Associated With Submarines

Tactical military submarines (i.e. 29 attack submarines as of 2008) equipped with hull-mounted mid-frequency use active sonar to detect and target enemy sub-marines and surface ships. The predominant active sonar system mounted on submarines is AN/BQQ-10 sonar that is used to detect and target enemy submarines and surface ships. Two other systems — AN/BQQ-5 and AN/BSY-1/2 — have operational parameters that would affect marine mammals in ways that are similar to the AN/BQQ-10. In addition, Seawolf Class attack submarines, Virginia Class attack submarines, Los Angeles Class attack submarines, and Ohio Class nuclear guided missile submarines also have the AN/BQS-15 sonar system, which uses high-frequency for under-ice navigation and mine-hunting.

1) AN/BQQ-10 (also known as Advanced Rapid Commercial-Off-the-Shelf Insertion) – 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 components. The system is characterized as mid-frequency active sonar, although the exact frequency range is classified. The AN/BQQ-10 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.

2) 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 MK 2. This sonar system is characterized as mid-frequency active sonar, although

the exact frequency range is classified. The AN/BQQ-5 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.

Sonar Systems Associated With Aircraft

Aircraft sonar systems that typically operate during Navy training exercises include sonobuoys and dipping sonar. Current dipping sonar systems used by the Navy are either AN/SQS-22 or AN/AQS -13. The AN/AQS -13 is an older and less powerful dipping sonar system (maximum source level 215 dB re µPa-s^2 at 1m) than the AN/AQS -22 (maximum source level 217 dB re µPa-s2 at 1m). In its modeling, the Navy assumed that all dipping sonar were AN/AQS -22. P-3 aircraft may deploy sonobuoys while helicopters may deploy sonobuoys or dipping sonars (the latter are used by carrier-based helicopters). Sonobuoys are expendable devices used by aircraft for the detection of underwater acoustic energy and for conducting vertical water column temperature measurements. Dipping sonar is an active or passive sonar device lowered on cable by helicopters to detect or maintain contact with underwater targets. In addition, the U.S. Navy employs tonal sonobuoys (DICASS, AN/SSQ-62) and the Improved Extended Echo Ranging (IEER) System.

1) The AN/SSQ-62C Directional Command Activated Sonobuoy System (DICASS) sonar system is part of a sonobuoy that operates under direct command of fixed-wing aircraft or helicopters. The system can determine the range and bearing of the target relative to the sonobuoy's position and can deploy to various depths within the water column. After it enters the water, the sonobuoy transmits sonar pulses (continuous waveform or linear frequency modulation) 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.

2) AN/SSQ-110A Explosive Source Sonobuoy is a commandable, air-dropped, high source level explosive sonobuoy. The AN/SSQ-110A explosive source sonobuoy 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 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 signal underwater sound 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 maritime patrol aircraft.

3) AN/SSQ-125 Advanced Extended Echo Ranging (AEER) Sonobuoy is a third generation of multi-static active acoustic search systems to be developed under the Extended Echo Ranging family of the systems and is being developed as the replacement for the AN/SSQ-110A. The AN/SSQ-125 sonobuoy is composed of two sections, the control section and the active

source section. The control section is similar to the upper electronics package of the AN/SSQ-62 DICASS sonobuoy. The lower section consists of the active sonar source. The echoes from pings of the sonar are then analyzed on the aircraft to determine a submarine's position. The AN/SSQ-125 sonobuoy will be deployed by maritime patrol aircraft.

Torpedoes

Torpedoes (primarily MK-46 and MK-48) are the primary anti-submarine warfare weapon used by surface ships, aircraft, and submarines. The guidance systems of these weapons 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 guidance.

In addition to these torpedoes, the U.S. Navy can employ Acoustic Device Countermeasures in their training exercises, which include MK-1, MK-2, MK-3, MK-4, noise acoustic emitter, and the AN/SLQ-25A NIXIE. These countermeasures act as decoys by making sounds to avert localization or torpedo attacks.

Targets

Anti-submarine warfare training targets are used to simulate target submarines. They are equipped with one or a combination of the following devices: (1) acoustic projectors emanating sounds to simulate submarine acoustic signatures; (2) echo repeaters to simulate the characteristics of the echo of a particular sonar signal reflected from a specific type of submarine; and (3) magnetic sources to trigger magnetic detectors.

Training targets include MK-30 anti-submarine warfare training targets, and MK-39 Expendable Mobile anti-submarine warfare training targets. Targets may be non-evading while operating on specified tracks or they may be fully evasive, depending on the training requirements of the training operation.

Portable Underwater Tracking Range

Portable underwater tracking ranges are self-contained, portable, undersea tracking capability that employs modern technologies to support coordinated undersea warfare training for forward deployed naval forces. These tracking ranges would be capable of tracking submarines, surface ships, weapons, targets, and unmanned underwater vehicles and distribute the data to a data processing and display system, either aboard ship, or at a shore site.

These systems temporarily instrument 100-square-mile or smaller areas on the seafloor with a baseline configuration of seven electronics packages, each approximately 3 ft long by 2 ft in diameter, on the seafloor by a range boat, in water depths from 400 to 3,500 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 ft-by-1.5 ft and would weigh approximately 300 pounds. When training is complete, the U.S. Navy recovers the equipment that is used to install the range, although the anchors would remain on the seafloor. No on-shore construction would take place.

Operation of this range requires exercise participants to 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 a range boat. The uplink signal is transmitted at 8.8 kilohertz (kHz) or 40 kHz, at source levels of 186 or 190 decibels. The Portable Undersea Tracking Range system also incorporates 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 battery life, the electronic packages would be recovered and the anchors would remain on the seafloor.

Range tracking pingers would be used on ships, submarines, and anti-submarine warfare targets when anti-submarine warfare tracking exercise is conducted on the portable undersea tracking range. A typical range pinger generates a 12.93 (or 37) kHz sine wave at source levels of 194 dB re 1 µPa at 1m in pulses with a maximum duty cycle of 30 milliseconds (3 percent duty cycle). Although the specific exercise, and number and type of participants will determine the number of pingers in use at any time, a maximum of four pingers and a minimum of one pinger would be used for each anti-submarine warfare training activity. A maximum of four pingers would be used for a portable undersea tracking range torpedo exercise or tracking exercise with event durations of about 8 hours.

Surveillance Towed Array Sensor System – Low Frequency Active

As a separate but related action, the U.S. Navy also proposes to employ the Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar system in Joint Multi-Strike Group Exercises it proposes to conduct in the Mariana Islands Range Complex. The operation of SURTASS LFA sonar has been evaluated under section 7 of the ESA in separate biological opinions (NMFS 2007; NMFS 2010c). It is included in this Opinion as a related activity for completeness but no additional take will be authorized under the ESA.

The SURTASS LFA sonar system is a long-range, low frequency sonar (between 100 and 500 Hertz (Hz)) that has both active and passive components. The SURTASS LFA is part of the U.S. Navy's Integrated Undersea Surveillance System (IUSS), which is designed to detect, classify, and track diesel and nuclear submarines operating in both shallow and deep regions of littoral waters and deep ocean areas.

The LFA systems will be operational on four SURTASS vessels: the USNS ABLE (T-AGOS 20), USNS EFFECTIVE (T-AGOS 21), USNS IMPECCABLE (T-AGOS 23), and USNS VICTORIOUS (T-AGOS 19). The active component of the SURTASS LFA sonar system (LFA) consists of up to 18 low-frequency acoustic-transmitting source elements (called projectors) that are suspended from a cable beneath a ship. The projectors transform electrical energy to mechanical energy by setting up vibrations, or pressure disturbances, with the water to produce the active sound (which is called a "pulse" or a "ping"). SURTASS LFA's transmitted beam is omnidirectional (full 360 degrees) in the horizontal. The nominal water depth of the center of the array is 400 ft (122 m), with a narrow vertical beamwidth that can be steered above or below the horizontal. The source level of an individual projector in the SURTASS LFA sonar array is about

215 dB, and the sound field of the array can never have a sound pressure level higher than that of an individual projector. The shallowest water depth that a SURTASS LFA vessel would operate is 100 m (328.1 ft).

The typical SURTASS LFA sonar signal is not a constant tone, but is a transmission of various signal types that vary in frequency and duration (including continuous wave and frequency-modulated signals). The Navy refers to a complete sequence of sound transmissions as a "ping" which can range from between 6 and 100 seconds, with no more than 10 seconds at any single frequency. The time between pings will typically range from 6 to 15 minutes. The Navy can control the average duty cycle (the ratio of sound "on" time to total time) for the system but the duty cycle cannot be greater than 20 percent; the Navy anticipates a typical duty cycle between 10 and 15 percent.

The passive or listening component of the system (SURTASS) uses hydrophones to detect echoes of the active signal returning from submerged objects, such as submarines. The hydrophones are mounted on a horizontal array that is towed behind the ship. The SURTASS LFA sonar ship maintains a minimum speed of 3.0 knots (5.6 km/hr; 3.4 mi/hr) in order to keep the array properly deployed. The return signals, which are usually below background or ambient noise levels, are then processed and evaluated to identify and classify potential underwater threats.

Missions for SURTASS LFA sonar systems typically occur over a 49-day period, with 40 days of operations and 9 days of transit. Based on a 7.5 percent duty cycle (based on earlier LFA operating parameters), the system transmits for about 72 hours per 49-day mission (about 432 hours per year for each of the two SURTASS LFA sonar systems). SURTASS LFA sonar vessels generally travel in straight lines or racetrack patterns depending on the operational scenario. The characteristics and operating features of the active component (LFA) are:

- The source is a vertical line array (VLA) of up to 18 source projectors suspended below the vessel. LFA's transmitted beam is omnidirectional (360 degrees) in the horizontal, with a narrow vertical beamwidth that can be steered above or below the horizontal.
- The source frequency is between 100 and 500 hertz (Hz). A variety of signal types can be used, including continuous wave (CW) and frequency-modulated (FM) signals.
- The source level (SL) of an individual source projector of the SURTASS LFA sonar array is approximately 215 dB or less. The sound field of the array can never be higher than the SL of an individual source projector.
- The typical LFA signal is not a constant tone, but rather a transmission of various waveforms that vary in frequency and duration. A complete sequence of sound transmissions is referred to as a wavetrain (also known as a "ping"). These wavetrains last between 6 and 100 seconds with an average length of 60 seconds. Within each wavetrain the duration of each continuous frequency sound transmission is never longer than 10 seconds.

- Average duty cycle (ratio of sound "on" time to total time) is less than 20 percent. The typical duty cycle, based on historical LFA operational parameters, is nominally 7.5 percent.
- The time between wavetrain transmissions is typically from 6 to 15 minutes.

High Frequency/Marine Mammal Monitoring Sonar [Hf/M3]

The source level required for the HF/M3 sonar to effectively detect marine mammals (and possibly sea turtles) out to the 180-dB LFA mitigation zone under the most adverse oceanographic conditions (low echo return and high ambient noise) is on the order of 220 dB.

2.3 Scope of the Proposed MMPA Regulations

On 3 August 2010, NMFS' Permits Division finalized regulations (50 CFR §218.100) that authorize the U.S. Navy to "take" marine mammals (a) within the U.S. Navy Mariana Islands Range Complex Study Area, which is bounded by a pentagon with the following five corners: 16°46'29.3376" N. latitutde (lat.), 138°00'59.835" E. longitude (long.); 20°02'24.8094" N. lat., 140°10'13.8642" E. long.; 20° 3' 27.5538" N. lat., 149° 17' 41.0388" E. long.; 7° 0' 30.0702" N. lat., 149° 16' 14.8542"E. long; and 6° 59' 24.633" N. lat, 138° 1' 29.7228" E. long. and (b) incidental to the following activities within the following designated amounts of use over the 12-month duration of the proposed LOA:

(1) The use of the following mid-frequency active sonar (MFAS) and high frequency active sonar (HFAS) sources for U.S. Navy anti-submarine warfare (ASW) training, maintenance, and research, development, testing and evaluation (RDT&E)

(i) AN/SQS-53 (hull-mounted active sonar) – up to 2173 hours;

(ii) AN/SQS-56 (hull-mounted active sonar) – 141 hours per year;

(iii) AN/SSQ-62 (Directional Command Activated Sonobuoy System (DICASS) sonobuoys) –1654 sonobuoys;

(iv) AN/AQS-22 (helicopter dipping sonar) - 592 dips;

(v) AN/BQQ-10 (submarine hull-mounted sonar) - 12 hours;

(vi) MK-48, MK-46, or MK-54 (torpedoes) –40 torpedoes;

(vii) AN/SSQ-110 (IEER) –106 per year;

(viii) AN/SSQ-125 (AEER) –106 per year;

(ix) Range Pingers - 280 hours; and

(x) PUTR Transponder - 280 hours.

(2) The detonation of the underwater explosives indicated in this paragraph (c)(2)(i) conducted as part of the training events indicated in this paragraph (c)(2)(ii):

(i) Underwater Explosives:

(A) 5" Naval Gunfire (9.5 lbs net explosive weigh or NEW);

(B) 76 mm rounds (1.6 lbs NEW);

(C) Maverick (78.5 lbs NEW);

(D) Harpoon (448 lbs NEW);

(E) MK-82 (238 lbs NEW);

(F) MK-83 (574 lbs NEW);

(G) MK-84 (945 lbs NEW);

(H) MK-48 (851 lbs NEW);

(I) Demolition Charges (10 lbs NEW);

(J) AN/SSQ-110A (IEER explosive sonobuoy - 5 lbs NEW);

(K) HELLFIRE (16.5lbs NEW);

(L) GBU 38/32/31.

(ii) Training Events:

(A) Gunnery Exercises (S-S GUNEX) – up to 12;

(B) Bombing Exercises (BOMBEX) – up to 4;

(C) Sinking Exercises (SINKEX) –up to 2;

(D) Extended Echo Ranging and Improved Extended Echo Ranging (EER/IEER) Systems - up to 106;

(E) Demolitions – up to 10; and

(F) Missile exercises (A-S MISSILEX) – up to 2.

No person in connection with the activities described in the proposed regulations may:

1. "Take" any marine mammals that are not specifically identified in the regulations;

2. "Take" any of the marine mammals identified in the regulations other than by incidental take;

3. "Take" a marine mammal identified in the regulations if such taking results in more than a negligible impact on the species or stocks of such marine mammal; or

4. Violate, or fail to comply with, the terms, conditions, and requirements of the proposed regulations or future Letters of Authorization issued under the proposed regulations.

2.4 Mitigation Measures Proposed by the U.S. Navy

As required to satisfy the requirements of the Marine Mammal Protection Act of 1972, as amended, the U.S. Navy proposes to implement measures that would allow their training activities to have the least practicable adverse impact on marine mammal species or stocks (which includes considerations of personnel safety, practicality of implementation, and impact on the effectiveness of the "military readiness activity"). Those measures were summarized in NMFS' June 2010 programmatic biological opinion on the U.S. Navy proposal to conduct military readiness activities on the Mariana Islands Range Complex (and the Permits Division's proposal to promulgate regulations to authorize the "take" of marine mammals incidental to those activities) and re-summarized here; for a complete description of all of the measures applicable to the proposed exercises, readers should refer to the U.S. Navy's request for a LOA and the Permit Division's regulations.

2.4.1 General Maritime

The following mitigation measures apply during general maritime activities.

Personnel Training – Watchstanders and Lookouts

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. All bridge watchstanders/lookouts will complete both parts one and two of the MSAT; part two is options for other personnel. Part 1 of 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. Part 2 focuses on identification of specific species.

- Navy lookouts will undertake extensive training in order 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 lookout. 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 preclude 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 protective measures if marine species are spotted.

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 mammal protective measures.
- Commanding Officers 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 mid-frequency active sonar, pedestal mounted "Big Eye" (20x110) binoculars will be properly installed and in good working order to assist in the detection of marine mammals and sea turtles 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 (NAVEDTRA 12968-D).
- 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 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 a safe distance from any observed marine mammal and avoid approaching them head-on. This requirement does 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 operations, launching and recovering aircraft or landing craft, minesweeping operations, replenishment while underway and towing operations that severely restrict a vessel's ability to deviate course. Vessels will take reasonable steps to alert other vessels in the vicinity of the marine mammal.
- 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. 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 mammals.

- All vessels will maintain logs and records documenting training activities 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.

2.4.2 Specific Training Events

These mitigation measures apply during training events as specified below.

Mid-Frequency Active Sonar Operations

General Maritime Mitigation Measures: Personnel Training

- All lookouts onboard platforms involved in ASW training events will review the NMFS approved MSAT material prior to MFA sonar use.
- All Commanding Officers, Executive Officers, 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 personnel will undertake extensive training in order to qualify as a lookout in accordance with the Lookout Training Handbook (Naval Education and Training [NAVEDTRA] 12968-D).
- Lookout training will include on-the-job instruction under the supervision of a qualified, experienced lookout. 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 preclude 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 protective 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.
- After sunset and prior to sunrise, lookouts will employ Night Lookouts Techniques in accordance with the Lookout Training Handbook. Application of these techniques, which include the use of night vision goggles, allow lookouts to effectively monitor a 1,100 yard (yd) (1,000 m) safety zone at night.
- 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 Officer of the Deck, 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 protective measures.
- Commanding Officers 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.
- 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 yds (914 m) of the sonar window or dome, 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. 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 MFA transmission levels by this 6-dB factor until the marine mammal has been seen to leave the 200-yard safety zone, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (1,829 m) beyond the location of the last detection.
  - Should a marine mammal be detected within or closing to inside 500 yds (457 m) of the sonar dome, active transmissions will be limited to at least 10 dB below the equipment's normal operating level. Ships and submarines will continue to limit maximum ping levels by this 10-dB factor until the marine mammal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (1829 m) beyond the location of the last detection.
  - Should the marine mammal be detected within 200 yards of the sonar dome, active sonar transmissions will cease. Sonar will not resume until the animal has been seen to leave the 500-yard safety zone, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (1829 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 Officer of the Deck 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 shall 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 the sonar was being operated).

- Prior to start up or restart of MFA sonar, operators will check that the Safety Zone radius around the sound source is clear of marine mammals.
- ACTIVE SONAR LEVELS (generally)—the ship or submarine will operate MFA sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.
- Helicopters shall observe/survey the vicinity of an ASW exercise for 10 minutes before the first deployment of active (dipping) sonar in the water.
- Helicopters shall not dip their sonar within 200 yds (183 m) of a marine mammal and shall cease pinging if a marine mammal closes within 200 yds (183 m) after pinging has begun.
- Submarine sonar operators will review detection indicators of close-aboard marine mammals prior to the commencement of ASW events involving MFA sonar.
- Increased vigilance during major ASW training with tactical MFA sonar when critical conditions are present.

Based on lessons learned from strandings in the Bahamas (2000), Madeira (2000), the Canaries (2002), and Spain (2006), beaked whales are of particular concern since they have been associated with MFA sonar operations. The Navy should avoid planning major ASW training with MFA sonar in areas where they will encounter conditions that, in their aggregate, may contribute to a marine mammal stranding event.

The conditions to be considered during exercise planning include:

- Areas of at least 1,094 yards (1,000 m depth) near a shoreline where there is a rapid change in bathymetry on the order of 1,000 to 6,000 yards (914 -5,486 m) occurring across a relatively short horizontal distance (e.g., 5 nautical miles [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 events involving multiple ships/subs (≥ 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 strong surface duct (i.e., a mixed layer of constant water temperature extending from the sea surface to 100 or more feet).
- 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. The Navy will increase vigilance by undertaking the following additional protective measure:
- A dedicated aircraft (Navy asset or contracted aircraft) will undertake 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, advance survey should occur within about 2 hours prior to MFA sonar use and periodic surveillance should continue for the duration of the exercise. Any unusual conditions (e.g., presence of sensitive species, groups of species milling out of habitat, and any stranded animals) shall be reported to the Officer in Tactical Command, who should give consideration to delaying, suspending, or altering the exercise.
- All safety zone power-down requirements described in this measure apply.
- The post-exercise report must include specific reference to any event conducted in areas where the above conditions exist, with exact location and time/duration of the event, and noting results of surveys conducted.

Surface-to-Surface Gunnery (up to 5-inch explosive rounds)

- For exercises using targets towed by a vessel, target-towing vessels shall maintain a trained lookout for marine mammals and sea turtles when feasible. If a marine mammal or sea turtle is sighted in the vicinity, the tow vessel will immediately notify the firing vessel, which will suspend the exercise until the area is clear.

- A 600 yard (585 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 and sea turtles prior to commencement and during the exercise as long as practicable. Due to the distance between the firing position and the buffer zone, lookouts are only expected to visually detect breaching whales, whale blows, and large pods of dolphins and porpoises.
- The exercise will be conducted only when the buffer zone is visible and marine mammals and sea turtles are not detected within it.

Surface-to-Surface Gunnery (non-explosive rounds)

- A 200 yard (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 and sea turtles prior to commencement and during the exercise as long as practicable. Due to the distance between the firing position and the buffer zone, lookouts are only expected to visually detect breaching whales, whale blows, and large pods of dolphins and porpoises.
- If applicable, target towing vessels will maintain a lookout. If a marine mammal or sea turtle 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 and sea turtles are not detected within the target area and the buffer zone.

Surface-to-Air Gunnery (explosive and non-explosive 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 attempt to recover any parachute deploying aerial targets to the extent practicable (and their parachutes if feasible) to reduce the potential for entanglement of marine mammals.
- Target towing vessel shall maintain a lookout if feasible. If a marine mammal or sea turtle 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.

Air-to-Surface Gunnery (explosive and non-explosive rounds)

- A 200 yard (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 and sea turtles prior to and during the exercise.
- Aerial surveillance of the buffer zone for marine mammals and sea turtles will be conducted prior to commencement of the exercise. Aerial surveillance altitude of 500 ft to 1,500 ft (152 – 456 m) is optimum. 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 and sea turtles are not visible within the buffer zone.

Small Arms Training (grenades, explosive and non-explosive rounds)

Lookouts will visually survey for marine mammals and sea turtles. Weapons will not be fired in the direction of known or observed marine mammals or sea turtles.

Air-to-Surface At-Sea Bombing Exercises (explosive bombs and rockets)

- Ordnance shall not be targeted to impact within 1,000 yards (914 m) of known or observed sea turtles or marine mammals.
- A buffer zone of 1,000 yards (914 m) radius 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 shall be made by flying at 1,500 ft (456 m) or lower, if safe to do so, and at the slowest safe speed. When safety or other considerations require the release of weapons without the releasing pilot having visual sight of the target area, a second aircraft, the "wingman," will clear the target area and perform the clearance and observation functions required before the dropping plane may release its weapons. Both planes must have direct communication to assure immediate notification to the dropping plane that the target area may have been fouled by encroaching animals or people. The clearing aircraft will assure it has visual site of the target area at a maximum height of 1500 ft. The clearing plane will remain within visual sight of the target until required to clear the area for safety reasons. Survey aircraft should employ most effective search tactics and capabilities.
- The exercises will be conducted only if marine mammals and sea turtles are not visible within the buffer zone.

Air-to-Surface At-Sea Bombing Exercises (non-explosive bombs and rockets)

- If surface vessels are involved, trained lookouts will survey for sea turtles and marine mammals. Ordnance shall not be targeted to impact within 1,000 yds (914 m) of known or observed sea turtles 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 and sea turtles prior to and during the exercise. The survey of the impact area shall be made by flying at 1,500 ft (456 m) or lower, if safe to do so, and at the slowest safe speed. When safety or other considerations require the release of weapons without the releasing pilot having visual sight of the target area, a second aircraft, the "wingman," will clear the target area and perform the clearance and observation functions required before the dropping plane may release its weapons. Both planes must have direct communication to assure immediate notification to the dropping plane that the target area may have been fouled by encroach¬ing animals or people. The clearing aircraft will assure it has visual site of the target area at a maximum height of 1500 ft. The clearing plane will remain within visual sight of the target until

required to clear the area for safety reasons. Survey aircraft should employ most effective search tactics and capabilities.

- The exercise will be conducted only if marine mammals and sea turtles are not visible within the buffer zone.

Underwater Detonations (up to 10 lb charges)

To ensure protection of marine mammals and sea turtles during underwater detonation training and mining activities, the surveillance area must be determined to be clear of marine mammals and sea turtles prior to detonation. Implementation of the following mitigation measures continue to ensure that marine mammals would not be exposed to temporary threshold shift (TTS), permanent threshold shift (PTS), or injury from physical contact with training mine shapes during Major Exercises.

Exclusion Zones

All Mine Warfare and Mine Countermeasures training activities involving the use of explosive charges must include exclusion zones for marine mammals and sea turtles to prevent physical and/or acoustic effects on those species. These exclusion zones shall extend in a 700-yard arc radius around the detonation site.

Pre-exercise Surveillance

For Demolition and Ship Mine Countermeasures training activities, pre-exercise surveillance shall be conducted within 30 minutes prior to the commencement of the scheduled explosive event. The surveillance may be conducted from the surface, by divers, and/or from the air, and personnel shall be alert to the presence of any marine mammal or sea turtle. Should such an animal be present within the surveillance area, the exercise shall be paused until the animal voluntarily leaves the area.

Post-Exercise Surveys and Reporting

Surveillance within the same radius shall also be conducted within 30 minutes after the completion of the explosive event. If there is evidence that a marine mammal or sea turtle may have been stranded, injured or killed by the action, Navy training activities will be immediately suspended and the situation immediately reported by the participating unit to the Officer in Charge of the Exercise (OCE), who will follow Navy procedures for reporting the incident to the Commander, Navy Marianas who will contact Commander, Pacific Fleet.

Sinking Exercise

The selection of sites suitable for Sinking Exercises (SINKEXs) involves a balance of operational suitability, requirements established under the Marine Protection, Research and Sanctuaries Act (MPRSA) permit granted to the Navy (40 Code of Federal Regulations §229.2), and the identification of areas with a low likelihood of encountering ESA listed species. To meet operational suitability criteria, locations must be within a reasonable distance of the target vessels' originating location. 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 2,000 yds (1,839 m) deep and at least 50 nm from land.

In general, most listed species prefer areas with strong bathymetric gradients and oceanographic fronts for significant biological activity such as feeding and reproduction. Typical locations include the shelf-edge.

SINKEX Mitigation Plan

The Navy has developed range clearance procedures to maximize the probability of sighting any ships or protected species in the vicinity of an exercise, which are as follows:

- All weapons firing would be conducted during the period 1 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 1.0 nm would be established around each target. This exclusion zone is based on calculations using a 990-pound (lb) H6 net explosive weight high explosive source detonated 5 ft below the surface of the water, which yields a distance of 0.85 nm (cold season) and 0.89 nm (warm season) beyond which the received level is below the 182 decibels (dB) re: 1 micropascal squared-seconds (μPa2-s) threshold established for the WINSTON S. CHURCHILL (DDG 81) shock trials (Navy 2001a). An additional buffer of 0.5 nm would be added to account for errors, target drift, and animal movements. Additionally, a safety zone, which extends from the exclusion zone at 1.0 nm out an additional 0.5 nm, would be surveyed. Together, the zones extend out 2 nm from the target.
- A series of surveillance over-flights would be conducted within the exclusion and the safety zones, prior to and during the exercise, when feasible. Survey protocol would be as follows:
    - Overflights within the exclusion zone would 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 would be conducted by Navy personnel trained in visual surveillance. At least one member of the mitigation team would have completed the Navy's marine mammal training program for lookouts.
    - In addition to the overflights, the exclusion zone would 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 vocalizing marine mammals (particularly sperm whales) in the vicinity of the exercise. The sonobuoys would 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 Officer Conducting the Exercise (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 would commence 2 hours prior to the first firing.
  - The results of all visual, aerial, and acoustic searches would be reported immediately to the OCE. No weapons launches or firing would commence until the OCE declares the safety and exclusion zones free of marine mammals and threatened and endangered species.
  - If a protected species observed within the exclusion zone is diving, firing would 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. This is based on a typical dive time of 30 minutes for traveling listed species of concern. The OCE would determine if the listed species is in danger of being adversely affected by commencement of the exercise.
  - During breaks in the exercise of 30 minutes or more, the exclusion zone would again be surveyed for any protected species. If protected species 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 would be monitored for 2 hours, or until sunset, to verify that no listed species were harmed.

- Aerial surveillance would 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 mammals and sea turtles 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. The exercise would not be conducted unless the exclusion zone could be adequately monitored visually.
- Every attempt would be made to conduct the exercise in sea states that are ideal for marine mammal sighting, Beaufort Sea State 3 or less. In the event of a 4 or above, survey efforts would be increased within the zones. This would be accomplished through the use of an additional aircraft, if available, and conducting tight search patterns.
- The exercise would not be conducted unless the exclusion zone could be adequately monitored visually.

- In the unlikely event that any listed species are observed to be harmed in the area, a detailed description of the animal would be taken, the location noted, and if possible, photos taken. This information would be provided to National Oceanic and Atmospheric Administration (NOAA) Fisheries per the stranding communication plan.
- An after action report detailing the exercise's 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 would 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 should be conducted below 500 yards (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 shall conduct a minimum of 30 minutes of visual and aural monitoring of the search area prior to commanding the first post 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 yards (914 m) of observed marine mammal activity, crews will deploy the receiver ONLY and monitor while conducting a visual search. When marine mammals are no longer detected within 1,000 yards (914 m) of the intended post position, crews will co-locate the explosive source sonobuoy (AN/SSQ-110A) (source) with the receiver.
- When operationally feasible, crews will conduct continuous visual and aural monitoring of marine mammal activity. This is to include monitoring of own-aircraft sensors from first sensor placement to checking off station and out of radio frequency (RF) of these sensors.

AN/SSQ-110A Pattern Employment

- Aural Detection:
  - Aural detection of marine mammals cues the aircrew to increase the diligence of their visual surveillance.
  - If, following aural detection, 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 yards (914 m) of the explosive source sonobuoy (AN/SSQ-110A) intended for use, then that payload shall not be detonated. Aircrews may utilize this post once the marine mammals have not been re-sighted for 10 minutes, or are observed to have moved outside the 1,000 yards (914 m) safety buffer.
  - Aircrews may shift their multi-static active search to another post, where marine mammals are outside the 1,000 yards (914 m) safety buffer.

AN/SSQ-110A Scuttling Sonobuoys

- Aircrews shall 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 shall refrain from using the "Scuttle" command when two payloads remain at a given post. Aircrews will ensure that a 1,000 yard (914 m) safety buffer, visually clear of marine mammals, is maintained around each post as is done during active search operations.
- Aircrews shall 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.
- Aircrews shall ensure all payloads are accounted for. Explosive source sonobuoys (AN/SSQ-110A) that cannot be scuttled shall be reported as unexploded ordnance via voice communications while airborne, then upon landing via naval message.
- Mammal monitoring shall continue until out of own-aircraft sensor range

2.4.3 Low Frequency Active Sonar

To avoid potential injuries to marine mammals (and possibly sea turtles), the Navy proposes to detect animals within an area they call the "LFA mitigation zone" (the area within the 180-dB isopleth of the SURTASS LFA sonar source sound field) before and during low frequency transmissions. NMFS has also added an additional 1-kilometer buffer zone beyond the LFA mitigation zone.

Monitoring will (a) commence at least 30 minutes before the first SURTASS LFA sonar transmission; (b) continue between pings; and (c) continue for at least 15 minutes after completion of a SURTASS LFA sonar transmission exercise or, if marine mammals are showing abnormal behavior patterns, for a period of time until those behavior patterns return to normal or until conditions prevent continued observations.

The Navy proposes to use three monitoring techniques: (a) visual monitoring for marine mammals and sea turtles from the SURTASS LFA sonar vessel during daylight hours; (b) use of the passive (low frequency) SURTASS array to listen for sounds generated by marine mammals as an indicator of their presence; and use of high frequency active sonar (High Frequency Marine Mammal Monitoring [HF/M3] sonar) to detect, locate, and track marine mammals (and possibly sea turtles) that might be affected by low frequency transmissions near the SURTASS LFA sonar vessel and the sound field produced by the SURTASS LFA sonar source array.

Visual Monitoring

Visual monitoring will include daytime observations from the SURTASS LFA sonar vessel for potentially affected species. This monitoring will begin 30 minutes before sunrise, for ongoing transmissions, or 30 minutes before SURTASS LFA sonar is deployed and continue until 30 minutes after sunset or until SURTASS LFA sonar array is recovered. Personnel trained in

detecting and identifying marine animals will make observations from the vessel. At least one observer, qualified by NMFS, will train, test and evaluate other visual observers. If a marine mammal is detected within the 180-dB LFA mitigation zone or the 1 km (0.54 nm buffer zone extending beyond the LFA mitigation zone, SURTASS LFA sonar transmissions will be immediately suspended. Transmissions will not resume less than 15 minutes after:

- All marine mammals have left the area of the LFA mitigation and buffer zones; and
- There is no further detection of any marine mammal within the LFA mitigation and buffer zones as determined by the visual and/or passive or active acoustic monitoring.

Passive Acoustic Monitoring

Passive acoustic monitoring for low frequency sounds generated by marine mammals will be conducted when SURTASS is deployed. The following actions will be taken:

- If sounds are detected and estimated to be from a marine mammal, the technician will notify the Officer in Charge who will alert the HF/M3 sonar operator and visual observers;
- If a sound produced by a marine mammal is detected, the technician will attempt to locate the sound source using localization software; and
- If it is determined that the animal will pass within the LFA mitigation zone or 1-km buffer zone (prior to or during transmissions), then the Officer in Charge will order the delay/suspension of transmissions when the animal is predicted to enter either of these zones.

High Frequency Active Acoustic Monitoring

The Navy will conduct high frequency active acoustic monitoring (by using an enhanced, commercial-type high frequency sonar) to detect, locate, and track marine mammals (and possibly sea turtles) that could pass close enough to the SURTASS LFA sonar transmit array to exceed the 180-dB mitigation criterion. This Navy-developed HF/M3 sonar operates with a similar power level, signal type, and frequency as high frequency “fish finder” type sonars used worldwide by both commercial and recreational fishermen.

The HF/M3 source will be ramped-up slowly to operating levels over a period of no less than 5 minutes:

- No later than 30 minutes before the first SURTASS LFA sonar transmission;
- Prior to any SURTASS LFA sonar calibrations or tests that are not part of regular SURTASS LFA sonar transmissions; and
- Anytime after the HF/M3 source has been powered down for a period of time greater than 2 minutes.

The HF/M3 source will not increase its sound pressure level once a marine mammal is detected; ramp-up may proceed once marine mammals are no longer detected.

HF/M3 Sonar, LFA Mitigation Zone, and Sound Propagation

The extent of the LFA mitigation zone (i.e., within the 180-dB sound field) is estimated by onboard acoustic modeling and environmental data collected in situ. Factored into this calculation are SURTASS LFA sonar source physical parameters of tow speed, depth, vertical steering, signal waveform/wavetrain selection, and peak transmit source level.

The HF/M3 sonar is located near the top of the SURTASS LFA sonar vertical line array. The HF/M3 sonar computer terminal for data acquisition/processing/display will be located in the SURTASS Operations Center. The HF/M3 sonar uses frequencies from 30 to 40 kHz with a variable bandwidth (1.5 to 6 kHz nominal); a 3-4 percent (nominal) duty cycle; a source level of 220 dB re 1 µPa (1 micropascal) at 1 m; a five-minute ramp-up period; and a maximum, nominal detection range of 2-2.5 km (1.08-1.35 nm).

The HF/M3 sonar will operate continuously while the SURTASS LFA sonar is deployed. A remote display from the PC control station will be situated at the Watch Supervisor console, which will be manned 24 hours a day during all SURTASS or SURTASS LFA sonar operations at sea.

When a marine animal is detected by the HF/M3 sonar, it automatically triggers an alert to the Watch Supervisor, who will notify the Officer in Charge. The Officer in Charge will then order the immediate delay/suspension of SURTASS LFA sonar transmissions until the animal is determined to have moved beyond the mitigation zone. All contacts will be recorded and provided to NMFS as part of the long-term monitoring program associated with the proposed action.

Analysis and testing of the HF/M3 sonar operating capabilities indicate that this system substantially increases the probability of detecting marine mammals within the LFA mitigation zone. It also provides an excellent monitoring capability (particularly for medium to large marine mammals) beyond the LFA mitigation zone, out to 2 to 2.5 km (1.08 to 1.35 nm). Recent testing of the HF/M3 sonar, as documented in the SURTASS LFA Sonar Final EIS Subchapter 2.3.2.2, has demonstrated a probability of single-ping detection above 95 percent within the LFA mitigation zone for most marine mammals.

When the SURTASS LFA sonar is deployed, all marine mammal and sea turtle sightings/ detections would be recorded and provided to NMFS as part of the Long Term Monitoring Program associated with the proposed action.

Geographic Restrictions

The SURTASS LFA sonar system would be operated in a manner that would not cause sonar sound fields to exceed 180 dB (re 1 µParms) within “coastal exclusion zones” or within 1 kilometer of designated offshore areas that are designated as biologically important. For any annual LOA NMFS issues for SURTASS LFA sonar missions, NMFS’ regulations establish a minimum coastal exclusion zone of 12 nautical miles of any coastline, including offshore islands or designated offshore areas that are biologically important for marine mammals outside the 12

nautical mile coastal exclusion zone during seasons specified for a particular area. When in the vicinity of known recreational and commercial dive sites, SURTASS LFA sonar will be operated to ensure that the sound field at these sites would not exceed 145 dB.

2.5 Mitigation and Monitoring Required by NMFS' Permits Division

The regulations that NMFS' Permits Division finalized for military readiness activities on the Mariana Islands Range Complex require the U.S. Navy to implement the following mitigation measures, monitoring, and reporting:

(a) Personnel Training:

(1) All commanding officers (COs), executive officers (XOs), lookouts, Officers of the Deck (OODs), junior OODs (JOODs), maritime patrol aircraft aircrews, and Anti-submarine Warfare (ASW)/Mine Warfare (MIW) helicopter crews shall complete the NMFS-approved Marine Species Awareness Training (MSAT) by viewing the U.S. Navy MSAT digital versatile disk (DVD). All bridge lookouts shall complete both parts one and two of the MSAT; part two is optional for other personnel.

(2) Navy lookouts shall undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (Naval Education and Training Command [NAVEDTRA] 12968-D).

(3) Lookout training shall include on-the-job instruction under the supervision of a qualified, experienced lookout. Following successful completion of this supervised training period, lookouts shall 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.

(4) Lookouts shall be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of protective measures if marine species are spotted.

(5) All lookouts onboard platforms involved in ASW training events will review the NMFS-approved Marine Species Awareness Training material prior to use of mid-frequency active sonar.

(6) All COs, XOs, and officers standing watch on the bridge will have reviewed the Marine Species Awareness Training material prior to a training event employing the use of MFAS/HFAS.

(b) General Operating Procedures (for all training types):

(1) Prior to major exercises, a Letter of Instruction, Mitigation Measures Message or Environmental Annex to the Operational Order shall be issued to further disseminate the personnel training requirement and general marine species protective measures.

(2) COs shall make use of marine species detection cues and information to limit interaction with marine mammals to the maximum extent possible consistent with safety of the ship.

(3) While underway, surface vessels shall have at least two lookouts with binoculars; surfaced submarines shall 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.

(4) On surface vessels equipped with a multi-function active sensor, pedestal mounted "Big Eye" (20x110) binoculars shall be properly installed and in good working order to assist in the detection of marine mammals in the vicinity of the vessel.

(5) Personnel on lookout shall employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).

(6) After sunset and prior to sunrise, lookouts shall employ Night Lookouts Techniques in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).

(7) While in transit, naval vessels shall be alert at all times, use extreme caution, and proceed at a "safe speed", which means the speed at which the CO can maintain crew safety and effectiveness of current operational directives, so that the vessel can take action to avoid a collision with any marine mammal.

(8) When marine mammals have been sighted in the area, Navy vessels shall increase vigilance and take all reasonable actions to avoid collisions and close interaction of naval assets and marine mammals. Such action may include changing speed and/or direction and are dictated by environmental and other conditions (e.g., safety, weather).

(9) Navy aircraft participating in exercises at-sea shall conduct and maintain surveillance for marine mammals as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.

(10) All marine mammal detections shall 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.

(11) 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.

(c) Operating Procedures (for Anti-submarine Warfare Operations):

(1) On the bridge of surface ships, there shall always be at least three people on watch whose duties include observing the water surface around the vessel.

(2) All surface ships participating in ASW training events shall have, in addition to the three personnel on watch noted in (i), at least two additional personnel on watch as lookouts at all times during the exercise.

(3) 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.

(4) Personnel on lookout shall be responsible for reporting all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the Officer of the Deck, 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 mammal that may need to be avoided.

(5) All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) shall monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action.

(6) During mid-frequency active sonar operations, personnel shall utilize all available sensor and optical systems (such as night vision goggles) to aid in the detection of marine mammals.

(7) Aircraft with deployed sonobuoys shall use only the passive capability of sonobuoys when marine mammals are detected within 200 yds (183 m) of the sonobuoy.

(8) Helicopters shall observe/survey the vicinity of an ASW exercise for 10 minutes before the first deployment of active (dipping) sonar in the water.

(9) Helicopters shall not dip their sonar within 200 yards of a marine mammal and shall cease pinging if a marine mammal closes within 200 yards after pinging has begun.

(10) Safety Zones— When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) the Navy shall ensure that sonar transmission levels are limited to at least 6 dB below normal operating levels if any detected marine mammals are within 1000 yards (914 m) of the sonar window or dome (i.e., limit to at most 229 dB for AN/SQS-53 and 219 for AN/SQS-56, etc.).

(i) Ships and submarines shall continue to limit maximum transmission levels by this 6-dB factor until the animal has been seen to leave the 1000-yd safety zone, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (1829 m) beyond the location of the last detection.

(ii) When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) the Navy shall ensure that sonar transmission levels are limited to at least 10 dB below normal operating levels if any detected marine mammals are within 500 yards (457 m) of the sonar window or dome. Ships and submarines shall 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 yds (1829 m) beyond the location of the last detection.

(iii) When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) the Navy shall ensure that sonar transmission ceases if any detected marine mammals are within 200 yards (about 182 m) of the sonar window or dome. Sonar shall 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 yds (1829 m) beyond the location of the last detection.

(iv) 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.

(v) If the need for power-down should arise (as detailed in 218.114(a)(3)(x)) when the Navy was operating a hull-mounted or sub-mounted source above 235 db (infrequent), the Navy shall 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).

(11) 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.

(12) Active sonar levels (generally)—Navy shall operate active sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.

(13) Submarine sonar operators will review detection indicators of close-aboard marine mammals prior to the commencement of ASW training events involving MFAS.

(d) Operating Procedures for Underwater Detonations (up to 10-lb charges):

(1) Exclusion Zones - All demolitions and ship mine countermeasures training exercises involving the use of explosive charges must include exclusion zones for marine mammals to prevent physical and/or acoustic effects to those species. These exclusion zones shall extend in a 700-yard arc radius around the detonation site. Should a marine mammal be present within the surveillance area, the explosive event shall not be started until the animal leaves the area.

(2) Pre-Exercise Surveys - For Demolition and Ship Mine Countermeasures Operations, pre-exercise surveys shall be conducted within 30 minutes prior to the commencement of the scheduled explosive event. The survey may be conducted from the surface, by divers, and/or from the air, and personnel shall be alert to the presence of any marine mammal. Should such an animal be present within the survey area, the explosive event shall not be started until the animal voluntarily leaves the area. The Navy will ensure the area is clear of marine mammals for a full 30 minutes prior to initiating the explosive event. Personnel will record any marine mammal observations during the exercise as well as measures taken if species are detected within the exclusion zone.

(3) Post-Exercise Surveys - Surveys within the same exclusion zone radius shall also be conducted within 30 minutes after the completion of the explosive event.

(4) Reporting - If there is evidence that a marine mammal may have been stranded, injured or killed by the action, Navy training activities shall be immediately suspended and the situation immediately reported by the participating unit to the Officer in Charge of the Exercise (OCE), who will follow Navy procedures for reporting the incident to Commander, Pacific Fleet, Commander, Navy Region Marianas, Environmental Director, and the chain-of-command. The situation shall also be reported to NMFS (see Stranding Plan for details).

(e) Sinking Exercise:

(1) All weapons firing shall be conducted during the period 1 hour after official sunrise to 30 minutes before official sunset.

(2) An exclusion zone with a radius of 1.0 nm (1.9 km) will be established around each target. An additional buffer of 0.5 nm (0.9 km) will be added to account for errors, target drift, and animal movements. Additionally, a safety zone, which will extend beyond the buffer zone by an additional 0.5 nm (0.9 km), would be surveyed. Together, the zones extend out 2 nm (3.7 km) from the target.

(3) A series of surveillance over-flights shall be conducted within the 2-nm zone around the target prior to and during the exercise, when feasible. Survey protocol shall be as follows:

(i) Overflights within the 2-nm zone around the target shall 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 environ-mental conditions of the day. These environmental conditions include the angle of sun inclination, amount of daylight, cloud cover, visibility, and sea state.

(ii) All visual surveillance activities shall 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.

(iii) In addition to the overflights, the 2-nm zone around the target shall be monitored by passive acoustic means, when assets are available. This passive acoustic monitoring would be maintained throughout the exercise. Additionally, passive sonar onboard submarines may be utilized to detect any vocalizing marine mammals in the area. The OCE will be informed of any aural detection of marine mammals and will include this information in the determination of when it is safe to commence the exercise.

(iv) On each day of the exercise, aerial surveillance of the 2-nm zone around the target shall commence 2 hours prior to the first firing.

(v) The results of all visual, aerial, and acoustic searches shall be reported immediately to the OCE. No weapons launches or firing may commence until the OCE declares the 2-nm zone around the target free of marine mammals.

(vi) If a marine mammal is observed within the 2-nm zone around the target, 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 can be assumed to have left the 2-nm zone around the target. The OCE will

determine if the marine mammal is in danger of being adversely affected by commencement of the exercise.

(vii) During breaks in the exercise of 30 minutes or more, the 2-nm zone around the target shall again be surveyed for any marine mammal. If marine mammals are sighted within the 2-nm zone around the target, the OCE shall be notified, and the procedure described above shall be followed.

(viii) Upon sinking of the vessel, a final surveillance of the 2-nm zone around the target shall be monitored for 2 hours, or until sunset, to verify that no marine mammals were harmed.

(4) Aerial surveillance shall 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 shall be used. These aircraft shall 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. Surveys of the 2-nm zone around the target 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.

(5) Every attempt shall be made to conduct the exercise in sea states that are ideal for marine mammal sighting, Beaufort Sea State 3 or less. In the event of a 4 or above, survey efforts shall be increased within the 2-nm zone around the targets. This shall be accomplished through the use of an additional aircraft, if available, and conducting tight search patterns.

(6) The exercise shall not be conducted unless the 2-nm zone around the target could be adequately monitored visually. Should low cloud cover or surface visibility prevent adequate visual monitoring as described previously, the exercise shall be delayed until conditions improved, and all of the above monitoring criteria could be met.

(7) In the event that any marine mammals are observed to be harmed in the area, a detailed description of the animal shall be taken, the location noted, and if possible, photos taken of the marine mammal. This information shall be provided to NMFS via the Navy's regional environmental coordinator for purposes of identification (see the Stranding Plan for detail).

(8) An after action report detailing the exercise's 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 shall be submitted to NMFS.

(f) Surface-to-Surface Gunnery (up to 5-inch Explosive Rounds)

(1) For exercises using targets towed by a vessel, target-towing vessels shall maintain a trained lookout for marine mammals when feasible. If a marine mammal is sighted in the vicinity, the tow vessel will immediately notify the firing vessel, which will suspend the exercise until the area is clear.

(2) A 600 yard (585 m) radius buffer zone will be established around the intended target.

(3) 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. Due to the distance between the firing position and the buffer zone, lookouts are only expected to visually detect breaching whales, whale blows, and large pods of dolphins and porpoises.

(4) The exercise will be conducted only when the buffer zone is visible and marine mammals are not detected within it.

(g) Surface-to-Surface Gunnery (non-explosive rounds)

(1) A 200-yd (183 m) radius buffer zone shall be established around the intended target.

(2) From the intended firing position, trained lookouts shall survey the buffer zone for marine mammals prior to commencement and during the exercise as long as practicable.

(3) If available, target towing vessels shall maintain a lookout (unmanned towing vessels will not have a lookout available). If a marine mammal is sighted in the vicinity of the exercise, the tow vessel shall immediately notify the firing vessel in order to secure gunnery firing until the area is clear.

(4) The exercise shall be conducted only when the buffer zone is visible and marine mammals are not detected within the 2-nm zone around the target.

(h) Surface-to-Air Gunnery (Explosive and Non-explosive Rounds)

(1) Vessels will orient the geometry of gunnery exercises in order to prevent debris from falling in the area of sighted marine mammals.

(2) Vessels will attempt to recover any parachute deploying aerial targets to the extent practicable (and their parachutes if feasible) to reduce the potential for entanglement of marine mammals.

(3) Target towing aircraft shall maintain a lookout if feasible. 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.

(i) Air-to-Surface Gunnery (Explosive and Non-explosive Rounds)

(1) A 200 yard (183 m) radius buffer zone will be established around the intended target.

(2) If surface vessels are involved, lookout(s) will visually survey the buffer zone for marine mammals to and during the exercise.

(3) Aerial surveillance of the buffer zone for marine mammals will be conducted prior to commencement of the exercise. Aerial surveillance altitude of 500 ft to 1,500 ft (152 – 457 m) is optimum. 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.

(4) The exercise will be conducted only if marine mammals are not visible within the buffer zone.

(j) Small Arms Training (Grenades, Explosive and Non-explosive Rounds)

- Lookouts will visually survey for marine mammals. Weapons will not be fired in the direction of known or observed marine mammals.

(k) Air-to-Surface At-sea Bombing Exercises (explosive bombs and rockets):

(1) If surface vessels are involved, trained lookouts shall survey for marine mammals. Ordnance shall not be targeted to impact within 1,000 yds (914 m) of known or observed marine mammals.

(2) A 1,000 yd (914 m) radius buffer zone shall be established around the intended target.

(3) Aircraft shall visually survey the target and buffer zone for marine mammals prior to and during the exercise. The survey of the impact area shall be made by flying at 1,500 ft (457 m) or lower, if safe to do so, and at the slowest safe speed. When safety or other considerations require the release of weapons without the releasing pilot having visual sight of the target area, a second aircraft, the “wingman,” will clear the target area and perform the clearance and observation functions required before the dropping plane may release its weapons. Both planes must have direct communication to assure immediate notification to the dropping plane that the target area may have been fouled by encroaching animals or people. The clearing aircraft will assure it has visual site of the target area at a maximum height of 1500 ft. The clearing plane will remain within visual sight of the target until required to clear the area for safety reasons. Survey aircraft shall employ most effective search tactics and capabilities. Survey aircraft should employ most effective search tactics and capabilities.

(4) The exercise will be conducted only if marine mammals are not visible within the buffer zone.

(l) Air-to-Surface At-Sea Bombing Exercises (Non-explosive Bombs and Rockets)

(1) If surface vessels are involved, trained lookouts will survey for marine mammals. Ordnance shall not be targeted to impact within 1,000 yards (914 m) of known or observed or marine mammals.

(2) A 1,000 yard (914 m) radius buffer zone will be established around the intended target.

(3) 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. When safety or other considerations require the release of weapons without the releasing pilot having visual sight of the target area, a second aircraft, the "wingman," will clear the target area and perform the clearance and observation functions required before the dropping plane may release its weapons. Both planes must have direct communication to assure immediate notification to the dropping plane that the target area may have been fouled by encroaching animals or people. The clearing aircraft will assure it has visual site of the target area at a maximum height of 1500 ft. The clearing plane will remain within visual sight of the target until required to clear the area for safety reasons. Survey aircraft shall employ most effective search tactics and capabilities.

(4) The exercise will be conducted only if marine mammals and are not visible within the buffer zone.

(m) Air-to-Surface Missile Exercises (explosive and non-explosive):

(1) Aircraft will visually survey the target area for marine mammals. Visual inspection of the target area will be made by flying at 1,500 (457 m) ft 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.

(2) Explosive ordnance shall not be targeted to impact within 1,800 yds (1646 m) of sighted marine mammals.

(n) Aircraft Training Activities Involving Non-Explosive Devices:

An exclusion zone of 200 yds (~ 183 m) around the target location shall be clear of marine mammals and around the target location. Pre- and post-surveillance and reporting requirements outlined for underwater detonations shall be implemented during Mining Training Activities.

(o) Extended Echo Ranging/Improved Extended Echo Ranging and Advanced Extended Echo-ranging (EER/IEER/AEER)

- The following mitigation measures shall be used with the employment of IEER/AEER sonobuoys:

(1) Crews shall conduct visual reconnaissance of the drop area prior to laying their intended sonobuoy pattern. This search shall be conducted at an altitude below 500 yd (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.

(2) For IEER (AN/SSQ-110A), crews shall conduct a minimum of 30 minutes of visual and aural monitoring of the search area prior to commanding the first post detonation. This 30-minute observation period may include pattern deployment time.

(3) For any part of the intended sonobuoy pattern where a post (source/receiver sonobuoy pair) will be deployed within 1,000 yd (914 m) of observed marine mammal activity, the Navy shall deploy the receiver ONLY (i.e., not the source) 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 source sonobuoy (AN/SSQ-110A/SSQ-125) will be co-located with the receiver.

(4) When operationally feasible, Navy crews shall conduct continuous visual and aural monitoring of marine mammal activity. This shall include monitoring of own-aircraft sensors from the time of the first sensor placement until the aircraft have left the area and are out of RF range of these sensors.

(5) Aural Detection - If the presence of marine mammals is detected aurally, then that shall 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.

(6) Visual Detection - If marine mammals are visually detected within 1,000 yd (914 m) of the explosive source sonobuoy (AN/SSQ-110A/SSQ-125) intended for use, then that payload shall not be activated. 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 914 m (1,000 yd) safety buffer.

(7) For IEER (AN/SSQ-110A), aircrews shall 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 shall refrain from using the “Scuttle” command when two payloads remain at a given post. Aircrews shall ensure that 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.

(8) Aircrews shall 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.

(9) The Navy shall ensure all payloads are accounted for. Explosive source sonobuoys (AN/SSQ-110A) that can not be scuttled shall be reported as unexploded ordnance via voice communications while airborne, then upon landing via naval message.

(10) Marine mammal monitoring shall continue until out of own-aircraft sensor range.

(p) The Navy shall abide by the letter of the "Stranding Response Plan for Major Navy Training Exercises in the MIRC" (available at: www.nmfs.noaa.gov/pr/permits/incidental.htm), which is incorporated herein by reference, to include the following measures:

(1) Shutdown Procedures – When an Uncommon Stranding Event (USE – defined in § 218.271) occurs during a Major Training Exercise (MTE) (as defined in the Stranding Plan, meaning including Multi-strike group exercises, Joint Expeditionary exercises, and Marine Air Ground Task Force exercises in the MIRC), the Navy shall implement the procedures described below.

(i) The Navy shall implement a Shutdown (as defined in the Stranding Response Plan for MIRC) when advised by a NMFS Office of Protected Resources Headquarters Senior Official designated in the MIRC Stranding Communication Protocol that a USE (as defined in the Stranding Response Plan for MIRC) involving live animals has been identified and that at least one live animal is located in the water. NMFS and Navy shall communicate, as needed, regarding the identification of the USE and the potential need to implement shutdown procedures.

(ii) Any shutdown in a given area shall remain in effect in that area until NMFS advises the Navy that the subject(s) of the USE at that area die or are euthanized, or that all live animals involved in the USE at that area have left the area (either of their own volition or herded).

(iii) If the Navy finds an injured or dead marine mammal floating at sea during an MTE, the Navy shall notify NMFS immediately or as soon as operational security considerations allow. The Navy shall provide NMFS with species or description of the animal (s), the condition of the animal(s) including carcass condition if the

animal(s) is/are dead), location, time of first discovery, observed behaviors (if alive), and photo or video of the animals (if available). Based on the information provided, NMFS shall determine if, and advise the Navy whether a modified shutdown is appropriate on a case-by-case basis.

(iv) 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 shall coordinate (including an investigation of other potential anthropogenic stressors in the area) to determine if the proximity of MFAS/HFAS activities 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 shall further coordinate to determine what measures are necessary to further minimize that likelihood and implement those measures as appropriate.

(2) Within 72 hours of NMFS notifying the Navy of the presence of a USE, the Navy shall provide available information to NMFS (per the MIRC Communication Protocol) regarding the location, number and types of acoustic/explosive sources, direction and speed of units using MFAS/HFAS, and marine mammal sightings information associated with training activities occurring within 80 nm (148 km) and 72 hours prior to the USE event. Information not initially available regarding the 80 nm (148 km), 72 hours, period prior to the event shall be provided as soon as it becomes available. The Navy shall provide NMFS investigative teams with additional relevant unclassified information as requested, if available.

2.6 Monitoring and Reporting

When conducting operations identified in 50 CFR § 218.100(c) and Condition 4(a), the Holder of the Authorization and any person(s) operating under his authority must implement the following monitoring and reporting measures. All reports should be submitted to the Director, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring MD 20910 and a copy provided to the Assistant Regional Administrator for Protected Resources, Pacific Islands Regional Office, National Marine Fisheries Service, 1601 Kapiolani Boulevard, Suite 1110, Honolulu, HI 96814.

(a) General Notification of Injured or Dead Marine Mammals - Navy personnel shall ensure that NMFS is notified immediately ((see Communication Plan) or as soon as clearance procedures allow) 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. The Navy will provide NMFS with the name of species or description of the animal (s), the condition of the animal(s) (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available). In the event that an injured, stranded, or dead marine mammal is found by the Navy that is not in the

vicinity of, or during or shortly after, MFAS, HFAS, or underwater explosive detonations, the Navy will report the same information as listed above as soon as operationally feasible and clearance procedures allow.

(b) General Notification of Ship Strike - In the event of a ship strike by any Navy vessel, at any time or place, the Navy shall do the following:

(1) 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 whether its status is unknown.

(2) Report to NMFS as soon as operationally feasible the size and length of animal, an estimate of the injury status (ex., dead, injured but alive, injured and moving, unknown, etc.), vessel class/type and operational status.

(3) Report to NMFS the vessel length, speed, and heading as soon as feasible.

(4) Provide NMFS a photo or video, if equipment is available.

(c) The Navy must conduct all monitoring and/or research required under the LOA, including abiding by the annual MIRC Monitoring Plan, which may be found at: www.nmfs.noaa.gov/pr/permits/incidental.htm#applications.

(d) Report on Monitoring required in paragraph (e) of this section – The Navy shall submit a report annually describing the implementation and results of the monitoring required in paragraph (d) of this section. Required submission date will be identified each year in the LOA. Navy will standardize data collection methods across ranges to allow for comparison in different geographic locations.

(e) Sonar Exercise Notification - The Navy shall submit to the NMFS Office of Protected Resources (specific contact information to be provided in LOA) either an electronic (preferably) or verbal report within fifteen calendar days after the completion of any MTER indicating:

(1) Location of the exercise;

(2) Beginning and end dates of the exercise; and

(3) Type of exercise.

(f) Annual MIRC Report - The Navy will submit an Annual Exercise MIRC Report every year. This report shall contain the subsections and information indicated below.

(1) MFAS/HFAS Major Training Exercises - This section shall contain the following information for the following Coordinated and Strike Group exercises, which for simplicity will be referred to as major training exercises for reporting (MTERs): Joint

Multi-strike Group Exercises; Joint Expeditionary Exercises; and Marine Air Ground Task Force MIRC:

(i) Exercise Information (for each MTER):

(A) Exercise designator;
(B) Date that exercise began and ended;
(C) Location;
(D) Number and types of active sources used in the exercise;
(E) Number and types of passive acoustic sources used in exercise;
(F) Number and types of vessels, aircraft, etc., participating in exercise;
(G) Total hours of observation by watchstanders;
(H) Total hours of all active sonar source operation;
(I) Total hours of each active sonar source (along with explanation of how hours are calculated for sources typically quantified in alternate way (buoys, torpedoes, etc.)); and
(J) Wave height (high, low, and average during exercise).

(ii) Individual marine mammal sighting info (for each sighting in each MTER):

(A) Location of sighting;
(B) Species (if not possible – indication of whale/dolphin/pinniped);
(C) Number of individuals;
(D) Calves observed (y/n);
(E) Initial Detection Sensor;
(F) Indication of specific type of platform observation made from (including, for example, what type of surface vessel, i.e., FFG, DDG, or CG);
(G) Length of time observers maintained visual contact with marine mammal(s);
(H) Wave height (in feet);
(I) Visibility;
(J) Sonar source in use (y/n);
(K) Indication of whether animal is <200yd, 200-500yd, 500-1000yd, 1000-2000yd, or >2000yd from sonar source in (x) above;
(L) Mitigation Implementation – Whether operation of sonar sensor was delayed, or sonar was powered or shut down, and how long the delay was;
(M) If source in use (x) is hullmounted, true bearing of animal from ship, true direction of ship's travel, and estimation of animal's motion relative to ship (opening, closing, parallel); and
(N) Observed behavior – Watchstanders shall report, in plain language and without trying to categorize in any way, the observed behavior of the

animals (such as animal closing to bow ride, paralleling course/speed, floating on surface and not swimming, etc.).

(iii) An evaluation (based on data gathered during all of the MTERs) of the effectiveness of mitigation measures designed to avoid exposing marine mammals to MFAS. This evaluation shall identify the specific observations that support any conclusions the Navy reaches about the effectiveness of the mitigation.

(2) ASW Summary - This section shall include the following information as summarized from non-major training exercises (unit-level exercises, such as TRACKEXs):

(i) Total Hours - Total annual hours of each type of sonar source (along with explanation of how hours are calculated for sources typically quantified in alternate way (buoys, torpedoes, etc.))

(ii) Cumulative Impacts - To the extent practicable, the Navy, in coordination with NMFS, shall develop and implement a method of annually reporting non-major training (i.e., ULT) utilizing hull-mounted sonar. The report shall present an annual (and seasonal, where practicable) depiction of non-major training exercises geographically across MIRC. The Navy shall include (in the MIRC annual report) a brief annual progress update on the status of the development of an effective and unclassified method to report this information until an agreed-upon (with NMFS) method has been developed and implemented.

(3) Sinking Exercises (SINKEXs) - This section shall include the following information for each SINKEX completed that year:

(i) Exercise Info:

(A) Location;
(B) Date and time exercise began and ended;
(C) Total hours of observation by watchstanders before, during, and after exercise;
(D) Total number and types of rounds expended / explosives detonated;
(E) Number and types of passive acoustic sources used in exercise;
(F) Total hours of passive acoustic search time;
(G) Number and types of vessels, aircraft, etc., participating in exercise;
(H) Wave height in feet (high, low and average during exercise); and
(I) Narrative description of sensors and platforms utilized for marine mammal detection and timeline illustrating how marine mammal detection was conducted.

(ii) Individual marine mammal observation during SINKEX (by Navy lookouts) information:

(A) Location of sighting;
(B) Species (if not possible – indication of whale/dolphin/pinniped);
(C) Number of individuals;
(D) Calves observed (y/n);
(E) Initial detection sensor;
(F) Length of time observers maintained visual contact with marine mammal;
(G) Wave height;
(H) Visibility;
(I) Whether sighting was before, during, or after detonations/exercise, and how many minutes before or after;
(J) Distance of marine mammal from actual detonations (or target spot if not yet detonated) – use four categories to define distance:

(1) the modeled injury threshold radius for the largest explosive used in that exercise type in that OPAREA (TBD m for SINKEX in MIRC);
(2) the required exclusion zone (1 nm for SINKEX in MIRC);
(3) the required observation distance (if different than the exclusion zone (2 nm for SINKEX in MIRC); and
(4) greater than the required observed distance. For example, in this case, the observer shall indicate if < 426 m, from 426 m – 1 nm, from 1 nm – 2 nm, and > 2 nm.

(K) Observed behavior – Watchstanders will report, in plain language and without trying to categorize in any way, the observed behavior of the animals (such as animal closing to bow ride, paralleling course/speed, floating on surface and not swimming etc.), including speed and direction.
(L) Resulting mitigation implementation – Indicate whether explosive detonations were delayed, ceased, modified, or not modified due to marine mammal presence and for how long.
(M) If observation occurs while explosives are detonating in the water, indicate munitions type in use at time of marine mammal detection.

(4) Improved Extended Echo-Ranging System (IEER)/Advanced Extended Echo-Ranging (AEER) Summary:

(i) Total number of IEER and AEER events conducted in MIRC;

(ii) Total expended/detonated rounds (buoys); and

(iii) Total number of self-scuttled IEER rounds.

(5) Explosives Summary

The Navy is in the process of improving the methods used to track explosive use to provide increased granularity. To the extent practicable, the Navy shall provide the

information described below for all of their explosive exercises. Until the Navy is able to report in full the information below, they will provide an annual update on the Navy's explosive tracking methods, including improvements from the previous year.

(i) Total annual number of each type of explosive exercise (of those identified as part of the "specified activity" in this final rule) conducted in MIRC; and

(ii) Total annual expended/detonated rounds (missiles, bombs, etc.) for each explosive type.

(6) MIRC 5-Yr Comprehensive Report - The Navy shall submit to NMFS a draft report that analyzes and summarizes all of the multi-year marine mammal information gathered during ASW and explosive exercises for which annual reports are required (Annual MIRC Exercise Reports and MIRC Monitoring Plan Reports). This report will be submitted at the end of the fourth year of the rule (November 2014), covering activities that have occurred through July 15, 2014.

(7) Comprehensive National ASW Report - By June, 2014, the Navy shall submit a draft National Report that analyzes, compares, and summarizes the active sonar data gathered (through January 1, 2014) from the watchstanders and pursuant to the implementation of the Monitoring Plans for the Northwest Training Range Complex, the Southern California Range Complex, the Atlantic Fleet Active Sonar Training, the Hawaii Range Complex, the Mariana Islands Range Complex, and the Gulf of Alaska.

(8) The 2010 LOA required that the Navy update the ICMP Plan to reflect development in three areas, specifically: (1) identifying more specific monitoring sub-goals under the major goals that have been identified; (2) characterizing Navy Range Complexes and study areas within the context of the prioritization guidelines described in the ICMP Plan; and (3) continuing to develop data management, organization and access procedures. The Navy has updated the ICMP Plan as required. Because the ICMP is an evolving Program, we posted the ICMP on NMFS website: http://www.nmfs.noaa.gov/pr/permits/incidental.htm.

2.7 Action Area

The action area for this Opinion consists of the Mariana Islands Range Complex and marine areas immediately adjacent to the range complex (see Figures 1 through 9). This area encompasses a 501,873-square-nautical mile area around the islands of Guam, Tinian, Saipan, Rota, Fallaron de Medenillia, and others and includes ocean areas in both the Pacific Ocean and the Philippine Sea. This action area is limited to those marine, coastal, and estuarine waters that are seaward of the mean higher high water line within this geographic area. Any of the proposed activities are likely to occur on the open ocean, seaward of the territorial seas off Guam and the Mariana Islands.

3 APPROACH TO THE ASSESSMENT

NMFS uses a series of steps to identify and analyze those aspects of proposed actions that are likely to have direct and indirect effect on the physical, chemical, and biotic environment of an action area (the term "potential stressors" is used for these aspects of an action). As part of this step, the spatial extent of any potential stressors is identified, including the degree to which the spatial extent of those stressors may change with time (the spatial extent of these stressors is the "action area" for a consultation).

The second step of the analyses starts by determining whether endangered species, threatened species, or designated critical habitat are likely to occur in the same space and at the same time as these potential stressors. If such co-occurrence is likely, then the nature of that co-occurrence is estimated (these represent our exposure analyses). In this step of the analyses, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an Action's effects and the populations or subpopulations those individuals represent.

Once we identify which listed resources (endangered and threatened species and designated critical habitat) are likely to be exposed to potential stressors associated with an action and the nature of that exposure, in the third step of our analyses we examine the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure (these represent our response analyses) (see Section 5). The final steps of our analyses — establishing the risks those responses pose to listed resources — are different for listed species and designated critical habitat (these represent our risk analyses) (see Section 5).

3.1 Potential Stressors

NMFS has identified several aspects of the proposed action as potential hazards to threatened or endangered species or critical habitat that has been designated for them:

1. surface vessels and submarines involved in training activities and the associated risk of collisions;
2. pressure waves produced by the underwater detonations;
3. projectiles associated with firing operations;
4. sound fields produced by the low-, mid-, and high-frequency active sonar systems the U.S. Navy would employ during the training activities it proposes;
5. sound fields produced by the underwater detonations the U.S. Navy would employ during the training activities it proposes;
6. disturbance produced by surface vessels and aircraft involved in training activities;
7. the chemical constituents of explosives, ordnance, chaff, and flares; and
8. parachutes associated with flares and sonobuoys.

The first step of our analysis evaluates the available evidence to determine the likelihood of listed species or critical habitat being exposed to these potential stressors. Our analysis assumed that these stressors pose no risk to listed species or critical habitat if these potential stressors do not co-occur, in space or time, with (1) individuals of endangered or threatened species or units of critical habitat that has been designated for endangered or threatened species; (2) species that are food for endangered or threatened species; (3) species that prey on or compete with endangered or threatened species; (4) pathogens for endangered or threatened species. During our analyses, we did not identify situations where the proposed training activities are likely to indirectly affect endangered or threatened species by disrupting marine food chains, or by adversely affecting the predators, competitors, or forage base of endangered or threatened species.

3.2 Exposure

Exposure analyses are designed to identify the listed resources that are likely to co-occur with these potential effects in space and time and the nature of that co-occurrence. This exposure analyses was designed to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an Action's effects and the populations or subpopulations (or other sub-divisions of "populations," including demes, runs, or races) those individuals represent.

NMFS generally relies on an action agency's estimates of the number of marine mammals that might be "taken" (as that term is defined for the purposes of the MMPA). In a small number of consultations, however, NMFS has conducted separate analyses to estimate the number of endangered or threatened marine animals that might be exposed to stressors produced by a proposed action to assess the effect of assumptions in an action agency's model on model estimates. For example, NMFS used a model based on components of Hollings' disc equation (1959) (Navy 2008b) to independently estimate the number of marine mammals that might be exposed to Navy training activities in a few recent consultations that satisfied the following conditions; first, the sole or primary stressor was hull-mounted mid-frequency active sonar; and second, data were available on the density of endangered or threatened animals in an action area, the ship's speed, the radial distance at which different received levels would be detected from a source given sound speed profiles, and the duration of specific training exercises.

These conditions have been met in less than one fourth of the consultations NMFS has completed on Navy training since 2002 (for example, opinions on anti-submarine warfare training on the Navy's Hawai'i Range Complex and Southern California Range Complex) so NMFS conducted independent exposure analyses and included the results of those analyses in Biological Opinions on those actions. In the remaining Opinions, hull-mounted mid-frequency active sonar was not the primary stressor associated with proposed training or the data for one of the model's variables were not available.

In this Opinion, we considered two different approaches to estimating the number of whales that might interact with sound fields associated with mid-frequency active sonar in the Mariana Islands Range Complex:

1. The method the U.S. Navy and the Permits Division develop to produce the "take" (as that term is defined pursuant to the MMPA) estimates that were necessary to apply for an authorization to take marine mammals incidental to training activities pursuant to the MMPA and for the effects analyses in the Environmental Impact Statement the U.S. Navy and NMFS' Permits Division prepared for activities the U.S. Navy proposes to conduct in the Mariana Islands Range Complex. The incidental "take" the Permits Division proposes to authorize in the proposed 5-year regulations reflect these "take" estimates.

2. An exposure model NMFS' Endangered Species Division developed using components of an established ecological model (the Hollings' disc equation) to estimate the number of endangered and threatened marine mammals that are likely to be exposed to active sonar during activities the U.S. Navy proposes to conduct in the Mariana Islands Range Complex (the data necessary to estimate the number of sea turtles that might be exposed to active sonar was not available).

The first approach was designed to estimate the number of times marine mammals might be "taken" (as that term is defined pursuant to the MMPA) as a result of being exposed to active sonar or underwater detonations during U.S. Navy training, which is a subset of the number of animals that might be exposed to those training activities or respond given exposure. Although the U.S. Navy's modeling efforts and the results of NMFS' exposure models may produce similar numerical results, the U.S. Navy and Permits Division estimated the number of times marine mammals might be 'taken' given that they have been exposed and respond to that exposure while we estimated the number of times marine mammals might be exposed to those activities. As a result, the "take" estimates produced by the U.S. Navy and the Permits Division are not comparable to the exposure estimates we produce in this Opinion.

U.S. Navy Exposure Estimates for the Proposed Actions

Over the past year, the U.S. Navy updated its approach to estimating the number of marine mammals that might be exposed to the activities the U.S. Navy plans to conduct in the Mariana Islands Range Complex over the five-year period beginning in 2010. What follows is a brief summary of the Navy's current approach (for more details, refer to Appendix F of the U.S. Navy's Final Environmental Impact Statement on the Mariana Islands Range Complex)(Navy 2010b).

The U.S. Navy's updated approach focuses on a suite of representative provinces based on sound velocity profiles, bathymetries, and bottom types. Within each of these provinces, the U.S. Navy modeled transmission losses in 5 meter increments and used the results to build sound fields (based on maximum sound pressure levels). The U.S. Navy then calculates an "impact volume,"

which is the volume of water in which an acoustic metric exceeds a specified threshold; in this case, the Navy used one of three acoustic metrics: energy flux density (in a limited band or across a full band), peak pressure, or positive impulse. By multiplying these "impact volumes" by estimates of animal densities in three dimensions (densities distributed by area and depth), the U.S. Navy estimated the expected number of animals that might be exposed to an acoustic metric (energy flux density, peak pressure, or positive impulse) at levels that exceed thresholds that had been specified in advance. Specifically, the U.S. Navy calculated impact volumes for sonar operations (using energy flux density to estimate the probability of injury), peak pressure, and a Goertner modified positive impulse (for onset of slight lung injury associated with explosions).

To calculate "impact volumes," the U.S. Navy used a "risk continuum" or a curve that the U.S. Navy and NMFS developed that relates the probability of a behavioral response given exposure to a received level that is generally represented by sound pressure level, but included sound exposure level to deal with threshold shifts. The risk continuum, which the U.S. Navy and NMFS' Permits Division adapted from a mathematical model presented in Feller (1968), was estimated using three data sources: (1) data from controlled experiments conducted at the U.S. Navy's Space and Naval Warfare Systems Center in San Diego, California (Finneran et al. 2003; Finneran et al. 2001; Finneran et al. 2005; Finneran and Schlundt. 2004; Schlundt et al. 2000), (2) data from a reconstruction of an incident in which killer whales were probably exposed to mid-frequency active sonar (Fromme 2004), and (3) a suite of studies of the response of baleen whales to low-frequency sound sources (Nowacek et al. 2004). The U.S. Navy and NMFS' Permits Division estimated the proportion of a population that is expected to exhibit behavioral responses that NMFS' would classify as "take" (as that term is defined by the MMPA) by multiplying the different "impact volumes" at particular received levels by the "risk continuum."

This approach would also tend to overestimate the number of marine mammals that might be exposed, because marine mammals are highly mobile and are likely to use their mobility to avoid stimuli like active sonar, just as they avoid vessel traffic. Consequently, the results of this approach would be conservative, in the sense that they would tend to overestimate the number of animals that are likely to be "taken" by the activities the U.S. Navy plans to conduct in the Mariana Islands Range Complex.

NMFS' Exposure Estimates using Components of Holling's Disc Equation

Our jeopardy analyses must consider all potential effects of proposed actions, including direct or indirect beneficial and adverse effects that do not necessarily rise to the level of "take." For example, jeopardy analyses must consider the direct beneficial or adverse effects of actions on endangered or threatened individuals as well as indirect effects that results from how competitors, prey, symbionts, or the habitat of those listed individuals respond to an action. We cannot begin those analyses with estimates of the number of individuals that might be "taken" (as that term is defined by the MMPA) because our analyses must consider direct and indirect effects that do not necessarily represent one or more form of "take."

We conduct our jeopardy analyses by first identifying the potential stressors associated with an action, then we determine whether endangered species, threatened species, or designated critical habitat are likely to occur in the same space and at the same time as these potential stressors. If we conclude that such co-occurrence is likely, we then try to estimate the nature of that co-occurrence. These two steps represent our *exposure analyses*, which are designed to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an Action's effects and the populations or subpopulations those individuals represent.

For our exposure analyses, NMFS developed a model to estimate the number of times endangered or threatened marine mammals might be exposed to active sonar or underwater detonations. The core of this model estimates the number of individuals that might be exposed (N) as a function of an area (A) and the estimated density of animals (D) in that area. That is, $N = D \times A$ (Buckland 2001; Buckland and Borchers 1993), where, for the purposes of our analyses, A is the total area that would be ensonified by active sonar or contained within the pressure wave or sound field produced by an underwater detonation. A complete description of the model was provided in the programmatic biological opinion (NMFS 2010b) and the biological opinion on the issuance of the 2010 LOA (NMFS 2010a). In applying this model, we relied on published sources of information and information contained in the U.S. Navy's Environmental Impact Statement on the Mariana Islands Range Complex (which itself relies on published sources) to estimate the density of endangered and threatened marine mammals in waters off Mariana Islands (Navy 2010b).

The model was used to develop and simulate a scenario that assumed that marine mammal densities never changed and that animals did not move during the course of an exercise (this is the closest approximation of the U.S. Navy's models).

The exposure model we developed assumed ship speeds of 10 knots (or 18.25 km per hour), which is the same assumption contained in the Navy's models. The "sensory field" in the model represented the U.S. Navy's estimates of the area that would be ensonified at different received levels presented in the U.S. Navy's Environmental Impact Statements for the Mariana Islands Range Complex, adjusted to eliminate overlap (Navy 2010b). Our exposure model was also based on the Navy's estimates of the number of hours of the different kinds of active sonar that would be employed in the different exercises.

3.3 Response Analysis

Once we identified which listed resources were likely to be exposed to the potential stressors associated with the proposed activities and the nature of that exposure, we examined the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure.

Prior to this consultation, we made several major changes to the conceptual model that forms the foundation for our response analyses. First, we constructed our revised model on a model of animal behavior and behavioral decision-making, which incorporates the cognitive processes

involved in behavioral decisions; earlier versions of this model ignored critical components of animal behavior and behavioral decision-making (see NMFS 2010a) for a detailed discussion of our conceptual response model). As a result, our revised model assumes that Navy's training activities primarily affect endangered and threatened species by changing their behavior, although we continue to recognize the risks of physical trauma and noise-induced losses in hearing sensitivity (threshold shift). Second, we expanded our concept of "hearing" to include cognitive processing of auditory cues, rather than a focus solely on the mechanical processes of the ear and auditory nerve. Third, our revised model incorporates the primary mechanisms by which behavioral responses affect the longevity and reproductive success of animals: changing an animal's energy budget, changing an animal's time budget (which is related to changes in an animal's energy budget), forcing animals to make life history trade-offs (for example, engaging in evasive behavior such a deep dives that involve short-term risks while promoting long-term survival), or changes in social interactions among groups of animals (for example, interactions between a cow and her calf).

3.4 Risk Analysis for Endangered and Threatened Species

Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species as those "species" have been listed, which can include true biological species, subspecies, or distinct population segments of vertebrate species. Because the continued existence of listed species depends on the fate of the populations that comprise them, the viability (that is, the probability of extinction or probability of persistence) of listed species depends on the viability of the populations that comprise the species. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them; populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so). Our risk analyses reflect these relationships between listed species and the populations that comprise them, and the individuals that comprise those populations.

Our risk analyses begin by identifying the probable risks the proposed actions are likely to pose to listed individuals that are likely to be exposed to an action's effects. Our analyses then integrate those risks to individuals to identify consequences to the populations that include those individuals. Our analyses conclude by determining the consequences of those population-level risks to the species those populations comprise.

We measure risks to listed individuals using the individual's current or expected future reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable response to stressors produced by an action would reasonably be expected to reduce the individual's current or expected future reproductive success by increasing the individual's likelihood of dying prematurely, having reduced longevity, increasing the age at which individuals become reproductively mature, reducing the age at which individuals stop reproducing, reducing the number of live births individuals produce during any reproductive bout, decreasing the number of times an individual is likely to reproduce over its reproductive lifespan (in animals that reproduce multiple times), or causing an individual's

progeny to experience any of these phenomena (Brommer et al. 1998; Coulson et al. 2006; Kotiaho et al. 2005; McGraw and Caswell 1996; Oli and Dobson 2003; Saether et al. 2005; Sterns 1992).

When individual, listed plants or animals are expected to experience reductions in their current or expected future reproductive success, we would expect those reductions to also reduce the abundance, reproduction rates, or growth rates (or increase variance in one or more of these rates) of the populations those individuals represent (see Sterns 1992). Reductions in one or more of these variables (or one of the variables we derive from them) is a *necessary* condition for reductions in a population's viability, which is itself a *necessary* condition for reductions in a species' viability. On the other hand, when listed plants or animals exposed to an Action's effects are *not* expected to experience reductions in fitness, we would not expect the Action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (for example, see Anderson 2000; Mills and Beatty 1979; Sterns 1992). If we conclude that listed plants or animals are *not* likely to experience reductions in their fitness, we would conclude our assessment.

If we conclude that listed plants or animals are likely to experience reductions in their current or expected future reproductive success, our assessment tries to determine if those reductions are likely to be sufficient to reduce the viability of the populations those individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, or variance in these measures to make inferences about the population's extinction risks). In this step of our analyses, we use the population's base condition (established in the *Environmental Baseline* and *Status of Listed Resources* sections of this Opinion) as our point of reference.

Finally, our assessment tries to determine if changes in population viability are likely to be sufficient to reduce the viability of the species those populations comprise. In this step of our analyses, we use the species' status (established in the *Status of the Species* section of this Opinion) as our point of reference. The primary advantage of this approach is that it considers the consequences of the response of endangered and threatened species in terms of fitness costs, which allows us to assess how particular behavioral decisions are likely to influence individual reproductive success (Bejder et al. 2009). Individual-level effects can then be translated into changes in demographic parameters of populations, thus allowing for an assessment of the biological significance of particular human disturbances.

Biological Opinions, then, distinguish among different kinds of "significance" (as that term is commonly used for NEPA analyses). First, we focus on potential physical, chemical, or biotic stressors that are "significant" in the sense of "salient" in the sense of being distinct from ambient or background. We then ask if (a) exposing individuals to those potential stressors is likely to (a) represent a "significant" adverse experience in the life of individuals that have been exposed; (b) exposing individuals to those potential stressors is likely to cause the individuals to experience "significant" physical, chemical, or biotic responses; and (c) any "significant"

physical, chemical, or biotic response is likely to have "significant" consequence for the fitness of the individual animal; in the latter two cases, (items (b) and (c)), the term "significant" means "clinically or biotically significant" rather than statistically significant.

For populations (or sub-populations, demes, etc.), we are concerned about whether the number of individuals that experience "significant" reductions in fitness and the nature of any fitness reductions are likely to have a "significant" consequence for the viability of the population(s) those individuals represent. Here "significant" also means "clinically or biotically significant" rather than statistically significant.

For "species" (this term refers to the entity that has been listed as endangered or threatened, not the biological species concept commonly referred to as "species"), we are concerned about whether the number of populations that experience "significant" reductions in viability (= increases in their extinction probabilities) and the nature of any reductions in viability are likely to have "significant" consequence for the viability (= probability of demographic, ecological, or genetic extinction) of the "species" those population comprise. Here, again, "significant" also means "clinically or biotically significant" rather than statistically significant.

3.5 Evidence Available for the Consultation

To conduct these analyses, we considered all lines of evidence available through published and unpublished sources that represent evidence of adverse consequences or the absence of such consequences. Over the past decade, a considerable body of scientific information on anthropogenic sound and its effects on marine mammals and other marine life has become available. Many investigators have studied the potential responses of marine mammals and other marine organisms to human-generated sounds in marine environments or have integrated and synthesized the results of these studies (Bowles 1994; Croll et al. 2001b; Frankel and Clark 1998b; Gisiner et al. 2006; McCauley and Cato. 2001; Norris 1994; NRC 2000; NRC 2005; Richardson et al. 1995; Southall et al. 2007; Tyack 2007; Tyack and Clark 2000; Wright et al. 2007).

In addition, we conducted electronic literature searches using the *Web of Science*, and Cambridge Abstract's *Aquatic Sciences and Fisheries Abstracts* (ASFA) database services. Our searches specifically focus on the *ArticleFirst*, *BasicBiosis*, *Dissertation Abstracts*, *Proceedings* and *ECO* databases, which index the major journals dealing with issues of ecological risk (for example, the journals *Environmental Toxicology and Chemistry*, *Human and Ecological Risk Assessment*), marine mammals (*Journal of Mammalogy*, *Canadian Journal of Zoology*, *Marine Mammal Science*), sea turtles (*Copeia*, *Herpetologia*, *Journal of Herpetology*), ecology (*Ambio*, *Bioscience*, *Journal of Animal Ecology*, *Journal of Applied Ecology*, *Marine Pollution Bulletin*, *Oikos*), bioacoustics (*Bioacoustics*, *Journal of the Acoustical Society of America*), and animal behavior (*Advances in the Study of Behavior*, *Animal Behavior*, *Behavior*, *Ethology*). We manually searched issues of the *Journal of Cetacean Research and Management* and *Reports of the International Whaling Commission*.

To supplement our searches, we examined the literature that was cited in documents and any articles we collected through our electronic searches. If a reference's title did not allow us to eliminate it as irrelevant to this inquiry, we acquired it. We did not conduct hand searches of published journals for this consultation. We organized the results of these searches using commercial bibliographic software.

Despite the information that is available, this assessment involved a large amount of uncertainty about the basic hearing capabilities of marine mammals; how marine mammals use sounds as environmental cues, how they perceive acoustic features of their environment; the importance of sound to the normal behavioral and social ecology of marine mammals; the mechanisms by which human-generated sounds affect the behavior and physiology (including the non-auditory physiology) of marine mammals, and the circumstances that are likely to produce outcomes that have adverse consequences for individual marine mammals and marine mammal populations (see NRC 2000 for further discussion of these unknowns).

3.6 Treatment of "Cumulative Impacts" (in the sense of NEPA)

Over the past few years, several organizations have argued that several of our previous biological opinions on the Navy's use of active sonar failed to consider the "cumulative impact" (in the NEPA sense of the term) of active sonar on the ocean environment and its organisms, particularly endangered and threatened species and critical habitat that has been designated for them. In each instance, we have had to explain how section 7 consultations and biological opinions consider "cumulative impacts" (in the NEPA sense of the term). We reiterate that explanation in this sub-section.

The U.S. Council on Environmental Quality defined "cumulative effects" (which we refer to as "cumulative impacts" to distinguish between NEPA and ESA uses of the same term) 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" (40 CFR §1508.7)(CEQ 1997).

By regulation, the Services assess the effects of a proposed action by adding its direct and indirect effects to the *impacts* of the activities we identify in an *Environmental Baseline* (50 CFR §402.02). Although our regulations use the term "adding" the effects of actions to an environmental baseline, we do not assume that the effects of actions are all additive; our assessments consider synergistic effects, multiplicative effects, and antagonistic effects of stressors on endangered species, threatened species, and any critical habitat that has been designated for those species.

In practice we address "cumulative impacts" by focusing on individual organisms, which integrate the environments they occupy or interact with indirectly over the course of their lives. In our assessments, we think in terms of the biotic or ecological "costs" of exposing endangered and threatened individuals to a single stressor, a sequence of single stressors, or a suite of stressors (or "stress regime"). At the level of individual organisms, these "costs" consist of

incremental reductions in the current or expected future reproductive success of the individuals that result from exposing those individuals to one or more stressors. The "costs" of those exposures might be immediately significant for an organism's reproductive success (for example, when an individual dies or loses one of its young) or the "costs" might become significant only over time. The costs of synergistic interactions between two stressors or a sequence of stressors would be expected to be higher than the "costs" incurred without the synergism; the "costs" of antagonistic interactions would be expected to be lower than the "costs" incurred without the antagonism.

We begin our assessments by either qualitatively or quantitatively accumulating the biotic "costs" of exposing endangered or threatened individuals to the threats we identify in the *Status of the Species* and *Environmental Baseline* sections of our biological opinions. Then we estimate the probable additional "costs" associated with the proposed action on those individuals and ask whether or to what degree those "costs" would be expected to translate into reductions in the current and expected future reproductive success of those individuals. If we would expect those "costs" to reduce the current and expected future reproductive success of individuals or an endangered or threatened species, we would assess the consequences of those reductions on the population or populations those individuals represent and the species those populations comprise.

3.7 A Brief Background on Sound

Sound is a wave of pressure variations propagating through a medium (for the sonar considered in this Opinion, the medium is marine water). Pressure variations are created by compressing and relaxing the medium. Sound measurements can be expressed in two forms: intensity and pressure. Acoustic intensity is the average rate of energy transmitted through a unit area in a specified direction and is expressed in watts per square meter (W/m^2). Acoustic intensity is rarely measured directly, it is derived from ratios of pressures; the standard reference pressure for underwater sound is 1 microPascal (µPa); for airborne sound, the standard reference pressure is 20 µPa (Richardson et al. 1995).

Acousticians have adopted a logarithmic scale for sound intensities, which is denoted in decibels (dB). Decibel measurements represent the ratio between a measured pressure value and a reference pressure value (in this case 1 µPa or, for airborne sound, 20 µPa.). The logarithmic nature of the scale means that each 10 dB increase is a ten-fold increase in power (e.g., 20 dB is a 100-fold increase, 30 dB is a 1,000-fold increase). Humans perceive a 10 dB increase in noise as a doubling of sound level, or a 10 dB decrease in noise as a halving of sound level. The term "sound pressure level" implies a decibel measure and a reference pressure that is used as the denominator of the ratio. Throughout this Opinion, we use 1 microPascal (denoted re: 1µPa) as a standard reference pressure unless noted otherwise.

It is important to note that decibels underwater and decibels in air are not the same and cannot be directly compared. Because of the different densities of air and water and the different decibel standards in water and air, a sound with the same intensity (i.e., power) in air and in water would

be approximately 63 dB quieter in air. Thus a sound that is 160 dB loud underwater would have the same effective intensity as a sound that is 97 dB loud in air.

Sound frequency is measured in cycles per second, or Hertz (abbreviated Hz), and is analogous to musical pitch; high-pitched sounds contain high frequencies and low-pitched sounds contain low frequencies. Natural sounds in the ocean span a huge range of frequencies: from earthquake noise at 5 Hz to harbor porpoise clicks at 150,000 Hz. These sounds are so low or so high in pitch that humans cannot even hear them; acousticians call these infrasonic and ultrasonic sounds, respectively. A single sound may be made up of many different frequencies. Sounds made up of only a small range of frequencies are called "narrowband", and sounds with a broad range of frequencies are called "broadband"; airguns are an example of a broadband sound source and sonars are an example of a narrowband sound source.

When considering the influence of various kinds of noise on the marine environment, it is necessary to understand that different kinds of marine life are sensitive to different frequencies of sound. Most dolphins, for instance, have excellent hearing at very high frequencies between 10,000 and 100,000 Hz. However, their sensitivity at lower frequencies below 1000 Hz is quite poor. On the other hand, the hearing sensitivity of most fish is best at frequencies between 100 Hz and 1000 Hz. Thus, fish might be expected to suffer more harmful effects from loud, low frequency noise than dolphins.

Because ears adapted to function underwater are physiologically different from human ears, comparisons using decibels would still not be adequate to describe the effects of a sound on a whale. When sound travels away from its source, its loudness decreases as the distance traveled by the sound increases. Thus, the loudness of a sound at its source is higher than the loudness of that same sound a kilometer distant. Acousticians often refer to the loudness of a sound at its source as the source level and the loudness of sound elsewhere as the received level. For example, a humpback whale 3 kilometers from an airgun that has a source level of 230 dB may only be exposed to sound that is 160 dB loud. As a result, it is important not to confuse source levels and received levels when discussing the loudness of sound in the ocean.

As sound moves away from a source, its propagation in water is influenced by various physical characteristics, including water temperature, depth, salinity, and surface and bottom properties that cause refraction, reflection, absorption, and scattering of sound waves. Oceans are not homogeneous and the contribution of each of these individual factors is extremely complex and interrelated. The physical characteristics that determine the sound's speed through the water will change with depth, season, geographic location, and with time of day (as a result, in actual sonar operations, crews will measure oceanic conditions, such as sea water temperature and depth, to calibrate models that determine the path the sonar signal will take as it travels through the ocean and how strong the sound signal will be at given range along a particular transmission path).

Sound tends to follow many paths through the ocean, so that a listener would hear multiple, delayed copies of transmitted signals (Richardson et al. 1995). Echoes are a familiar example of

this phenomenon in air. In order to determine what the paths of sound transmission are, one rule is to seek paths that deliver the sound to the receiver the fastest. These are called acoustic rays. If the speed of sound were constant throughout the ocean, acoustic rays would consist of straight-line segments, with reflections off the surface and the bottom. However, because the speed of sound varies in the ocean, most acoustic rays are curved.

Sound speed in seawater is about 1,500 m/s (5,000 ft/s) and varies with water density, which is affected by water temperature, salinity (the amount of salt in the water), and depth (pressure). The speed of sound increases as temperature and depth (pressure), and to a lesser extent, salinity, increase. The variation of sound speed with depth of the water is generally presented by a "sound speed profile," which varies with geographic latitude, season, and time of day.

In shallow waters of coastal regions and on continental shelves, sound speed profiles become influenced by surface heating and cooling, salinity changes, and water currents. As a result, these profiles tend to be irregular and unpredictable, and contain numerous gradients that last over short time and space scales. As sound travels through the ocean, the intensity associated with the wavefront diminishes, or attenuates. This decrease in intensity is referred to as propagation loss, also commonly called transmission loss.

4 STATUS OF LISTED RESOURCES

This section identifies the ESA-listed species that occur within the Action Area that may be affected by the Navy's acitivies in the Mariana Island Range Complex. It then summarizes the biology and ecology of those species and what is known about their life histories in the Action Area. The species occurring within the action area that may be affected by the Proposed Action are listed in Table 2, along with their ESA listing status.

Table 2. Species listed under the Federal Endangered Species Act (ESA) under NMFS jurisdiction that may occur in the Action Area for the SURTASS LFA sonar.

Species	ESA Status	Critical Habitat	Recovery Plan
Marine Mammals – Cetaceans			
Blue Whale (*Balaenoptera musculus*)	E - 35 FR 18319	-- --	07/1998
Fin Whale (*Balaenoptera physalus*)	E - 35 FR 18319	-- --	71 FR 38385
Humpback Whale (*Megaptera novaeangliae*)	E - 35 FR 18319	-- --	55 FR 29646
North Pacific Right Whale (*Eubalaena japonica*)	E - 73 FR 12024	73 FR 19000	-- --
Sei Whale (*Balaenoptera borealis*)	E - 35 FR 18319	-- --	-- --
Sperm Whale (*Physeter macrocephalus*)	E - 35 FR 18619	-- --	75 FR 81584
Sea Turtles			
Green Sea Turtle (*Chelonia mydas*)	E - 43 FR 32800	63 FR 46693	63 FR 28359
Hawksbill Sea Turtle (*Eretmochelys imbricate*)	E – 35 FR 8491	63 FR 46693	63 FR 28359
Loggerhead Sea Turtle (*Caretta caretta*)	Prop. E - 75 FR 12598	Prop. 75 FR 12598	63 FR 28359
Olive Ridley Sea Turtle (*Lepidochelys olivacea*)	E - 61 FR 17	-- --	63 FR 28359

Species	ESA Status	Critical Habitat	Recovery Plan
Leatherback Sea Turtle (*Dermochelys coriacea*)	E - 61 FR 17	Prop. 75 FR 319	63 FR 28359

4.1 Species and Critical Habitat Not Considered Further in this Opinion

As described in the Approach to the Assessment, NMFS uses two criteria to identify those endangered or threatened species that are not likely to be adversely affected by the various activities the U.S. Navy proposes to conduct in the Mariana Islands Range Complex from August 2011 to August 2012. The first criterion was exposure or some reasonable expectation of a co-occurrence between one or more potential stressor associated with the U.S. Navy's activities and a particular listed species: if we conclude that a listed species is not likely to be exposed to U.S. Navy's activities, we must also conclude that the species is not likely to be adversely affected by those activities. The second criterion is the probability of a response given exposure, which considers susceptibility: species that may be exposed to sound transmissions from active sonar, for example, but are likely to be unaffected by the sonar (at sound pressure levels they are likely to be exposed to) are also not likely to be adversely affected by the sonar. We applied these criteria to the species listed at the beginning of this section; this subsection summarizes the results of those evaluations.

There is no designated critical habitat in the action area. Therefore, no critical habitat would be affected by the proposed action.

4.1.1 North Pacific Right Whale

Very little is known of the population size and distribution of right whales in the North Pacific because very few of these animals have been seen over the past 20 years. Nevertheless, Brownell et al. (Brownell Jr. et al. 2001) identified the waters within about 200 miles of the coast of Japan, including outlying islands as accounting for 37.4 percent of right whale sightings since 1900 in the Pacific. Best et al. (Best et al. 2001) suggested the Ryukyu Islands, Yellow Sea, and Sea of Japan as important breeding and calving areas for Pacific right whales. The winter distribution of right whales in the Pacific remains unknown, although some right whales have been sighted as far south as 27ºN in the eastern North Pacific (Best et al. 2001).

Historically, North Pacific right whales occurred in waters off Guam and the Mariana Islands (Clapham et al. 2004; Scarff 1986). Despite many years of systematic aerial and ship-based surveys for marine mammals off the western coast of the U.S., only seven documented sightings of right whales were made from 1990 through 2000 (Waite et al. 2003). The relative rarity of reports of this species and the extremely low population numbers of this species suggests that these right whales have a very low probability of being exposed to ship and aircraft traffic and sonar transmissions associated with the activities considered in this Opinion. Consequently, we conclude that the proposed activities may affect, but are not likely to adversely affect endangered northern right whales so this species will not be considered in greater detail in the remainder of this opinion.

4.1.2 Leatherback, Loggerhead, and Olive Ridely Sea Turtles

Leatherback, loggerhead, and olive ridley sea turtles have all been reported in waters offshore of the Mariana Islands, but they are reported as transients in the region (Wiles et al. 1995) or they are reported as not occurring in those waters. Sea turtle surveys that have been conducted in waters on or adjacent to the Mariana Islands Range Complex have not reported observations of these sea turtles (Grimm and Farley 2008; Kolinksi et al. 2005; Kolinski 2001; Pultz et al. 1999; Randall et al. 1975; Stojkovich 1977; Vogt 2009). As a result, we assume that the probability of exposing these sea turtles to one or more of the stressors associated with the proposed action is sufficiently small to be discountable. Therefore, we assume that leatherback, loggerhead, and olive ridley sea turtles are not likely to be adversely affected by the activities the U.S. Navy plans to conduct on the Mariana Islands Range Complex. Consequently, we conclude that the proposed activities may affect, but are not likely to adversely affect these three sea turtles so they will not be considered in greater detail in the remainder of this Opinion.

4.2 Climate Change

There is now widespread consensus within the scientific community that atmospheric temperatures on earth are increasing (warming) and that this will continue for at least the next several decades (IPCC 2001; Oreskes 2004). There is also consensus within the scientific community that this warming trend will alter current weather patterns and patterns associated with climatic phenomena, including the timing and intensity of extreme events such as heat-waves, floods, storms, and wet-dry cycles. The threats posed by the direct and indirect effects of global climate change are, or will be, common to all of the species we discuss in this Opinion. Because of this commonality, we present this narrative here rather than in each of the species-specific narratives that follow.

The IPCC estimated that average global land and sea surface temperature has increased by 0.6°C (±0.2) since the mid-1800s, with most of the change occurring since 1976. This temperature increase is greater than what would be expected given the range of natural climatic variability recorded over the past 1,000 years (Crowley 2000). The IPCC reviewed computer simulations of the effect of greenhouse gas emissions on observed climate variations that have been recorded in the past and evaluated the influence of natural phenomena such as solar and volcanic activity. Based on their review, the IPCC concluded that natural phenomena are insufficient to explain the increasing trend in land and sea surface temperature, and that most of the warming observed over the last 50 years is likely to be attributable to human activities (IPCC 2001). Climatic models estimate that global temperatures would increase between 1.4 to 5.8°C from 1990 to 2100 if humans do nothing to reduce greenhouse gas emissions (IPCC 2001). These projections identify a suite of changes in global climate conditions that are relevant to the future status and trend of endangered and threatened species (Table 3).

Climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine, coastal, and terrestrial ecosystems in the foreseeable future (Houghton 2001; IPCC 2001; Parry et al. 2007). The direct effects of climate change would result in increases in atmospheric temperatures, changes in sea surface

temperatures, changes in patterns of precipitation, and changes in sea level. Oceanographic models project a weakening of the thermohaline circulation resulting in a reduction of heat transport into high latitudes of Europe, an increase in the mass of the Antarctic ice sheet, and a decrease in the Greenland ice sheet, although the magnitude of these changes remain unknown.

The indirect effects of climate change would result from changes in the distribution of temperatures suitable for calving and rearing calves, the distribution and abundance of prey, and the distribution and abundance of competitors or predators. For example, variations in the recruitment of krill (*Euphausia superba*) and the reproductive success of krill predators have been linked to variations in sea-surface temperatures and the extent of sea-ice cover during the winter months. Although the IPCC (2001) did not detect significant changes in the extent of Antarctic sea-ice using satellite measurements, Curran (2003) analyzed ice-core samples from 1841 to 1995 and concluded Antarctic sea ice cover had declined by about 20 percent since the 1950s.

The Antarctic Peninsula, which is the northern extension of the Antarctic continent, contains the richest areas of krill in the Southern Ocean. The extent of sea ice cover around this Peninsula has the highest degree of variability relative to other areas within the distribution of krill. Relatively small changes in climate conditions are likely to exert a strong influence on the seasonal pack-ice zone in the Peninsula area, which is likely to affect densities of krill in this region. Because krill

Table 3. Phenomena associated with projections of global climate change including levels of confidence associated with projections (adapted from IPCC 2001 and Campbell-Lendrum Woodruff 2007).

Phenomenon	Confidence in Observed Changes (observed in the latter 20th Century)	Confidence in Projected Changes (during the 21st Century)
Higher maximum temperatures and a greater number of hot days over almost all land areas	Likely	Very likely
Higher minimum temperatures with fewer cold days and frost days over almost all land areas	Very likely	Very likely
Reduced diurnal temperature range over most land areas	Very likely	Very likely
Increased heat index over most land areas	Likely over many areas	Very likely over most areas
More intense precipitation events	Likely over many mid- to high-latitude areas in Northern Hemisphere	Very likely over many areas
Increased summer continental drying and associated probability of drought	Likely in a few areas	Likely over most mid-latitude continental interiors (projections are inconsistent for other areas)
Increase in peak wind intensities in tropical	Not observed	Likely over some areas

cyclones		
Increase in mean and peak precipitation intensities in tropical cyclones	Insufficient data	Likely over some areas

are important prey for baleen whales or form a critical component of the food chains on which baleen whales depend, increasing the variability of krill densities or causing those densities to decline dramatically is likely to have adverse effect on populations of baleen whales in the Southern Ocean.

Reid and Croxall (2001) analyzed a 23-year time series of the reproductive performance of predators that depend on krill for prey — Antarctic fur seals (*Arctocephalus gazella*), gentoo penguins (*Pygoscelis papua*), macaroni penguins (*Eudyptes chrysolophus*), and black-browed albatrosses (*Thalassarche melanophrys*) — at South Georgia Island and concluded that these populations experienced increases in the 1980s followed by significant declines in the 1990s accompanied by an increase in the frequency of years with reduced reproductive success. The authors concluded that macaroni penguins and black-browed albatrosses had declined by as much as 50 percent in the 1990s, although incidental mortalities in longline fisheries probably contributed to the decline of the albatross. These authors concluded, however, that these declines result, at least in part, from changes in the structure of the krill population, particularly reduced recruitment into older age classes, which lowers the number of predators this prey species can sustain. The authors concluded that the biomass of krill within the largest size class was sufficient to support predator demand in the 1980s but not in the 1990s.

Similarly, a study of relationships between climate and sea-temperature changes and the arrival of squid off southwestern England over a 20-year period concluded that veined squid (*Loligo forbesi*) migrate eastwards in the English Channel earlier when water in the preceding months is warmer, and that higher temperatures and early arrival correspond with warm phases of the North Atlantic oscillation (Sims et al. 2001). The timing of squid peak abundance advanced by 120- 150 days in the warmest years compared with the coldest. Seabottom temperature were closely linked to the extent of squid movement and temperature increases over the five months prior to and during the month of peak squid abundance did not differ between early and late years. These authors concluded that the temporal variation in peak abundance of squid seen off Plymouth represents temperature-dependent movement, which is in turn mediated by climatic changes associated with the North Atlantic Oscillation.

Climate-mediated changes in the distribution and abundance of keystone prey species like krill and climate-mediated changes in the distribution of cephalopod populations worldwide is likely to affect marine mammal populations as they re-distribute throughout the world's oceans in search of prey. Blue whales, as predators that specialize in eating krill, seem likely to change their distribution in response to changes in the distribution of krill (for example, see Payne et al. 1990; Payne 1986); if they did not change their distribution or could not find the biomass of krill necessary to sustain their population numbers, their populations seem likely to experience declines similar to those observed in other krill predators, which would cause dramatic declines

in their population sizes or would increase the year-to-year variation in population size; either of these outcomes would dramatically increase the extinction probabilities of these whales.

Sperm whales, whose diets can be dominated by cephalopods, would have to re-distribute following changes in the distribution and abundance of their prey. This statement assumes that projected changes in global climate would only affect the distribution of cephalopod populations, but would not reduce the number or density of cephalopod populations. If, however, cephalopod populations collapse or decline dramatically, sperm whale populations are likely to collapse or decline dramatically as well.

The response of North Atlantic right whales to changes in the North Atlantic Oscillation also provides insight into the potential consequences of a changing climate on large whales. Changes in the climate of the North Atlantic have been directly linked to the North Atlantic Oscillation, which results from variability in pressure differences between a low pressure system that lies over Iceland and a high pressure system that lies over the Azore Islands. As these pressure systems shift from east to west, they control the strength of westerly winds and storm tracks across the North Atlantic Ocean. The North Atlantic Oscillation Index, which is positive when both systems are strong (producing increased differences in pressure that produce more and stronger winter storms) and negative when both systems are weak (producing decreased differences in pressure resulting in fewer and weaker winter storms), varies from year to year, but also exhibits a tendency to remain in one phase for intervals lasting several years.

Sea surface temperatures in the North Atlantic Ocean are closely related to this oscillation which influences the abundance of marine mammal prey such as zooplankton and fish. In the 1970s and 1980s, the North Atlantic Oscillation Index has been positive and sea surface temperatures increased. These increases are believed to have produced conditions that were favorable for the copepod (*Calanus finmarchicus*), which is the principal prey of North Atlantic right whales (Conversi et al. 2001) and may have increased calving rates of these whales (we cannot verify this association because systematic data on North Atlantic right whale was not collected until 1982) (Greene et al. 2003a). In the late 1980s and 1990s, the North Atlantic Oscillation Index was mainly positive but exhibited two substantial, multi-year reversals to negative values. This was followed by two major, multi-year declines in copepod prey abundance (Drinkwater et al. 2003; Pershing et al. 2010). Calving rates for North Atlantic right whales followed the declining trend in copepod abundance, although there was a time lag between the two (Greene et al. 2003b).

Although the North Atlantic Oscillation Index has been positive for the past 25 years, atmospheric models suggest that increases in ocean temperature associated with climate change forecasts may produce more severe fluctuations in the North Atlantic Oscillation. Such fluctuations would be expected to cause dramatic shifts in the reproductive rate of critically endangered North Atlantic right whales (Drinkwater et al. 2003; Greene et al. 2003b) and possibly a northward shift in the location of right whale calving areas (Kenney 2007).

Changes in global climatic patterns are also projected to have profound effect on the coastlines of every continent by increasing sea levels and increasing the intensity, if not the frequency, of hurricanes and tropical storms. Based on computer models, these phenomena would inundate nesting beaches of sea turtles, change patterns of coastal erosion and sand accretion that are necessary to maintain those beaches, and would increase the number of turtle nests that are destroyed by tropical storms and hurricanes. Further, the combination of increasing sea levels, changes in patterns of coastal erosion and accretion, and changes in rainfall patterns are likely to affect coastal estuaries, submerged aquatic vegetation, and reef ecosystems that provide foraging and rearing habitat for several species of sea turtles. Finally, changes in ocean currents associated with climate change projections would affect the migratory patterns of sea turtles. The loss of nesting beaches, by itself, would have catastrophic effect on sea turtles populations globally if they are unable to colonize any new beaches that form of if the beaches that form do not provide the sand depths, grain patterns, elevations above high tides, or temperature regimes necessary to allow turtle eggs to survive. When combined with changes in coastal habitats and ocean currents, the future climates that are forecast place sea turtles at substantially greater risk of extinction than they already face.

As of the date this Opinion was drafted, we do not know whether the computer models on which these projections are based are accurate or, if so, how far into the future these effects might become manifest because these are long-term projections. Nevertheless, based on the best scientific and commercial data available, none of these effects are likely to affect the status or trend of the endangered or threatened species we considered in our 2010 programmatic biological opinion on military readiness activities on the Mariana Islands Range Complex or the activities that would occur during the twelve month interval of the proposed Letters of Authorization.

4.3 Species Considered Further in this Biological Opinion

The rest of this section of our Opinion consists of narratives for each of the threatened and endangered species that occur in the action area and that may be adversely affected by the activities the U.S. Navy proposes to conduct. In each narrative, we present a general species description and a summary of information on the distribution and population structure of each species to provide a foundation for the exposure analyses that appear later in this Opinion. Then we summarize information on the threats to the species and the species' status given those threats to provide points of reference for the jeopardy determinations we make later in this Opinion. That is, we rely on a species' status and trend to determine whether or not an action's direct or indirect effects are likely to increase the species' probability of becoming extinct.

After the *Status* subsection of each narrative, we present information on the diving and social behavior of the different species because that behavior helps determine whether aerial and ship board surveys are likely to detect each species. We also summarize information on the vocalizations and hearing of the different species because that background information lays the foundation for our assessment of the how the different species are likely to respond to low, mid, and high frequency sonar.

More detailed background information on the status of these species and critical habitat can be found in a number of published documents including status reviews, recovery plans for the blue whale (NMFS 1998b), fin whales (NMFS 2010d), fin and sei whale (NMFS 1998a), humpback whale (NMFS 1991), sperm whale (NMFS 2010e), a status report on large whales prepared by Perry et al. (1999a) and the recovery plans for the green and hawksbill sea turtles (NMFS and USFWS 1998a; NMFS and USFWS 1998c; NMFS and USFWS 1998d; NMFS and USFWS 2007). Richardson et al. (1995) and Tyack (2000) provide detailed analyses of the functional aspects of cetacean communication and their responses to active sonar. Finally, Croll et al. (1999b), NRC (2000; 2003a; 2005), and Richardson and Wursig (1995) provide information on the potential and probable effects of active sonar on the marine animals considered in this Opinion.

4.3.1 Blue Whale

The blue whale, *Balaenoptera musculus* (Linnæus 1758), is a cosmopolitan species of baleen whale. It is the largest animal ever known to have lived on Earth: adults in the Antarctic have reached a maximum body length of about 33 m and can weigh more than 150,000 kg. The largest blue whales reported from the North Pacific are a female that measured 26.8 m (88 ft) taken at Port Hobron in 1932 (Reeves et al. 1985) and a 27.1 m (89 ft) female taken by Japanese pelagic whaling operations in 1959 (NMFS 1998b).

As is true of other baleen whale species, female blue whales are somewhat larger than males. Blue whales are identified by the following characteristics: a long-body and comparatively slender shape; a broad, flat "rostrum" when viewed from above; a proportionately smaller dorsal fin than other baleen whales; and a mottled gray color pattern that appears light blue when seen through the water.

Distribution

Blue whales are found along the coastal shelves of North America and South America (Clarke 1980; Donovan 1984; Rice 1998). In the western North Atlantic Ocean, blue whales are found from the Arctic to at least the mid-latitude waters of the North Atlantic (CETAP 1982; Gagnon and Clark 1993; Wenzel et al. 1988; Yochem and Leatherwood 1985). Blue whales have been observed frequently off eastern Canada, particularly in waters off Newfoundland, during the winter. In the summer month, they have been observed in Davis Strait (Mansfield 1985), the Gulf of St. Lawrence (from the north shore of the St. Lawrence River estuary to the Strait of Belle Isle), and off eastern Nova Scotia (Sears 1987a). In the eastern North Atlantic Ocean, blue whales have been observed off the Azores Islands, although Reiner et al. (1996) do not consider them common in that area.

In 1992, the Navy conducted an extensive acoustic survey of the North Atlantic Ocean using the Integrated Underwater Surveillance System's fixed acoustic array system (Clark 1995). Concentrations of blue whale sounds were detected in the Grand Banks off Newfoundland and west of the British Isles. In the lower latitudes, one blue whale was tracked acoustically for 43 days, during which time the animal traveled 1400 nautical miles around the western North

Atlantic from waters northeast of Bermuda to the southwest and west of Bermuda (Gagnon and Clark 1993).

In the North Pacific Ocean, blue whales have been recorded off the island of Oahu in the main Hawaiian Islands and off Midway Island in the western edge of the Hawaiian Archipelago (Barlow 2006; Northrop et al. 1971; Thompson and Friedl 1982), although blue whales are rarely sighted in Hawaiian waters and have not been reported to strand in the Hawaiian Islands.

In the eastern tropical Pacific Ocean, the Costa Rica Dome appears to be important for blue whales based on the high density of prey (euphausiids) available in the Dome and the number of blue whales that appear to reside there (Reilly and Thayer 1990). Blue whales have been sighted in the Dome area in every season of the year, although their numbers appear to be highest from June through November. Blue whales have also been reported year-round in the northern Indian Ocean, with sightings in the Gulf of Aden, Persian Gulf, Arabian Sea, and across the Bay of Bengal to Burma and the Strait of Malacca (Mizroch et al. 1984). The migratory movements of these whales are unknown.

Blue whales in the eastern Pacific winter from California south; in the western Pacific, they winter from the Sea of Japan, the East China and Yellow Seas, and the Philippine Sea. Blue whales occur in summer foraging areas in the Chukchi Sea, the Sea of Okhotsk, around the Aleutian Islands, and the Gulf of Alaska. Nishiwaki (1966) reported that blue whales occur in the Aleutian Islands and in the Gulf of Alaska. An array of hydrophones, deployed in October 1999, detected two blue whale call types in the Gulf of Alaska (Stafford 2003). Fifteen blue whale sightings off British Columbia and in the Gulf of Alaska have been made since 1997 (Calambokidis et al. 2009). Three of these photographically verified sightings were in the northern Gulf of Alaska within 71 nm of each other and were less than 100 nm offshore (Calambokidis et al. 2009).

Population Structure

For this and all subsequent species, the term "population" refers to groups of individuals whose patterns of increase or decrease in abundance over time are determined by internal dynamics (births resulting from sexual interactions between individuals in the group and deaths of those individuals) rather than external dynamics (immigration or emigration). This definition is a reformulation of definitions articulated by Futuymda (1986) and Wells and Richmond (1995) and is more restrictive than those uses of 'population' that refer to groups of individuals that co-occur in space and time but do not have internal dynamics that determine whether the size of the group increases or decreases over time (see review by Wells and Richmond 1995). The definition we apply is important to section 7 consultations because such concepts as 'population decline,' 'population collapse,' 'population extinction,' and 'population recovery' apply to the restrictive definition of 'population' but do not explicitly apply to alternative definitions. As a result, we do not treat the different whale "stocks" recognized by the International Whaling Commission or other authorities as populations unless those distinctions were clearly based on

demographic criteria. We do, however, acknowledge those "stock" distinctions in these narratives.

At least three subspecies of blue whales have been identified based on body size and geographic distribution (*B. musculus intermedia*, which occurs in the higher latitudes of the Southern Oceans, *B. m. musculus*, which occurs in the Northern Hemisphere, and *B. m. brevicauda* which occurs in the mid-latitude waters of the southern Indian Ocean and north of the Antarctic convergence), but this consultation will treat them as a single entity. Readers who are interested in these subspecies will find more information in Gilpatrick et al. (1997), Kato et al. (1995), Omura et al. (1970), and Ichihara (1966).

In addition to these subspecies, the International Whaling Commission's Scientific Committee has formally recognized one blue whale population in the North Pacific (Donovan 1991), although there is increasing evidence that there may be more than one blue whale population in the Pacific Ocean (Barlow 1995; Gilpatrick et al. 1997; Mizroch et al. 1984; Ohsumi and Masaki. 1972). For example, studies of the blue whales that winter off Baja California and in the Gulf of California suggest that these whales are morphologically distinct from blue whales of the western and central North Pacific (Gilpatrick et al. 1997), although these differences might result from differences in the productivity of their foraging areas more than genetic differences (Barlow et al. 1997; Calambokidis et al. 1990; Sears 1987b). A population of blue whales that has distinct vocalizations inhabits the northeast Pacific from the Gulf of Alaska to waters off Central America (Gregr et al. 2000; Mate et al. 1998; Stafford 2003). We assume that this population is the one affected by the activities considered in this Opinion.

Natural Threats

Natural causes of mortality in blue whales are largely unknown, but probably include predation and disease (not necessarily in their order of importance). Blue whales are known to become infected with the nematode *Carricauda boopis* (Baylis 1928), which are believed to have caused fin whales to die as a result of renal failure (Lambertsen 1986); see additional discussion under Fin whales). Killer whales and sharks are also known to attack, injure, and kill very young or sick fin and humpback whales and probably hunt blue whales as well (Perry et al. 1999a).

Anthropogenic Threats

Two human activities are known to threaten blue whales; whaling and shipping. Historically, whaling represented the greatest threat to every population of blue whales and was ultimately responsible for listing blue whales as an endangered species. As early as the mid-seventeenth century, the Japanese were capturing blue, fin, and other large whales using a fairly primitive open-water netting technique (Tonnessen and Johnsen 1982). In 1864, explosive harpoons and steam-powered catcher boats were introduced in Norway, allowing the large-scale exploitation of previously unobtainable whale species.

From 1889 to 1965, whalers killed about 5,761 blue whales in the North Pacific Ocean (Hill et al. 1999). From 1915 to 1965, the number of blue whales captured declined continuously (Mizroch et al. 1984). Evidence of a population decline was seen in the catch data from Japan. In

1912, whalers captured 236 blue whales; in 1913, 58 blue whales; in 194, 123 blue whales; from 1915 to 1965, the number of blue whales captured declined continuously (Mizroch et al. 1984). In the eastern North Pacific, whalers killed 239 blue whales off the California coast in 1926. And, in the late 1950s and early 1960s, Japanese whalers killed 70 blue whales per year off the Aleutian Islands (Mizroch et al. 1984).

Although the International Whaling Commission banned commercial whaling in the North Pacific in 1966, Soviet whaling fleets continued to hunt blue whales in the North Pacific for several years after the ban. Surveys conducted in these former-whaling areas in the 1980s and 1990s failed to find any blue whales (Forney and Brownell Jr. 1996). By 1967, Soviet scientists wrote that blue whales in the North Pacific Ocean (including the eastern Bering Sea and Prince William Sound) had been so overharvested by Soviet whaling fleets that some scientists concluded that any additional harvests were certain to cause the species to become extinct in the North Pacific (Latishev 2007). As its legacy, whaling has reduced blue whales to a fraction of their historic population size and, as a result, makes it easier for other human activities to push blue whales closer to extinction. Otherwise, whaling currently does not threaten blue whale populations.

In 1980, 1986, 1987, and 1993, ship strikes have been implicated in the deaths of blue whales off California (Barlow 1997). More recently, Berman-Kowalewski et al. (2010) reported that between 1988 and 2007, 21 blue whale deaths were reported along the California coast, typically one or two cases annually. In addition, several photo-identified blue whales from California waters were observed with large scars on their dorsal areas that may have been caused by ship strikes. Studies have shown that blue whales respond to approaching ships in a variety of ways, depending on the behavior of the animals at the time of approach, and speed and direction of the approaching vessel. While feeding, blue whales react less rapidly and with less obvious avoidance behavior than whales that are not feeding (Sears 1983). Within the St. Lawrence Estuary, blue whales are believed to be affected by large amounts of recreational and commercial vessel traffic. Blue whales in the St. Lawrence appeared more likely to react to these vessels when boats made fast, erratic approaches or sudden changes in direction or speed (Edds and Macfarlane 1987).

Although commercial fisheries using large gill nets or other large set gears poses some entanglement risk to marine mammals, there is little direct evidence of blue whale mortality from fishing gears. Therefore it is difficult to estimate the numbers of blue whales killed or 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 becoming entangled and cause little damage to nets (Carretta et al. 2008).

Status and Trends

Blue whales (including all subspecies) were originally listed as endangered in 1970 (35 FR 18319), and this status continues since the inception of the ESA in 1973. Blue whales are listed as endangered on the IUCN Red List of Threatened Animals (IUCN 2010). They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for blue whales.

It is difficult to assess the current status of blue whales because (1) there is no general agreement on the size of the blue whale population prior to whaling and (2) estimates of the current size of the different blue whale populations vary widely. We may never know the size of the blue whale population prior to whaling, although some authors have concluded that their population numbered about 200,000 animals before whaling. Similarly, estimates of the global abundance of blue whales are uncertain. Since the cessation of whaling, the global population of blue whales has been estimated to range from 11,200 to 13,000 animals (Maser et al. 1981). These estimates, however, are more than 20 years old.

A lot of uncertainty surrounds estimates of blue whale abundance in the North Pacific Ocean. Barlow (1994) estimated the North Pacific population of blue whales at approximately 1,400 to 1,900. Barlow (1995) estimated the abundance of blue whales off California at 2,200 individuals. Wade and Gerrodette (1993) and Barlow et al. (1997) estimated there were a minimum of 3,300 blue whales in the North Pacific Ocean in the 1990s.

The size of the blue whale population in the North Atlantic is also uncertain. The population has been estimated to number from a few hundred individuals (Allen 1970; Mitchell 1974) to 1,000 to 2,000 individuals (Sigurjónsson 1995). Gambell (1976) estimated there were between 1,100 and 1,500 blue whales in the North Atlantic before whaling began and Braham (1991) estimated there were between 100 and 555 blue whales in the North Atlantic during the late 1980s and early 1990s. Sears et al. (1987) identified over 300 individual blue whales in the Gulf of St. Lawrence, which provides a minimum estimate for their population in the North Atlantic. Sigurjónsson and Gunnlaugson (1990) concluded that the blue whale population had been increasing since the late 1950s and argued that the blue whale population had increased at an annual rate of about 5 percent between 1979 and 1988, although the level of confidence we can place in these estimates is low.

Estimates of the number of blue whales in the Southern Hemisphere range from 5,000 to 6,000 (Yochem and Leatherwood 1985) with an average rate of increase that has been estimated at between 4 and 5 percent per year. Butterworth et al. (1993), however, estimated the Antarctic population at 710 individuals. More recently, Stern (2001) estimated the blue whale population in the Southern Ocean at between 400 and 1,400 animals (CV 0.4). The pygmy blue whale population has been estimated at 6,000 individuals (Yochem and Leatherwood 1985).

The information available on the status and trend of blue whales do not allow us to reach any conclusions about the extinction risks facing blue whales as a species, or particular populations

of blue whales. With the limited data available on blue whales, we do not know whether these whales exist at population sizes large enough to avoid demographic phenomena that are known to increase the extinction probability of species that exist as "small" populations (that is, "small" populations experience phenomena such as demographic stochasticity, inbreeding depression, and Allee effects, among others, that cause their population size to become a threat in and of itself) or if blue whales are threatened more by exogenous threats such as anthropogenic activities (primarily whaling and ship strikes) or natural phenomena (such as disease, predation, or changes in the distribution and abundance of their prey in response to changing climate).

Diving and Social Behavior

Blue whales spend more than 94 percent of their time underwater (Lagerquist et al. 2000). Generally, blue whales dive 5-20 times at 12-20 sec intervals before a deep dive of 3-30 min (Croll et al. 1999a; Leatherwood et al. 1976; Maser et al. 1981; Yochem and Leatherwood 1985). Average foraging dives are 140 m deep and last for 7.8 min (Croll et al. 2001a). Non-foraging dives are shallower and shorter, averaging 68 m and 4.9 min (Croll et al. 2001a). However, dives of up to 300 m are known (Calambokidis et al. 2003). Nighttime dives are generally shallower (50 m).

Blue whales occur singly or in groups of two or three (Aguayo 1974; Mackintosh 1965; Nemoto 1964; Pike and Macaskie 1969; Ruud 1956; Slijper 1962). However, larger foraging aggregations, even with other species such as fin whales, are regularly reported (Fiedler et al. 1998; Schoenherr 1991). Little is known of the mating behavior of blue whales.

Vocalization and Hearing

Blue whales produce prolonged low-frequency vocalizations that include moans in the range from 12.5-400 Hz, with dominant frequencies from 16-25 Hz, and songs that span frequencies from 16-60 Hz that last up to 36 sec repeated every 1 to 2 min (see McDonald et al. 1995). Berchok et al. (2006) examined vocalizations of St. Lawrence blue whales and found mean peak frequencies ranging from 17.0-78.7 Hz. Reported source levels are 180-188 dB re 1μPa, but may reach 195 dB re 1μPa (Aburto et al. 1997; Clark and Gagnon 2004; Ketten 1998; McDonald et al. 2001). Samaran et al. (2010) estimated Antarctic blue whale calls in the Indian Ocean at 179 ± 5 dB re 1 μPa_{rms} -1 m in the 17-30 Hz range and pygmy blue whale calls at 175± 1 dB re 1 μPa_{rms} -1 m in the 17-50 Hz range.

As with other baleen whale vocalizations, blue whale vocalization function is unknown, although numerous hypotheses exist (maintaining spacing between individuals, recognition, socialization, navigation, contextual information transmission, and location of prey resources) (Edds-Walton 1997; Payne and Webb. 1971; Thompson et al. 1992). Intense bouts of long, patterned sounds are common from fall through spring in low latitudes, but these also occur less frequently while in summer high-latitude feeding areas. Short, rapid sequences of 30-90 Hz calls are associated with socialization and may be displays by males based upon call seasonality and structure. The low-frequency sounds produced by blue whales can, in theory, travel long distances, and it is possible that such long-distance communication occurs (Edds-Walton 1997; Payne and Webb.

1971). The long-range sounds may also be used for echolocation in orientation or navigation (Tyack 1999).

Cetaceans have an auditory anatomy that follows the basic mammalian pattern, with some modifications to adapt to the demands of hearing in the sea. The typical mammalian ear is divided into the outer ear, middle ear, and inner ear. The outer ear is separated from the inner ear by the tympanic membrane, or eardrum. In terrestrial mammals, the outer ear, eardrum, and middle ear function to transmit airborne sound to the inner ear, where the sound is detected in a fluid. Since cetaceans already live in a fluid medium, they do not require this matching, and thus do not have an air-filled external ear canal. The inner ear is where sound energy is converted into neural signals that are transmitted to the central nervous system via the auditory nerve. Acoustic energy causes the basilar membrane in the cochlea to vibrate. Sensory cells at different positions along the basilar membrane are excited by different frequencies of sound (Tyack 1999). Baleen whales have inner ears that appear to be specialized for low-frequency hearing. In a study of the morphology of the mysticete auditory apparatus, Ketten (1997) hypothesized that large mysticetes have acute infrasonic hearing.

Direct studies of blue whale hearing have not been conducted, but it is assumed that blue whales can hear the same frequencies that they produce (low-frequency) and are likely most sensitive to this frequency range (Ketten 1997; Richardson et al. 1995).

Critical Habitat

Critical habitat has not been designated for blue whales.

4.3.2 Fin Whale

The fin whale, *Balaenoptera physalus* (Linnæus 1758), is a well-defined, cosmopolitan species of baleen whale (Gambell 1985a). Fin whales are the second-largest whale species by length. Fin whales are long-bodied and slender, with a prominent dorsal fin set about two-thirds of the way back on the body. The streamlined appearance can change during feeding when the pleated throat and chest area becomes distended by the influx of prey and seawater, giving the animal a tadpole-like appearance. The basic body color of the fin whale is dark gray dorsally and white ventrally, but the pigmentation pattern is complex. The lower jaw is gray or black on the left side and creamy white on the right side. This asymmetrical coloration extends to the baleen plates as well, and is reversed on the tongue. Individually distinctive features of pigmentation, along with dorsal fin shapes and body scars, have been used in photo-identification studies (Agler et al. 1990). Fin whales live 70-80 years (Kjeld 1982).

Distribution

Fin whales are distributed widely in every ocean except the Arctic Ocean. In the North Atlantic Ocean, fin whales occur in summer foraging areas from the coast of North America to the Arctic, around Greenland, Iceland, northern Norway, Jan Meyers, Spitzbergen, and the Barents Sea. In the western Atlantic, they winter from the edge of sea ice south to the Gulf of Mexico and the West Indies. In the eastern Atlantic, they winter from southern Norway, the Bay of Biscay, and Spain with some whales migrating into the Mediterranean Sea (Gambell 1985a).

In the Southern Hemisphere, fin whales are distributed broadly south of 50° S in the summer and migrate into the Atlantic, Indian, and Pacific Oceans in the winter, along the coast of South America (as far north as Peru and Brazil), Africa, and the islands in Oceania north of Australia and New Zealand (Gambell 1985a).

Fin whales are common off the Atlantic coast of the United States in waters immediately off the coast seaward to the continental shelf (about the 1,000-fathom contour). In this region, they tend to occur north of Cape Hatteras where they accounted for about 46 percent of the large whales observed in surveys conducted between 1978 and 1982. During the summer months, fin whales in this region tend to congregate in feeding areas between 41°20'N and 51°00'N, from shore seaward to the 1,000-fathom contour. This species preys opportunistically on both invertebrates and fish (Watkins et al. 1984). They feed by filtering large volumes of water for the associated prey.

In the North Pacific Ocean, fin whales occur in summer foraging areas in the Chukchi Sea, the Sea of Okhotsk, around the Aleutian Islands, and the Gulf of Alaska; in the eastern Pacific, they occur south to California; in the western Pacific, they occur south to Japan. Fin whales in the eastern Pacific winter from California south; in the western Pacific, they winter from the Sea of Japan, the East China and Yellow Seas, and the Philippine Sea (Gambell 1985a). The overall distribution may be based on prey availability. Fin whales are larger and faster than humpback and right whales and are less concentrated in nearshore environments.

Population Structure

Fin whales have two recognized subspecies: *Balaoptera physalus physalus* occurs in the North Atlantic Ocean while *B. p. quoyi* (Fischer 1829) occurs in the Southern Ocean. Globally, fin whales are sub-divided into three major groups: Atlantic, Pacific, and Antarctic. Within these major areas, different organizations use different population structure.

In the North Atlantic Ocean, the International Whaling Commission recognizes seven management units or “stocks” of fin whales: (1) Nova Scotia, (2) Newfoundland-Labrador, (3) West Greenland, (4) East Greenland-Iceland, (5) North Norway, (6) West Norway-Faroe Islands, and (7) British Isles-Spain-Portugal. In addition, the population of fin whales that resides in the Ligurian Sea, in the northwestern Mediterranean Sea, is believed to be genetically distinct from other fin whale populations.

In the North Pacific Ocean, the International Whaling Commission recognizes two “stocks”: (1) East China Sea and (2) rest of the North Pacific (Donovan 1991). However, Mizroch et al. (1984) concluded that there were five possible “stocks” of fin whales within the North Pacific based on histological analyses and tagging experiments: (1) East and West Pacific that intermingle around the Aleutian Islands; (2) East China Sea; (3) British Columbia; (4) Southern-Central California to Gulf of Alaska; and (5) Gulf of California. Based on genetic analyses, Berube et al. (1998) concluded that fin whales in the Sea of Cortez represent an isolated population that has very little genetic exchange with other populations in the North Pacific Ocean

(although the geographic distribution of this population and other populations can overlap seasonally). They also concluded that fin whales in the Gulf of St. Lawrence and Gulf of Maine are distinct from fin whales found off Spain and in the Mediterranean Sea.

Regardless of how different authors structure the fin whale population, mark-recapture studies have demonstrated that individual fin whales migrate between management units (Mitchell 1974; Sigurjonsson et al. 1989), which suggests that these management units are not geographically isolated populations.

Mizroch et al. (1984) identified five fin whale "feeding aggregations" in the Pacific Ocean: (1) an eastern group that move along the Aleutians, (2) a western group that move along the Aleutians (Berzin and Rovnin 1966; Nasu 1974); (3) an East China Sea group; (4) a group that moves north and south along the west coast of North America between California and the Gulf of Alaska (Rice 1974); and (5) a group centered in the Sea of Cortez (Gulf of California).

Hatch (2004) reported that fin whale vocalizations among five regions of the eastern North Pacific were heterogeneous: the Gulf of Alaska, the northeast North Pacific (Washington and British Columbia), the southeast North Pacific (California and northern Baja California), the Gulf of California, and the eastern tropical Pacific.

Sighting data show no evidence of migration between the Sea of Cortez and adjacent areas in the Pacific, but seasonal changes in abundance in the Sea of Cortez suggests that these fin whales might not be isolated (Tershy et al. 1993). Nevertheless, Bérubé et al. (2002) concluded that the Sea of Cortez fin whale population is genetically distinct from the oceanic population and have lower genetic diversity, which suggests that these fin whales might represent an isolated population.

Natural Threats

Natural sources and rates of mortality are largely unknown, but Aguilar and Lockyer (1987) suggested annual natural mortality rates might range from 0.04 to 0.06 for northeast Atlantic fin whales. The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure and may be preventing some fin whale populations from recovering (Lambertsen 1983). Adult fin whales engage in flight responses (up to 40 km/h) to evade killer whales, which involves high energetic output, but show little resistance if overtaken (Ford and Reeves 2008). Killer whale or shark attacks may also result in serious injury or death in very young and sick individuals (Perry et al. 1999a).

Anthropogenic Threats

Fin whales have undergone significant exploitation, but are currently protected under the IWC. Fin whales are still hunted in subsistence fisheries off West Greenland. In 2004, five males and six females were killed, and two other fin whales were struck and lost. In 2003, two males and four females were landed and two others were struck and lost (IWC 2005). Between 2003 and 2007, the IWC set a catch limit of up to 19 fin whales in this subsistence fishery. However, the scientific recommendation was to limit the number killed to four individuals until accurate

populations could be produced (IWC 2005). The Japanese whalers plan to kill 50 whales per year starting in the 2007-2008 season and continuing for the next 12 years (IWC 2006; Nishiwaki et al. 2006).

Fin whales experience significant injury and mortality from fishing gear and ship strikes (Carretta et al. 2007; Douglas et al. 2008; Lien 1994; Perkins and Beamish 1979; Waring et al. 2007). Between 1969 and 1990, 14 fin whales were captured in coastal fisheries off Newfoundland and Labrador; of these seven are known to have died because of capture (Lien 1994; Perkins and Beamish 1979). In 1999, one fin whale was reported killed in the Gulf of Alaska pollock trawl fishery and one was killed the same year in the offshore drift gillnet fishery (Angliss and Outlaw 2005; Carretta and Chivers. 2004). According to Waring et al. (2007), four fin whales in the western North Atlantic died or were seriously injured in fishing gear, while another five were killed or injured as a result of ship strikes between January 2000 and December 2004.

Jensen and Silber (2004) review of the NMFS' ship strike database revealed fin whales as the most frequently confirmed victims of ship strikes (26 percent of the recorded ship strikes [n = 75/292 records]), with most collisions occurring off the east coast, followed by the west coast of the U.S. and Alaska/Hawai′i. Between 1999-2005, there were 15 reports of fin whales strikes by vessels along the U.S. and Canadian Atlantic coasts (Cole et al. 2005; Nelson et al. 2007). Of these, 13 were confirmed, resulting in the deaths of 11 individuals. Five of seven fin whales stranded along Washington State and Oregon showed evidence of ship strike with incidence increasing since 2002 (Douglas et al. 2008). Similarly, 2.4 percent of living fin whales from the Mediterranean show ship strike injury and 16 percent of stranded individuals were killed by vessel collision (Panigada et al. 2006). There are also numerous reports of ship strikes off the Atlantic coasts of France and England (Jensen and Silber 2004).

Management measures aimed at reducing the risk of ships hitting right whales should also reduce the risk of collisions with fin whales. In the Bay of Fundy, recommendations for slower vessel speeds to avoid right whale ship strike appear to be largely ignored (Vanderlaan et al. 2008). However, new rules for seasonal (June through December) slowing of vessel traffic to 10 knots and changing shipping lanes by less than one nautical mile to avoid the greatest concentrations of right whales are predicted to be capable of reducing ship strike mortality by 27 percent in the Bay of Fundy region.

The organochlorines DDE, DDT, and PCBs have been identified from fin whale blubber, but levels are lower than in toothed whales due to the lower level in the food chain that fin whales feed at (Aguilar and Borrell 1988; Borrell 1993; Borrell and Aguilar 1987; Henry and Best 1983; Marsili and Focardi 1996). Females contained lower burdens than males, likely due to mobilization of contaminants during pregnancy and lactation (Aguilar and Borrell 1988; Gauthier et al. 1997). Contaminant levels increase steadily with age until sexual maturity, at which time levels begin to drop in females and continue to increase in males (Aguilar and Borrell 1988).

Climate change also presents a potential threat to fin whales, particularly in the Mediterranean Sea, where fin whales appear to rely exclusively upon northern krill as a prey source. These krill occupy the southern extent of their range and increases in water temperature could result in their decline and that of fin whales in the Mediterranean Sea (Gambaiani et al. 2009).

Status and Trends

Fin whales were originally listed as endangered in 1970 (35 FR 18319), and this status continues since the inception of the ESA in 1973. Although fin whale population structure remains unclear, various abundance estimates are available. Pre-exploitation fin whale abundance is estimated at 464,000 individuals worldwide; the estimate for 1991 was roughly 25 percent of this (Braham 1991). Historically, worldwide populations were severely depleted by commercial whaling, with more than 700,000 whales harvested in the twentieth century (Cherfas 1989).

The status and trend of fin whale populations is largely unknown. Over 26,000 fin whales were harvested between 1914-1975 (Braham 1991 as cited in Perry et al. 1999a). NMFS estimates roughly 3,000 individuals occur off California, Oregon, and Washington based on ship surveys in summer/autumn of 1996, 2001, and 2005, of which estimates of 283 and 380 have been made for Oregon and Washington alone (Barlow 2003; Barlow and Taylor 2001; Forney 2007). Barlow (2003) noted densities of up to 0.0012 individuals/km^2 off Oregon and Washington and up to 0.004 individuals/km^2 off California.

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 Gulf of Alaska since the cessation of whaling activities to assess abundance of large whale stocks. Fin whale calls have been recorded year-round in the Gulf of Alaska, but are most prevalent from August-February (Moore et al. 1998; Moore et al. 2006).

Regardless of which of these estimates, if any, have the closest correspondence to the actual size and trend of the fin whale population, all of these estimates suggest that the global population of fin whales consists of tens of thousands of individuals and that the North Atlantic population consists of at least 2,000 individuals. Based on ecological theory and demographic patterns derived from several hundred imperiled species and populations, fin whales appear to exist at population sizes that are large enough to avoid demographic phenomena that are known to increase the extinction probability of species that exist as “small” populations (that is, “small” populations experience phenomena such as demographic stochasticity, inbreeding depression, and Allee effects, among others, that cause their population size to become a threat in and of itself). As a result, we assume that fin whales are likely to be threatened more by exogenous threats such as anthropogenic activities (primarily whaling, entanglement, and ship strikes) or natural phenomena (such as disease, predation, or changes in the distribution and abundance of their prey in response to changing climate) than endogenous threats caused by the small size of their population.

Nevertheless, based on the evidence available, the number of fin whales that are recorded to have been killed or injured in the past 20 years by human activities or natural phenomena, does not appear to be increasing the extinction probability of fin whales, although it may slow the rate at which they recover from population declines that were caused by commercial whaling.

Diving and Social Behavior

The amount of time fin whales spend at the surface varies. Some authors have reported that fin whales make 5-20 shallow dives, each of 13-20 s duration, followed by a deep dive of 1.5-15 min (Gambell 1985a; Lafortuna et al. 2003; Stone et al. 1992). Other authors have reported that the fin whale's most common dives last 2-6 min (Hain et al. 1992; Watkins 1981b). The most recent data support average dives of 98 m and 6.3 min for foraging fin whales, while non-foraging dives are 59 m and 4.2 min (Croll et al. 2001a). However, Lafortuna et al. (1999) found that foraging fin whales have a higher blow rate than when traveling. Foraging dives in excess of 150 m are known (Panigada et al. 1999). In waters off the U.S. Atlantic Coast, individuals or duos represented about 75 percent of sightings during the Cetacean and Turtle Assessment Program (Hain et al. 1992).

Individuals or groups of less than five individuals represented about 90 percent of the observations. Barlow (2003) reported mean group sizes of 1.1–4.0 during surveys off California, Oregon, and Washington.

Vocalization and Hearing

Fin whales produce a variety of low-frequency sounds in the 10-200 Hz range (Edds 1988; Thompson et al. 1992; Watkins 1981a; Watkins et al. 1987). Typical vocalizations are long, patterned pulses of short duration (0.5-2 s) in the 18-35 Hz range, but only males are known to produce these (Clark et al. 2002; Patterson and Hamilton 1964). Richardson et al. (1995) reported the most common sound as a 1 s vocalization of about 20 Hz, occurring in short series during spring, summer, and fall, and in repeated stereotyped patterns in winter. Au (2000) reported moans of 14-118 Hz, with a dominant frequency of 20 Hz, tonal vocalizations of 34-150 Hz, and songs of 17-25 Hz (Cummings and Thompson 1994; Edds 1988; Watkins 1981a). Source levels for fin whale vocalizations are 140-200 dB re 1μPa-m (see also Clark and Gagnon 2004; as compiled by Erbe 2002b). The source depth of calling fin whales has been reported to be about 50 m (Watkins et al. 1987).

Although their function is still in doubt, low-frequency fin whale vocalizations travel over long distances and may aid in long-distance communication (Edds-Walton 1997; Payne and Webb. 1971). During the breeding season, fin whales produce pulses in a regular repeating pattern, which have been proposed to be mating displays similar to those of humpbacks (Croll et al. 2002). These vocal bouts last for a day or longer (Tyack 1999).

Cetaceans have an auditory anatomy that follows the basic mammalian pattern, with some modifications to adapt to the demands of hearing in the sea. The typical mammalian ear is divided into the outer ear, middle ear, and inner ear. The outer ear is separated from the inner ear by the tympanic membrane, or eardrum. In terrestrial mammals, the outer ear, eardrum, and

middle ear function to transmit airborne sound to the inner ear, where the sound is detected in a fluid. Since cetaceans already live in a fluid medium, they do not require this matching, and thus do not have an air-filled external ear canal. The inner ear is where sound energy is converted into neural signals that are transmitted to the central nervous system via the auditory nerve. Acoustic energy causes the basilar membrane in the cochlea to vibrate. Sensory cells at different positions along the basilar membrane are excited by different frequencies of sound (Tyack 1999). Baleen whales have inner ears that appear to be specialized for low-frequency hearing. In a study of the morphology of the mysticete auditory apparatus, Ketten (1997) hypothesized that large mysticetes have acute infrasonic hearing.

Direct studies of fin whale hearing have not been conducted, but it is assumed that fin whales can hear the same frequencies that they produce (low) and are likely most sensitive to this frequency range (Ketten 1997; Richardson et al. 1995).

Critical Habitat

Critical habitat has not been designated for fin whales.

4.3.3 Humpback Whale

Humpback whales (*Megaptera novaeangliae*) are distinguished from other whales in the same Family (Balaenopteridae) by extraordinarily long flippers (up to 5 m or about 1/3 total body length), a more robust body, fewer throat grooves (14-35), more variable dorsal fin, and utilization of very long (up to 30 min.), complex, repetitive vocalizations (songs) (Payne and McVay 1971) during courtship. Their grayish-black baleen plates, approximately 270-440 on each side of the jaw, are intermediate in length (6570 cm) to those of other baleen whales. Humpbacks in different geographical areas vary somewhat in body length, but maximum recorded size is 18m (Winn and Reichley 1985).

The whales are generally dark on the back, but the flippers, sides and ventral surface of the body and flukes may have substantial areas of natural white pigmentation plus acquired scars (white or black). Researchers distinguish individual humpbacks by the apparently unique black and white patterns on the underside of the flukes as well as other individually variable features (Glockner and Venus 1983; Katona and Whitehead 1981; Kaufman and Osmond 1987).

Distribution

Humpback whales are a cosmopolitan species that occur in the Atlantic, Indian, Pacific, and Southern oceans. Humpback whales migrate seasonally between warmer, tropical or sub-tropical waters in winter months (where they breed and give birth to calves, although feeding occasionally occurs) and cooler, temperate or sub-Arctic waters in summer months (where they feed). In both regions, humpback whales tend to occupy shallow, coastal waters. However, migrations are undertaken through deep, pelagic waters (Winn and Reichley 1985).

In the North Pacific Ocean, the summer range of humpback whales includes coastal and inland waters from Point Conception, California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk (Tomlin

1967, Nemoto 1957, Johnson and Wolman 1984 as cited in NMFS 1991). These whales migrate to Hawai'i, southern Japan, the Mariana Islands (Fulling et al. 2011), and Mexico during the winter. Most contemporary reports of humpback whales in the Marianas place them there from February and March (Fulling et al. 2011; SRS-Parsons 2007).

Population Structure

Descriptions of the population structure of humpback whales differ depending on whether an author focuses on where humpback whales winter or where they feed. During winter months in northern or southern hemispheres, adult humpback whales migrate to specific areas in warmer, tropical waters to reproduce and give birth to calves. During summer months, humpback whales migrate to specific areas in northern temperate or sub-arctic waters to forage. In summer months, humpback whales from different "reproductive areas" will congregate to feed; in the winter months, whales will migrate from different foraging areas to a single wintering area. In either case, humpback whales appear to form "open" populations; that is, populations that are connected through the movement of individual animals.

North Pacific. Based on genetic and photo-identification studies, the NMFS currently recognizes four stocks, likely corresponding to populations, of humpback whales in the North Pacific Ocean: two in the eastern North Pacific, one in the central North Pacific, and one in the western Pacific (Hill and DeMaster 1998). However, gene flow between them may exist. Humpback whales summer in coastal and inland waters from Point Conception, California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk (Johnson and Wolman 1984; Nemoto 1957; Tomilin 1967). These whales migrate to Hawai′i, southern Japan, the Mariana Islands, and Mexico during winter. However, more northerly penetrations in Arctic waters occur on occasion (Hashagen et al. 2009). The central North Pacific population winters in the waters around Hawai′i while the eastern North Pacific population (also called the California-Oregon-Washington-Mexico stock) winters along Central America and Mexico. However, Calambokidis et al. (1997) identified individuals from several populations wintering (and potentially breeding) in the areas of other populations, highlighting the potential fluidity of population structure.

Between 2004 and 2006, an international group of whale researchers coordinated their surveys to conduct a comprehensive assessment of the population structure, levels of abundance, and status of humpback whales in the North Pacific (Calambokidis et al. 2008). That effort identified a total of 7,971 unique individuals from photographs taken during close approaches. Based on the data collected during that study, Calambokidis et al. (2008) estimated the rates of exchange among humpback whales in different areas in the Hawaiian Islands that are presented in Table 4.

Herman (1979) presented extensive evidence that humpback whales associated with the main Hawaiian Islands immigrated there only in the past 200 years. Winn and Reichley (1985) identified genetic exchange between the humpback whales that winter off Hawai′i and Mexico (with further mixing on feeding areas in Alaska) and suggested that humpback whales that winter in Hawai′i may have emigrated from Mexican wintering areas. A "population" of humpback

whales winters in the South China Sea east through the Philippines, Ryukyu Retto, Ogasawara Gunto, Mariana Islands, and Marshall Islands, with occurrence in the Mariana Islands, at Guam, Rota, and Saipan from January-March (Darling and Cerchio 1993; Eldredge 1991; Eldredge 2003; Rice 1998). During summer, whales from this population migrate to the Kuril Islands, Bering Sea, Aleutian Islands, Kodiak, Southeast Alaska, and British Columbia to feed (Angliss and Outlaw 2008; Calambokidis 1997; Calambokidis et al. 2001).

Separate feeding groups of humpback whales are thought to inhabit western U.S. and Canadian waters, with the boundary between them located roughly at the U.S./Canadian border. The southern feeding ground ranges between 32°-48°N, with limited interchange with areas north of Washington State (Calambokidis et al. 2004; Calambokidis et al. 1996). Humpback whales feed along the coasts of Oregon and Washington from May-November, with peak numbers reported May-September, when they are the most commonly reported large cetacean in the region (Calambokidis and Chandler. 2000; Calambokidis et al. 2004; Dohl 1983; Green et al. 1992). Off Washington State, humpback whales concentrate between Juan de Fuca Canyon and the outer edge of the shelf break in a region called "the Prairie," near Barkley and Nitnat canyons, in the Blanco upwelling zone, and near Swiftsure Bank (Calambokidis et al. 2004). Humpback whales also tend to congregate near Heceta Bank off the coast of Oregon (Green et al. 1992). Additional data suggest that further subdivisions in feeding groups may exist, with up to six feeding groups present between Kamchatka and southern California (Witteveen et al. 2009).

Table 4. Rates of exchange among humpback whales in sub-areas in the Hawaiian Islands based on data presented in Calambokidis et al. (2008). [1]

Sub-Area	Kaua'i	Oahu	Penguin Bank[2]	Moloka'i	Maui	Hawai'i
Kaua'i	**203 (0.0793)**	1 (0.0049)	0 (0.0000)	4 (0.0197)	29 (0.1429)	2 (0.0099)
O'ahu		**89 (0.0348)**	0 (0.0000)	5 (0.0562)	20 (0.2247)	9 (0.1011)
Penguin Bank			**34 (0.0133)**	3 (0.0882)	4 (0.1176)	3 (0.0882)
Moloka'i				**201 (0.0785)**	61 (0.3035)	12 (0.0597)
Maui					**1526 (0.596)**	99 (0.0649)
Hawai'i						**507 (0.1980)**

1 *Numbers along the diagonal are the total number of individuals that were identified in a sub-area (highlighted in bold), number in the sub-diagonals are the number of individuals from one sub-area that were identified in other areas. Numbers in parentheses are percentages.*

2 *Penguin Bank is located off the southwest tip of the island of Molokai and is an important shallow, marine habitat that is part of the Hawaiian Islands Humpback Whale National Marine Sanctuary.*

Natural Threats

Natural sources and rates of mortality of humpback whales are not well known. Based upon prevalence of tooth marks, attacks by killer whales appear to be highest among humpback

whales migrating between Mexico and California, although populations throughout the Pacific Ocean appear to be targeted to some degree (Steiger et al. 2008). Juveniles appear to be the primary age group targeted. Humpback whales engage in grouping behavior, flailing tails, and rolling extensively to fight off attacks. Calves remain protected near mothers or within a group and lone calves have been known to be protected by presumably unrelated adults when confronted with attack (Ford and Reeves 2008).

Parasites and biotoxins from red-tide blooms are other potential causes of mortality (Perry et al. 1999a). The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure in humpback whales and may be preventing some populations from recovering (Lambertsen 1992). Studies of 14 humpback whales that stranded along Cape Cod between November 1987 and January 1988 indicate they apparently died from a toxin produced by dinoflagellates during this period.

Anthropogenic Threats

Three human activities are known to threaten humpback whales: whaling, commercial fishing, and shipping. Historically, whaling represented the greatest threat to every population of whales and was ultimately responsible for listing several species as endangered.

Humpback whales are also killed or injured during interactions with commercial fishing gear. Like fin whales, humpback whales have been entangled by fishing gear off Newfoundland and Labrador, Canada. A total of 595 humpback whales were reported captured in coastal fisheries in those two provinces between 1969 and 1990, of which 94 died (Lien 1994; Perkins and Beamish 1979). Along the Atlantic coast of the U.S. and the Maritime Provinces of Canada, there were 160 reports of humpback whales being entangled in fishing gear between 1999 and 2005 (Cole et al. 2005; Nelson et al. 2007). Of these, 95 entangled humpback whales were confirmed, with 11 whales sustaining injuries and nine dying of their wounds. NMFS estimates that between 2002 and 2006, there were incidental serious injuries to 0.2 humpback whales 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 2009).

More humpback whales are killed in collisions with ships than any other whale species except fin whales (Jensen and Silber 2003). Along the Pacific coast, a humpback whale is known to be killed about every other year by ship strikes (Barlow et al. 1997). Of 123 humpback whales that stranded along the Atlantic coast of the U.S. between 1975 and 1996, 10 (8.1 percent) showed evidence of collisions with ships (Laist et al. 2001). Between 1999 and 2005, there were 18 reports of humpback whales being struck by vessels along the Atlantic coast of the U.S. and the Maritime Provinces of Canada (Cole et al. 2005; Nelson et al. 2007). Of these reports, 13 were confirmed as ship strikes and in seven cases, ship strike was determined to be the cause of death. In the Bay of Fundy, recommendations for slower vessel speeds to avoid right whale ship strike appear to be largely ignored (Vanderlaan et al. 2008). However, new rules for seasonal (June

through December) slowing of vessel traffic to 10 knots and changing shipping lanes by less than one nautical mile to avoid the greatest concentrations of right whales are expected to reduce the chance of humpback whales being hit by ships by 9 percent.

Organochlorines, including PCB and DDT, have been identified from humpback whale blubber (Gauthier et al. 1997). Higher PCB levels have been observed in Atlantic waters versus Pacific waters along the United States and levels tend to increase with individual age (Elfes et al. 2010). Although humpback whales in the Gulf of Maine and off Southern California tend to have the highest PCB concentrations, overall levels are on par with other baleen whales, which are generally lower than odontocete cetaceans (Elfes et al. 2010). As with blue whales, these contaminants are transferred to young through the placenta, leaving newborns with contaminant loads equal to that of mothers before bioaccumulating additional contaminants during life and passing the additional burden to the next generation (Metcalfe et al. 2004). Contaminant levels are relatively high in humpback whales as compared to blue whales. Humpback whales feed higher on the food chain, where prey carry higher contaminant loads than the krill that blue whales feed on.

Status and Trends

Humpback whales were originally listed as endangered in 1970 (35 FR 18319), and this status remains under the ESA.

In the North Pacific the pre-exploitation population size may have been as many as 15,000 humpback whales, and current estimates are 6,000-8,000 whales (Calambokidis et al. 2009; Rice 1978). It is estimated that 15,000 humpback whales resided in the North Pacific in 1905 (Rice 1978). However, from 1905 to 1965, nearly 28,000 humpback whales were harvested in whaling operations, reducing the number of all North Pacific humpback whale to roughly 1,000 (Perry et al. 1999a). Population estimates have risen over time from 1,407-2,100 in the 1980s to 6,010 in 1997 (Baker 1985; Baker and Herman. 1987; Calambokidis et al. 1997; Darling and Morowitz 1986). Based on surveys between 2004 and 2006, Calambokidis et al. (2008) estimated that the number of humpback whales in the North Pacific consisted of about 18,300 whales, not counting calves. Because estimates vary by methodology, they are not directly comparable and it is not clear which of these estimates is more accurate or if the change from 1,407 to 18,300 is the result of a real increase or an artifact of model assumptions. Tentative estimates of the eastern North Pacific stock suggest an increase of 6-7 percent annually, but fluctuations have included negative growth in the recent past (Angliss and Outlaw 2005).

Diving

Maximum diving depths are approximately 170 m, with a very deep dive (240 m) recorded off Bermuda (Hamilton et al. 1997). Dives can last for up to 21 min, although feeding dives ranged from 2.1-5.1 min in the north Atlantic (Dolphin 1987). In southeast Alaska, average dive times were 2.8 min for feeding whales, 3.0 min for non-feeding whales, and 4.3 min for resting whales (Dolphin 1987). Because most humpback prey is likely found within 300 m of the surface, most humpback dives are probably relatively shallow. In Alaska, capelin are the primary prey of

humpback and are found primarily between 92 and 120 m; depths to which humpbacks apparently dive for foraging (Witteveen et al. 2008).

Social Behavior

During the feeding season, humpback whales form small groups that occasionally aggregate on concentrations of food that may be stable for long-periods of times. Humpbacks use a wide variety of behaviors to feed on various small, schooling prey including krill and fish (Hain et al. 1982; Hain et al. 1995; Jurasz and Jurasz 1979; Weinrich et al. 1992). There is good evidence of some territoriality on feeding and calving areas (Clapham 1994; Clapham 1996; Tyack 1981). Humpback whales are generally believed to fast while migrating and on breeding grounds, but some individuals apparently feed while in low-latitude waters normally believed to be used exclusively for reproduction and calf-rearing (Danilewicz et al. 2009; Pinto De Sa Alves et al. 2009). Some individuals, such as juveniles, may not undertake migrations at all (Findlay and Best 1995).

Humpback whales feed on pelagic schooling euphausiids and small fish including capelin, herring and mackerel. 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 (southeast Alaska), most dives were of fairly short duration (<4 min) with the deepest dive to 148 m (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.

Vocalization and Hearing

Humpback whale vocalization is much better understood than is hearing. Different sounds are produced that correspond to different functions: feeding, breeding, and other social calls (Dunlop et al. 2008). Males sing complex sounds while in low-latitude breeding areas in a frequency range of 20 Hz to 4 kHz with estimated source levels from 144-174 dB (Au et al. 2006; Au et al. 2000; Frazer and Mercado III 2000; Richardson et al. 1995; Winn et al. 1970). Males also produce sounds associated with aggression, which are generally characterized as frequencies between 50 Hz to 10 kHz and having most energy below 3 kHz (Silber 1986; Tyack 1983). Such sounds can be heard up to 9 km away (Tyack 1983). Other social sounds from 50 Hz to 10 kHz (most energy below 3 kHz) are also produced in breeding areas (Richardson et al. 1995; Tyack 1983). While in northern feeding areas, both sexes vocalize in grunts (25 Hz to 1.9 kHz), pulses (25-89 Hz), and songs (ranging from 30 Hz to 8 kHz but dominant frequencies of 120 Hz to 4 kHz) which can be very loud (175-192 dB re 1 μPa at 1 m; (Au et al. 2000; Erbe 2002a; Payne 1985; Richardson et al. 1995; Thompson et al. 1986). However, humpbacks tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson et al. 1995).

Critical Habitat

Critical habitat has not been designated for humpback whales.

4.3.4 Sei Whale

Sei whales (pronounced "say" or "sigh"; *Balaenoptera borealis*) are members of the baleen whale family and are considered one of the "great whales" or rorquals. Two subspecies of sei whales are recognized, *B. b. borealis* in the Northern Hemisphere and *B. b. schlegellii* in the Southern Hemisphere.

These large animals can reach lengths of about 40-60 ft (12-18 m) and weigh 100,000 lbs (45,000 kg). Females may be slightly longer than males. Sei whales have a long, sleek body that is dark bluish-gray to black in color and pale underneath. The body is often covered in oval-shaped scars (probably caused from cookie-cutter shark and lamprey bites) and sometimes has subtle "mottling". This species has an erect "falcate", "dorsal" fin located far down (about two-thirds) the animals back. They often look similar in appearance to Bryde's whales, but can be distinguished by the presence of a single ridge located on the animal's "rostrum". Bryde's whales, unlike other rorquals, have three distinct prominent longitudinal ridges on their rostrum. Sei whales have 219-410 baleen plates that are dark in color with gray/white fine inner fringes in their enormous mouths. They also have 30-65 relatively short ventral pleats that extend from below the mouth to the naval area. The number of throat grooves and baleen plates may differ depending on geographic population.

The Sei is regarded as the fastest swimmer among the great whales, reaching bursts of speed in excess of 20 knots. When a sei whale begins a dive it usually submerges by sinking quietly below the surface, often remaining only a few meters deep, leaving a series of swirls or tracks as it move its flukes. When at the water's surface, sei whales can be sighted by a columnar or bushy blow that is about 10-13 ft (3-4 m) in height. The dorsal fin usually appears at the same time as the blowhole, when the animal surfaces to breathe. This species usually does not arch its back or raise its flukes when diving.

Sei whales become sexually mature at 6-12 years of age when they reach about 45 ft (13 m) in length, and generally mate and give birth during the winter in lower latitudes. Females breed every 2-3 years, with a gestation period of 11-13 months. Females give birth to a single calf that is about 15 ft (4.6 m) long and weighs about 1,500 lbs (680 kg). Calves are usually nursed for 6-9 months before being weaned on the preferred feeding grounds. Sei whales have an estimated lifespan of 50-70 years.

Distribution

The sei whale occurs in all oceans of the world except the Arctic. The migratory pattern of this species is thought to encompass long distances from high-latitude feeding areas in summer to low-latitude breeding areas in winter; however, the location of winter areas remains largely unknown (Perry et al. 1999a). Sei whales are often associated with deeper waters and areas along continental shelf edges (Hain et al. 1985). This general offshore pattern is disrupted during occasional incursions into shallower inshore waters (Waring et al. 2004). The species appears to

lack a well-defined social structure and individuals are usually found alone or in small groups of up to six whales (Perry et al. 1999a). When on feeding grounds, larger groupings have been observed (Gambell 1985b).

In the western Atlantic Ocean, sei whales occur from Nova Scotia and Labrador in the summer months and migrate south to Florida, the Gulf of Mexico, and the northern Caribbean (Gambell 1985b). In the eastern Atlantic Ocean, sei whales occur in the Norwegian Sea (as far north as Finnmark in northeastern Norway), occasionally occurring as far north as Spitsbergen Island, and migrate south to Spain, Portugal, and northwest Africa (Gambell 1985b).

In the North Pacific Ocean, sei whales occur from the Bering Sea south to California (on the east) and the coasts of Japan and Korea (on the west). During the winter, sei whales are found from 20°-23°N (Gambell 1985b; Masaki 1977).

Sei whales occur throughout the Southern Ocean during the summer months, although they do not migrate as far south to feed as blue or fin whales. During the austral winter, sei whales occur off Brazil and the western and eastern coasts of Southern Africa and Australia.

Population Structure

The population structure of sei whales is not well defined, but presumed to be discrete by ocean basin (north and south), except for sei whales in the Southern Ocean, which may form a ubiquitous population or several discrete ones.

North Pacific. Some mark-recapture, catch distribution, and morphological research indicate more than one population may exist – one between 155°-175° W, and another east of 155° W (Masaki 1976; Masaki 1977). During marine mammal and sea turtles surveys conducted in the Mariana Islands from January through April 2007, sei whales were observed in the offshore areas of Guam and the Mariana Islands south to nearly 10° N (SRS-Parsons 2007). During these surveys, sei whales were most commonly observed in waters between 3,164 and 9,322 m (10,381 – 30,583 ft) in depth; all of these sightings were south of Saipan (about 15°N). Sei whales have been reported primarily south of the Aleutian Islands, in Shelikof Strait and waters surrounding Kodiak Island, in the Gulf of Alaska, and inside waters of southeast Alaska and south to California to the east and Japan and Korea to the west (Leatherwood et al. 1982; Nasu 1974). Sightings have also occurred in Hawaiian waters (Smultea et al. 2010). Sei whales have been occasionally reported from the Bering Sea and in low numbers on the central Bering Sea shelf (Hill and DeMaster 1998). Whaling data suggest that sei whales do not venture north of about 55°N (Gregr et al. 2000). Masaki (1977) reported sei whales concentrating in the northern and western Bering Sea from July-September, although other researchers question these observations because no other surveys have reported sei whales in the northern and western Bering Sea. Harwood (1987) evaluated Japanese sighting data and concluded that sei whales rarely occur in the Bering Sea. Harwood (1987) reported that 75-85 percent of the North Pacific population resides east of 180°. During winter, sei whales are primarily found from 20°-23° N (Gambell 1985b; Masaki 1977). Considering the many British Columbia whaling catches in the early to

mid 1900s, sei whales have clearly utilized this area in the past (Gregr et al. 2000; Pike and Macaskie 1969).

Sei whales appear to prefer to forage in regions of steep bathymetric relief, such as continental shelf breaks, canyons, or basins situated between banks and ledges (Best and Lockyer. 2002; Gregr and Trites. 2001; Kenney and Winn. 1987), where local hydrographic features appear to help concentrate zooplankton, especially copepods. In their foraging areas, sei whales appear to associate with oceanic frontal systems (Horwood 1987). In the north Pacific, sei whales are found feeding particularly along the cold eastern currents (Perry et al. 1999a).

Natural Threats

The foraging areas of right and sei whales in the western North Atlantic Ocean overlap and both whales feed preferentially on copepods (Mitchell 1975).

Andrews (1916) suggested that killer whales attacked sei whales less frequently than fin and blue whales in the same areas. Sei whales engage in a flight responses to evade killer whales, which involves high energetic output, but show little resistance if overtaken (Ford and Reeves 2008). Endoparasitic helminths (worms) are commonly found in sei whales and can result in pathogenic effects when infestations occur in the liver and kidneys (Rice 1977).

Anthropogenic Threats

Human activities known to threaten sei whales include whaling, commercial fishing, and maritime vessel traffic. Historically, whaling represented the greatest threat to every population of sei whales and was ultimately responsible for listing sei whales as an endangered species. Sei whales are thought to not be widely hunted, although harvest for scientific whaling or illegal harvesting may occur in some areas.

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.

Sei whales are occasionally killed in collisions with vessels. Of three sei whales that stranded along the U.S. Atlantic coast between 1975 and 1996, two showed evidence of collisions (Laist et al. 2001). Between 1999 and 2005, there were three reports of sei whales being struck by vessels along the U.S. Atlantic coast and Canada's Maritime Provinces (Cole et al. 2005; Nelson et al. 2007). Two of these ship strikes were reported as having resulted in death. One sei whale was killed in a collision with a vessel off the coast of Washington in 2003 (Waring et al. 2009). New rules for seasonal (June through December) slowing of vessel traffic in the Bay of Fundy to 10 knots and changing shipping lanes by less than one nautical mile to avoid the greatest concentrations of right whales are predicted to reduce sei whale ship strike mortality by 17 percent.

Sei whales are known to accumulate DDT, DDE, and PCBs (Borrell 1993; Borrell and Aguilar 1987; Henry and Best 1983). Males carry larger burdens than females, as gestation and lactation transfer these toxins from mother to offspring.

Status and Trends

The sei whale was originally listed as endangered in 1970 (35 FR 18319), and this status remained since the inception of the ESA in 1973.

Ohsumi and Fukuda (1975) estimated that sei whales in the North Pacific numbered about 49,000 whales in 1963, had been reduced to 37,000-38,000 whales by 1967, and reduced again to 20,600-23,700 whales by 1973. From 1910-1975, approximately 74,215 sei whales were caught in the entire North Pacific Ocean (Harwood and Hembree. 1987; Perry et al. 1999a). From the early 1900s, Japanese whaling operations consisted of a large proportion of sei whales: 300-600 sei whales were killed per year from 1911-1955. The sei whale catch peaked in 1959, when 1,340 sei whales were killed. In 1971, after a decade of high sei whale catch numbers, sei whales were scarce in Japanese waters. Japanese and Soviet catches of sei whales in the North Pacific and Bering Sea increased from 260 whales in 1962 to over 4,500 in 1968-1969, after which the sei whale population declined rapidly (Mizroch et al. 1984). When commercial whaling for sei whales ended in 1974, the population in the North Pacific had been reduced to 7,260-12,620 animals (Tillman 1977). There have been no direct estimates of sei whale populations for the eastern Pacific Ocean (or the entire Pacific). Between 1991 and 2001, during aerial surveys, there were two confirmed sightings of sei whales along the U.S. Pacific coast.

Sei whales are known to occur in the Gulf of Alaska 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 have not been sighted during recent surveys (Rone et al. 2010; Waite et al. 2003).

Diving

Generally, sei whales make 5-20 shallow dives of 20-30 sec duration followed by a deep dive of up to 15 min (Gambell 1985b). The depths of sei whale dives have not been studied; however the composition of their diet suggests that they do not perform dives in excess of 300 m. Sei whales are usually found in small groups of up to 6 individuals, but they commonly form larger groupings when they are on feeding grounds (Gambell 1985b).

Social Behavior

Sei whales are primarily planktivorous, feeding mainly on euphausiids and copepods, although they are also known to consume fish (Waring et al. 2007). In the Northern Hemisphere, sei whales consume small schooling fish such as anchovies, sardines, and mackerel when locally abundant (Mizroch et al. 1984; Rice 1977). Sei whales in the North Pacific feed on euphausiids and copepods, which make up about 95 percent of their diets (Calkins 1986). The dominant food for sei whales off California during June-August is northern anchovy, while in September-October whales feed primarily on krill (Rice 1977). The balance of their diet consists of squid and schooling fish, including smelt, sand lance, Arctic cod, rockfish, pollack, capelin, and Atka mackerel (Nemoto and Kawamura 1977). In the Southern Ocean, analysis of stomach contents indicates sei whales consume Calanus spp. and small-sized euphasiids with prey composition showing latitudinal trends (Kawamura 1974). Evidence indicates that sei whales in the Southern Hemisphere reduce direct interspecific competition with blue and fin whales by consuming a wider variety of prey and by arriving later to feeding grounds (Kirkwood 1992). Rice (1977) suggested that the diverse diet of sei whales may allow them greater opportunity to take advantage of variable prey resources, but may also increase their potential for competition with commercial fisheries.

Little is known about the actual social system of these animals. Groups of 2-5 individuals are typically observed, but sometimes thousands may gather if food is abundant. However, these large aggregations may not be dependent on food supply alone, as they often occur during times of migration. Norwegian workers call the times of great sei whale abundance "invasion years." During mating season, males and females may form a social unit, but strong data on this issue are lacking.

Vocalization and Hearing

Data on sei whale vocal behavior is limited, but includes records off the Antarctic Peninsula of broadband sounds in the 100-600 Hz range with 1.5 s duration and tonal and upsweep calls in the 200-600 Hz range of 1-3 s durations (McDonald et al. 2005). Differences may exist in vocalizations between ocean basins (Rankin et al. 2009). Vocalizations from the North Atlantic consisted of paired sequences (0.5-0.8 sec, separated by 0.4-1.0 sec) of 10-20 short (4 msec) FM sweeps between 1.5-3.5 kHz (Richardson et al. 1995).

A general description of the anatomy of the ear for cetaceans is provided in the description of the blue whale.

Critical Habitat

Critical habitat has not been designated for sei whales.

4.3.5 Sperm Whale

Sperm whales (*Physeter macrocephalus*) are the largest of the odontocetes (toothed whales) and the most sexually dimorphic cetaceans, with males considerably larger than females. Adult females may grow to lengths of 36 ft (11 m) and weigh 15 tons (13,607 kg). Adult males, however, reach about 52 ft (16 m) and may weigh as much as 45 tons (40,823 kg).

The sperm whale is distinguished by its extremely large head, which takes up to 25 to 35 percent of its total body length. It is the only living cetacean that has a single blowhole asymmetrically situated on the left side of the head near the tip. Sperm whales have the largest brain of any animal (on average 17 pounds (7.8 kg) in mature males), however, compared to their large body size, the brain is not exceptional in size.

There are between 20-26 large conical teeth in each side of the lower jaw. The teeth in the upper jaw rarely erupt and are often considered to be vestigial. It appears that teeth may not be necessary for feeding, since they do not break through the gums until puberty, if at all, and healthy sperm whales have been caught that have no teeth.

Sperm whales are mostly dark gray, but oftentimes the interior of the mouth is bright white, and some whales have white patches on the belly. Their flippers are paddle-shaped and small compared to the size of the body, and their flukes are very triangular in shape. They have small dorsal fins that are low, thick, and usually rounded.

Distribution

Sperm whales are distributed in all of the world's oceans, from equatorial to polar waters, and are highly migratory. Mature males range between 70º N in the North Atlantic and 70º S in the Southern Ocean (Perry et al. 1999a; Reeves and Whitehead 1997), whereas mature females and immature individuals of both sexes are seldom found higher than 50º N or S (Reeves and Whitehead 1997). In winter, sperm whales migrate closer to equatorial waters (Kasuya and Miyashita 1988; Waring 1993) where adult males join them to breed.

Population Structure

There is no clear understanding of the global population structure of sperm whales (Dufault et al. 1999). Recent ocean-wide genetic studies indicate low, but statistically significant, genetic diversity and no clear geographic structure, but strong differentiation between social groups (Lyrholm and Gyllensten 1998; Lyrholm et al. 1996; Lyrholm et al. 1999). The IWC currently recognizes four sperm whale stocks: North Atlantic, North Pacific, northern Indian Ocean, and Southern Hemisphere (Dufault et al. 1999; Reeves and Whitehead 1997). The NMFS recognizes six stocks under the MMPA- three in the Atlantic/Gulf of Mexico and three in the Pacific (Alaska, California-Oregon-Washington, and Hawai′i; (Perry et al. 1999b; Waring et al. 2004). Genetic studies indicate that movements of both sexes through expanses of ocean basins are common, and that males, but not females, often breed in different ocean basins than the ones in

which they were born (Whitehead 2003). Sperm whale populations appear to be structured socially, at the level of the clan, rather than geographically (Whitehead 2003; Whitehead 2008).

During marine mammal and sea turtles surveys conducted in the Mariana Islands from January through April 2007 (Fulling et al. 2011; SRS-Parsons 2007), sperm whales were encountered (visually or acoustically) more frequently than any other cetacean; they were detected acoustically three times more than they were observed.(Croll et al. 1999b).

Sperm whales are found throughout the North Pacific and are distributed broadly in tropical and temperate waters to the Bering Sea as far north as Cape Navarin in summer, and occur south of 40° N in winter (Gosho et al. 1984; Miyashita et al. 1995 as cited in Carretta et al. 2005; Rice 1974). Sperm whales are found year-round in Californian and Hawaiian waters (Barlow 1995; Dohl 1983; Forney et al. 1995; Shallenberger 1981). They are seen in every season except winter (December-February) in Washington and Oregon (Green et al. 1992). Summer/fall surveys in the eastern tropical Pacific (Wade and Gerrodette 1993). Summer/fall surveys in the eastern tropical Pacific (Wade and Gerrodette 1993).

Natural Threats

Sperm whales are known to be occasionally predated upon by killer whales (Jefferson et al. 1991; Pitman et al. 2001) by pilot whales (Arnbom et al. 1987; Palacios and Mate. 1996; Rice 1989; Weller et al. 1996; Whitehead et al. 1997) and large sharks (Best et al. 1984) and harassed by pilot whales (Arnbom et al. 1987; Palacios and Mate. 1996; Rice 1989; Weller et al. 1996; Whitehead et al. 1997). Strandings are also relatively common events, with one to dozens of individuals generally beaching themselves and dying during any single event. Although several hypotheses, such as navigation errors, illness, and anthropogenic stressors, have been proposed (Goold et al. 2002; Wright 2005), direct widespread causes remain unclear. Calcivirus and papillomavirus are known pathogens of this species (Lambertsen et al. 1987; Smith and Latham 1978).

Anthropogenic Threats

Sperm whales historically faced severe depletion from commercial whaling operations. From 1800 to 1900, the IWC estimated that nearly 250,000 sperm whales were killed by whalers, with another 700,000 from 1910 to 1982 (IWC Statistics 1959-1983). However, other estimates have included 436,000 individuals killed between 1800-1987 (Carretta et al. 2005). However, all of these estimates are likely underestimates due to illegal killings and inaccurate reporting by Soviet whaling fleets between 1947 and 1973. In the Southern Hemisphere, these whalers killed an estimated 100,000 whales that they did not report to the IWC (Yablokov et al. 1998), with smaller harvests in the Northern Hemisphere, primarily the North Pacific, that extirpated sperm whales from large areas (Yablokov 2000). Additionally, Soviet whalers disproportionately killed adult females in any reproductive condition (pregnant or lactating) as well as immature sperm whales of either gender.

Following a moratorium on whaling by the IWC, significant whaling pressures on sperm whales were eliminated. However, sperm whales are known to have become entangled in commercial

fishing gear and 17 individuals are known to have been struck by vessels (Jensen and Silber 2004). Whale-watching vessels are known to influence sperm whale behavior (Richter et al. 2006).

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).

Interactions between sperm whales and longline fisheries in the Gulf of Alaska have been reported since 1995 and are increasing in frequency (Hill and DeMaster 1998; Hill et al. 1999; Rice 1989). Between 2002 and 2006, there were three observed serious injuries (considered mortalities) to sperm whales in the Gulf of Alaska from the sablefish longline fishery (Angliss and Outlaw 2008). Sperm whales have also been observed in Gulf of Alaska feeding off longline gear (for sablefish and halibut) at 38 of the surveyed stations (Angliss and Outlaw 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).

Contaminants have been identified in sperm whales, but vary widely in concentration based upon life history and geographic location, with northern hemisphere individuals generally carrying higher burdens (Evans et al. 2004). Contaminants include dieldrin, chlordane, DDT, DDE, PCBs, HCB and HCHs in a variety of body tissues (Aguilar 1983; Evans et al. 2004), as well as several heavy metals (Law et al. 1996). However, unlike other marine mammals, females appear to bioaccumulate toxins at greater levels than males, which may be related to possible dietary differences between females who remain at relatively low latitudes compared to more migratory males (Aguilar 1983; Wise et al. 2009). Chromium levels from sperm whales skin samples worldwide have varied from undetectable to 122.6 µg Cr/g tissue, with the mean (8.8 µg Cr/g tissue) resembling levels found in human lung tissue with chromium-induced cancer (Wise et al. 2009). Older or larger individuals did not appear to accumulate chromium at higher levels.

Status and Trends

Sperm whales were originally listed as endangered in 1970 (35 FR 18319), and this status remained with the inception of the ESA in 1973. Although population structure of sperm whales is unknown, several studies and estimates of abundance are available. Sperm whale populations probably are undergoing the dynamics of small population sizes, which is a threat in and of itself. In particular, the loss of sperm whales to directed Soviet whaling likely inhibits recovery due to the loss of adult females and their calves, leaving sizeable gaps in demographic and age structuring (Whitehead and Mesnick 2003).

There are approximately 76,803 sperm whales in the eastern tropical Pacific, eastern North Pacific, Hawai′i, and western North Pacific (Whitehead 2002a). Minimum estimates in the eastern North Pacific are 1,719 individuals and 5,531 in the Hawaiian Islands (Carretta et al. 2007). The tropical Pacific is home to approximately 26,053 sperm whales and the western North

Pacific has approximately 29,674 (Whitehead 2002a). There was a dramatic decline in the number of females around the Galapagos Islands during 1985-1999 versus 1978-1992 levels, likely due to migration to nearshore waters of South and Central America (Whitehead and Mesnick 2003).

Hill and DeMaster (1999) concluded that about 258,000 sperm whales were harvested in the North Pacific between 1947-1987. Although the IWC protected sperm whales from commercial harvest in 1981, Japanese whalers continued to hunt sperm whales in the North Pacific until 1988 (Reeves and Whitehead 1997). In 2000, the Japanese Whaling Association announced plans to kill 10 sperm whales in the Pacific Ocean for research. Although consequences of these deaths are unclear, the paucity of population data, uncertainly regarding recovery from whaling, and re-establishment of active programs for whale harvesting pose risks for the recovery and survival of this species. Sperm whales are also hunted for subsistence purposes by whalers from Lamalera, Indonesia, where a traditional whaling industry has been reported to kill up to 56 sperm whales per year.

Diving

Sperm whales are probably the deepest and longest diving mammalian species, with dives to 3 km down and durations in excess of 2 hours (Clarke 1976; Watkins 1985; Watkins et al. 1993). However, dives are generally shorter (25- 45 min) and shallower (400-1,000 m). Dives are separated by 8-11 min rests at the surface (Gordon 1987; Watwood et al. 2006) (Jochens et al. 2006; Papastavrou et al. 1989). Sperm whales typically travel ~3 km horizontally and 0.5 km vertically during a foraging dive (Whitehead 2003). Differences in night and day diving patterns are not known for this species, but, like most diving air-breathers for which there are data (rorquals, fur seals, and chinstrap penguins), sperm whales probably make relatively shallow dives at night when prey are closer to the surface.

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 (Clarke 1986; Whitehead 2002b). 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).

Social Behavior

Movement patterns of Pacific female and immature male groups appear to follow prey distribution and, although not random, movements are difficult to anticipate and are likely associated with feeding success, perception of the environment, and memory of optimal foraging areas (Whitehead 2008). However, no sperm whale in the Pacific has been known to travel to points over 5,000 km apart and only rarely have been known to move over 4,000 km within a time frame of several years. This means that although sperm whales do not appear to cross from eastern to western sides of the Pacific (or vice-versa), significant mixing occurs that can maintain genetic exchange. Movements of several hundred miles are common, (i.e. between the Galapagos Islands and the Pacific coastal Americas). Movements appear to be group or clan specific, with some groups traveling straighter courses than others over the course of several days. However, general transit speed averages about 4 km/h. Sperm whales in the Caribbean region appear to be much more restricted in their movements, with individuals repeatedly sighted within less than 160 km of previous sightings.

Gaskin (1973) proposed a northward population shift of sperm whales off New Zealand in the austral autumn based on reduction of available food species and probable temperature tolerances of calves.

Sperm whales have a strong preference for waters deeper than 1,000 m (Reeves and Whitehead 1997; Watkins and Schevill 1977), although Berzin (1971) reported that they are restricted to waters deeper than 300 m. While deep water is their typical habitat, sperm whales are rarely found in waters less than 300 m in depth (Clarke 1956; Rice 1989). Sperm whales have been observed near Long Island, New York, in water between 40-55 m deep (Scott and Sadove 1997). When they are found relatively close to shore, sperm whales are usually associated with sharp increases in topography where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke 1956). Such areas include oceanic islands and along the outer continental shelf.

Sperm whales are frequently found in locations of high productivity due to upwelling or steep underwater topography, such as continental slopes, seamounts, or canyon features (Jaquet 1996; Jaquet and Whitehead. 1996). Cold-core eddy features are also attractive to sperm whales in the Gulf of Mexico, likely because of the large numbers of squid that are drawn to the high concentrations of plankton associated with these features (Biggs et al. 2000; Davis et al. 2000b; Davis et al. 2002). Surface waters with sharp horizontal thermal gradients, such as along the Gulf Stream in the Atlantic, may also be temporary feeding areas for sperm whales (Griffin 1999; Jaquet and Whitehead. 1996; Waring et al. 1993). Sperm whales over George's Bank were associated with surface temperatures of 23.2-24.9°C (Waring et al. 2004).

Local information is inconsistent regarding sperm whale tendencies. Gregr and Trites (2001) reported that female sperm whales off British Columbia were relatively unaffected by the surrounding oceanography. However, Tynan et al. (2005) reported increased sperm whales densities with strong turbulence associated topographic features along the continental slope near

Heceta Bank. Two noteworthy strandings in the region include an infamous incident (well publicized by the media) of attempts to dispose of a decomposed sperm whale carcass on an Oregon beach by using explosives. In addition, a mass stranding of 47 individuals in Oregon occurred during June 1979 (Norman et al. 2004; Rice et al. 1986).

Stable, long-term associations among females form the core of sperm whale societies (Christal et al. 1998). Up to about a dozen females usually live in such groups, accompanied by their female and young male offspring. Young individuals are subject to alloparental care by members of either sex and may be suckled by non-maternal individuals (Gero et al. 2009). Group sizes may be smaller overall in the Caribbean Sea (6-12 individuals) versus the Pacific (25-30 individuals) (Jaquet and Gendron 2009). Males start leaving these family groups at about 6 years of age, after which they live in "bachelor schools," but this may occur more than a decade later (Pinela et al. 2009). The cohesion among males within a bachelor school declines with age. During their breeding prime and old age, male sperm whales are essentially solitary (Christal and Whitehead 1997).

Vocalization and Hearing

Sound production and reception by sperm whales are better understood than in most cetaceans. Sperm whales produce broad-band clicks in the frequency range of 100 Hz to 20 kHz that can be extremely loud for a biological source (200-236 dB re 1μPa), although lower source level energy has been suggested at around 171 dB re 1 μPa (Goold and Jones 1995; Madsen et al. 2003; Weilgart and Whitehead 1997; Weilgart et al. 1993). Most of the energy in sperm whale clicks is concentrated at around 2-4 kHz and 10-16 kHz (Goold and Jones 1995; NMFS 2006; Weilgart et al. 1993). The highly asymmetric head anatomy of sperm whales is likely an adaptation to produce the unique clicks recorded from these animals (Cranford 1992; Norris and Harvey 1972). These long, repeated clicks are associated with feeding and echolocation (Goold and Jones 1995; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997). However, clicks are also used in short patterns (codas) during social behavior and intra-group interactions (Weilgart et al. 1993). They may also aid in intra-specific communication. Another class of sound, "squeals", are produced with frequencies of 100 Hz to 20 kHz (e.g., Weir et al. 2007).

Our understanding of sperm whale hearing stems largely from the sounds they produce. The only direct measurement of hearing was from a young stranded individual from which auditory evoked potentials were recorded (Carder and Ridgway 1990). From this whale, responses support a hearing range of 2.5-60 kHz. However, behavioral responses of adult, free-ranging individuals also provide insight into hearing range; sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins 1985; Watkins and Schevill 1975). They also stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995). Because they spend large amounts of time at depth and use low-frequency sound, sperm whales are likely to be susceptible to low frequency sound in the ocean (Croll et al. 1999b).

Critical Habitat

Critical habitat has not been designated for sperm whales.

4.3.6 Green Sea Turtle

Green turtles are the largest of all the hard-shelled sea turtles with a comparatively small head. While hatchlings are just 2 inches (50 mm) long, adults can grow to more than 3 ft (0.91 m) long and weigh 300-350 pounds (136-159 kg). Adult green turtles are unique among sea turtles in that they are herbivorous, feeding primarily on seagrasses and algae. This diet is thought to give them greenish colored fat, from which they take their name. A green turtle's carapace (top shell) is smooth and can be shades of black, gray, green, brown, and yellow. Their plastron (bottom shell) is yellowish white.

Scientists estimate green turtles reach sexual maturity anywhere between 20 and 50 years, at which time females begin returning to their natal beaches (i.e., the same beaches where they were born) every 2-4 years to lay eggs. The nesting season varies depending on location. In the southeastern U.S., females generally nest between June and September, while peak nesting occurs in June and July. During the nesting season, females nest at approximately two week intervals, laying an average of five clutches. In Florida, green turtle nests contain an average of 135 eggs, which will incubate for approximately 2 months before hatching.

Distribution

Green turtles are found in the Pacific Ocean, Atlantic Ocean, Indian Ocean, Carribean Sea, and Mediterranean Sea, primarily in tropical or, to a lesser extent, subtropical waters. These regions can be further divided into nesting aggregations within the eastern, central, and western Pacific Ocean; the western, northern, and eastern Indian Ocean; Mediterranean Sea; and eastern, southern, and western Atlantic Ocean, including the Caribbean Sea.

Green turtles appear to prefer waters that usually remain around 20°C in the coldest month. During warm spells (e.g., El Niño), green turtles may be found considerably north of their normal distribution. Stinson (1984) found green turtles most frequently in U.S. coastal waters with temperatures exceeding 18°C.

Further, green sea turtles seem to occur preferentially in drift lines or surface current convergences, probably because of the prevalence of cover and higher densities of their food items associated with these oceanic phenomena. For example, in the western Atlantic Ocean, drift lines commonly contain floating *Sargassum* capable of providing small turtles with shelter and sufficient buoyancy to raft upon (NMFS and USFWS 1998b). Underwater resting sites include coral recesses, the underside of ledges, and sand bottom areas that are relatively free of strong currents and disturbance from natural predators and humans. Available information indicates that green turtle resting areas are in proximity to their feeding pastures (NMFS and USFWS 1998b).

Population Structure

The population dynamics of green sea turtles and all of the other sea turtles considered in this Opinion are usually described based on the distribution and habit of nesting females, rather than their male counterparts. The spatial structure of male sea turtles and their fidelity to specific coastal areas is unknown; however, we describe sea turtle populations based on the nesting beaches that female sea turtles return to when they mature. Because the patterns of increase or decrease in the abundance of sea turtle nests over time are determined by internal dynamics rather than external dynamics, we make inferences about the growth or decline of sea turtle populations based on the status and trend of their nests.

Primary nesting aggregations of green turtles (i.e. sites with greater than 500 nesting females per year) include: Ascension Island (south Atlantic Ocean), Australia, Brazil, Comoros Islands, Costa Rica, Ecuador (Galapagos Archipelago), Equatorial Guinea (Bioko Island), Guinea-Bissau (Bijagos Archipelago), Iles Eparses - (Tromelin Island, Europa Island), Indonesia, Malaysia, Myanmar, Oman, Philippines, Saudi Arabia, Seychelles Islands, Suriname, and United States (Florida; NMFS and USFWS 1998c; Seminoff et al. 2002).

Smaller nesting aggregations include: Angola, Bangladesh, Bikar Atoll, Brazil, Chagos Archipelago, China, Costa Rica, Cuba, Cyprus, Democratic Republic of Yemen, Dominican Republic, d'Entrecasteaux Reef, French Guiana, Ghana, Guyana, India, Iran, Japan, Kenya, Madagascar, Maldives Islands, Mayotte Archipelago, Mexico, Micronesia, Pakistan, Palmerston Atoll, Papua New Guinea, Primieras Islands, Sao Tome é Principe, Sierra Leone, Solomon Islands, Somalia, Sri Lanka, Taiwan, Tanzania, Thailand, Turkey, Scilly Atoll, United States (Hawai'i), Venezuela, and Vietnam.

Molecular genetic techniques have helped researchers gain insight into the distribution and ecology of migrating and nesting green sea turtles. In the Pacific Ocean, green sea turtles group into two distinct regional clades: (1) western Pacific and South Pacific islands, and (2) eastern Pacific and central Pacific, including the rookery at French Frigate Shoals, Hawai'i. In the eastern Pacific, green sea turtles forage coastally from San Diego Bay, California in the north to Mejillones, Chile in the South. Based on mtDNA analyses, green sea turtles found on foraging grounds along Chile's coast originate from the Galapagos nesting beaches, while those green sea turtles foraging in the Gulf of California originate primarily from the Michoacan nesting stock. Green turtles foraging in San Diego Bay and along the Pacific coast of Baja California originate primarily from rookeries of the Islas Revillagigedos.

Threats to the Species

The various habitat types green sea turtles occupy throughout their lives exposes these sea turtles to a wide variety of natural threats. The beaches on which green sea turtles nest and the nests themselves are threatened by hurricanes and tropical storms as well as the storm surges, sand accretion, and rainfall that are associated with hurricanes. Hatchlings are hunted by predators like herons, gulls, dogfish, and sharks. Larger green sea turtles, including adults, are also killed by sharks and other large, marine predators.

Green turtles in the northwest Hawaiian Islands are afflicted with a tumor disease, fibropapilloma, which is of an unknown etiology and often fatal, as well as spirochidiasis, both of which are the major causes of strandings of this species. The presence of fibropapillomatosis among stranded turtles has increased significantly over the past 17 years, ranging from 47-69 percent during the past decade (Murakawa et al. 2000). Preliminary evidence suggests an association between the distribution of fibropapillomatosis in the Hawaiian Islands and the distribution of toxic benthic dinoflagellates (*Prorocentrum* spp.) known to produce a tumor promoter, okadaic acid (Landsberg et al. 1999).

Three human activities are known to threaten green sea turtles: overharvests of individual animals, incidental capture in commercial fisheries, and human development of coastlines. Historically, the primary cause of the global decline of green sea turtles populations were the number of eggs and adults captured and killed on nesting beaches in combination with the number of juveniles and adults captured and killed in coastal feeding areas. Some population of green sea turtles still lose large number of eggs, juveniles, and adults to subsistence hunters, local communities that have a tradition of harvesting sea turtles, and poachers in search of turtle eggs and meat.

Directed harvests of eggs and other life stages of green sea turtles were identified as a "major problem" in American Samoa, Guam, Palau, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Republic of the Marshall Islands, and the Unincorporated Islands (Wake, Johnston, Kingman, Palmyra, Jarvis, Howland, Baker, and Midway). In the Atlantic, green sea turtles are captured and killed in turtle fisheries in Colombia, Grenada, the Lesser Antilles, Nicaragua, St. Vincent and the Grenadines (Brautigam and Eckert 2006); the turtle fishery along the Caribbean coast of Nicaragua, by itself, has captured more than 11,000 green sea turtles each year (Brautigam and Eckert 2006; Lagueux 1998).

Severe overharvests have resulted from a number of factors in modern times: (1) the loss of traditional restrictions limiting the number of turtles taken by island residents; (2) modernized hunting gear; (3) easier boat access to remote islands; (4) extensive commercial exploitation for turtle products in both domestic markets and international trade; (5) loss of the spiritual significance of turtles; (6) inadequate regulations; and (7) lack of enforcement (NMFS and USFWS 1998c).

Green sea turtles are also captured and killed in commercial fisheries. Gillnets account for the highest number of green sea turtles that are captured and killed, but they are also captured and killed in trawls, traps and pots, longlines, and dredges. Along the Atlantic coast of the U.S., NMFS estimated that almost 19,000 green sea turtles are captured in shrimp trawl fisheries each year in the Gulf of Mexico, with 514 of those sea turtles dying as a result of their capture. Each year, several hundred green sea turtles are captured in herring fisheries; mackerel, squid, and butterfish fisheries; monkfish fisheries; pound net fisheries, summer flounder and scup fisheries; Atlantic pelagic longline fisheries; and gillnet fisheries in Pamlico Sound. Although most of

these turtles are released alive, these fisheries are expected to kill almost 100 green sea turtles each year; the health effects of being captured on the sea turtles that survive remain unknown.

Green sea turtles are also threatened by domestic or domesticated animals which prey on their nests; artificial lighting that disorients adult female and hatchling sea turtles, which can dramatically increase the mortality rates of hatchling sea turtles; beach replenishment; ingestion and entanglement in marine debris; and environmental contaminants.

Oil spills are a risk for all sea turtles. Several aspects of sea turtles life histories put them at risk, including the lack of avoidance behavior of oiled waters and indiscriminate feeding in convergence zones. Sea turtles are air breathers and all must come to the surface frequently to take a breath of air. In a large oil spill, these animals may be exposed to volatile chemicals during inhalation.

Additionally, sea turtles may experience oiling impacts on nesting beaches when they come ashore to lay their eggs, and their eggs may be exposed during incubation potentially resulting in increased egg mortality and/or possibly developmental defects in hatchlings. Hatchlings emerging from their nests may encounter oil on the beach and in the water as they begin their lives at sea.

External Effects: Oil and other chemicals on skin and body may result in skin and eye irritation, burns to mucous membranes of eyes and mouth, and increased susceptibility to infection.

Internal Effects: Inhalation of volatile organics from oil or dispersants may result in respiratory irritation, tissue injury, and pneumonia. Ingestion of oil or dispersants may result in gastrointestinal inflammation, ulcers, bleeding, diarrhea, and maldigestion. Absorption of inhaled and ingested chemicals may damage organs such as the liver or kidney, result in anemia and immune suppression, or lead to reproductive failure or death.

Status

Green sea turtles are listed as threatened under the ESA, except for breeding populations found in Florida and the Pacific coast of Mexico, which are listed as endangered. Causes for this decline include harvest of eggs, subadults and adults, incidental capture by fisheries, loss of habitat, and disease.

While some nesting populations of green sea turtles appear to be stable or increasing in the Atlantic Ocean (e.g. Bujigos Archipelago (Guinea-Bissau), Ascension Island, Tortuguero (Costa Rica), Yucatan Peninsula (Mexico), and Florida), declines of over 50 percent have been documented in the eastern (Bioko Island, Equatorial Guinea) and western Atlantic (Aves Island, Venezuela). Nesting populations in Turkey (Mediterranean Sea) have declined between 42 percent and 88 percent since the late 1970s. Population trend variations also appear in the Indian Ocean. Declines greater than 50 percent have been documented at Sharma (Republic of Yemen) and Assumption and Aldabra (Seychelles), while no changes have occurred at Karan Island (Saudi Arabia) or at Ras al Hadd (Oman). The number of females nesting annually in the Indian

Ocean has increased at the Comoros Islands, Tromelin and maybe Europa Island (Iles Esparses; Seminoff 2004).

Green turtles are thought to be declining throughout the Pacific Ocean, with the exception of Hawai'i, as a direct consequence of a historical combination of overexploitation and habitat loss (Eckert 1993; Seminoff 2004). They are also thought to be declining in the Atlantic Ocean. However, like several of the species we have already discussed, the information available on the status and trend of green sea turtles do not allow us to make definitive statement about the global extinction risks facing these sea turtles or risks facing particular populations (nesting aggregations) of these turtles. With the limited data available on green sea turtles, we do not know whether green sea turtles exist at population sizes large enough to avoid demographic phenomena that are known to increase the extinction probability of species that exist as "small" populations (that is, "small" populations experience phenomena such as demographic stochasticity, inbreeding depression, and Allee effects, among others, that cause their population size to become a threat in and of itself) or if green sea turtles are threatened more by exogenous threats such as anthropogenic activities (entanglement, habitat loss, overharvests, etc.) or natural phenomena (such as disease, predation, or changes in the distribution and abundance of their prey in response to changing climate). Nevertheless, with the exception of the Hawaiian nesting aggregations, we assume that green sea turtles are threatened or endangered because of both anthropogenic and natural threats as well as changes in their population dynamics.

A recovery plan for the U.S Population of Atlantic Green Turtles was written in 1991 (NMFS and USFWS 1991). A recovery plan for the U.S. Pacific Populations of the Green Turtle was written in 1998 (NMFS and USFWS 1998c).

Diving and Social Behavior

Based on the behavior of post-hatchlings and juvenile green turtles raised in captivity, it is presumed that those in pelagic habitats live and feed at or near the ocean surface, and that their dives do not normally exceed several meters in depth (NMFS and USFWS 1998c).). The maximum recorded dive depth for an adult green turtle was 110 m (Berkson 1967) (Lutcavage and Lutz 1997), while subadults routinely dive 20 m for 9-23 minutes, with a maximum recorded dive of 66 minutes (Brill et al. 1995 in Lutcavage and Lutz 1997).

Vocalizations and Hearing

The information on green sea turtle hearing is very limited. Ridgway et al. (1969) studied the auditory evoked potentials of three green sea turtles (in air and through mechanical stimulation of the ear) and concluded that their maximum sensitivity occurred from 300 to 400 Hz with rapid declines for tones at lower and higher frequencies. They reported an upper limit for cochlear potentials without injury of 2000 Hz and a practical limit of about 1000 Hz. This is similar to estimates for loggerhead sea turtles, which had most sensitive hearing between 250 and 1000 Hz, with rapid decline above 1000 Hz (Bartol et al. 1999).

In a study of the auditory brainstem responses of subadult green sea turtles, Ketten and Bartol (2005) reported responses to frequencies between 100 and 500 Hz; with highest sensitivity

between 200 and 400 Hz. They reported that two juvenile green turtles had hearing sensitivities that were slightly broader in range: they responded to sounds at frequencies from 100 to 800 Hz, with highest hearing sensitivities from 600 to 700 Hz.

These hearing sensitivities are similar to the hearing sensitivities reported for two terrestrial species: pond turtles (*Pseudemys scripta*) and wood turtles (*Chrysemys inscuplta*). Pond turtles are reported to have best hearing responsiveness between 200 and 700 Hz, with slow declines below 100 Hz and rapid declines above 700 Hz and almost no sensitivity above 3000 Hz (Wever and Vernon 1956). Wood turtles are reported to have sensitivities up to about 500 Hz, followed by a rapid decline above 1000 Hz and almost no responses beyond 3000 or 4000 Hz (Patterson 1966).

4.3.7 Hawksbill Sea Turtle

The hawksbill turtle is small to medium-sized compared to other sea turtle species. Adults weigh 100-150 lbs (45 to 68 kg) on average, but can grow as large as 200 lbs (91 kg). Hatchlings weigh about 0.5 oz (14 g). The carapace (top shell) of an adult ranges from 25 to 35 inches (63 to 90 cm) in length and has a "tortoiseshell" coloring, ranging from dark to golden brown, with streaks of orange, red, and/or black. Male hawksbills mature when they are about 27 inches (69 cm) long. Females mature at about 31 inches (78 cm). The ages at which turtles reach these lengths are unknown.

The hawksbill turtle's head is elongated and tapers to a point, with a beak-like mouth that gives the species its name. The shape of the mouth allows the hawksbill turtle to reach into holes and crevices of coral reefs to find sponges, their primary food source as adults, and other invertebrates. Hawksbill turtles are unique among sea turtles in that they have two pairs of prefrontal scales on the top of the head and each of the flippers usually has two claws.

Female hawksbills return to their natal beaches every 2-3 years to nest at night approximately every 14-16 days during the nesting season. A female hawksbill generally lays 3-5 nests per season, which contain an average of 130 eggs. Hawksbill turtles usually nest high up on the beach under or in the beach/dune vegetation on both calm and turbulent beaches. They commonly nest on pocket beaches, with little or no sand.

The shells of hatchlings are 1-2 inches (about 42 mm) long and are mostly brown and somewhat heart-shaped. The plastron (bottom shell) is clear yellow. The rear edge of the carapace is almost always serrated, except in older adults, and has overlapping "scutes".

Distribution

Hawksbill sea turtles occur in tropical and subtropical seas of the Atlantic, Pacific and Indian Oceans. The species is widely distributed in the Caribbean Sea and western Atlantic Ocean, with individuals from several life history stages occurring regularly along southern Florida and the northern Gulf of Mexico (especially Texas); in the Greater and Lesser Antilles; and along the Central American mainland south to Brazil. Within the United States, hawksbills are most common in Puerto Rico and its associated islands, and in the U.S. Virgin Islands.

In the continental U.S., hawksbill sea turtles have been reported in every state on the coast of the Gulf of Mexico and along the coast of the Atlantic Ocean from Florida to Massachusetts, except for Connecticut; however, sightings of hawksbill sea turtles north of Florida are rare. The only states where hawksbill sea turtles occur with any regularity are Florida (particularly in the Florida Keys and the reefs off Palm Beach County on Florida's Atlantic coast, where the warm waters of the Gulf Stream pass close to shore) and Texas. In both of these states, most sightings are of post-hatchlings and juveniles that are believed to have originated from nesting beaches in Mexico.

Hawksbill sea turtles have stranded along almost the entire Atlantic coast of the United States, although most stranding records occur south of Cape Canaveral, Florida, particularly in Palm Beach, Broward and Miami-Dade counties (Florida Sea Turtle Stranding and Salvage database). During their pelagic-stage, hawksbills disperse from the Gulf of Mexico and southern Florida in the Gulfstream Current, which would carry them offshore of Georgia and the Carolinas. As evidence of this, a pelagic-stage hawksbill was captured 37 nautical miles east of Sapelo Island, Georgia in May 1994 (Parker 2005). There are also records of hawksbill sea turtles stranding on the coast of Georgia (Odell et al. 2008), being captured in pound nets off Savannah, and being captured in summer flounder trawls (Epperly et al. 1995), gillnets (Epperly et al. 1995), and power plants off Georgia and the Carolinas. There are also records of hawksbill sea turtles being captured in pound nets off Savannah, and being captured in summer flounder trawls, gillnets, and power plants off Georgia and the Carolinas (Epperly et al. 1995).

Within United States territories and U.S. dependencies in the Caribbean Region, hawksbill sea turtles nest principally in Puerto Rico and the U.S. Virgin Islands, particularly on Mona Island and Buck Island. They also nest on other beaches on St. Croix, Culebra Island, Vieques Island, mainland Puerto Rico, St. John, and St. Thomas. Within the continental United States, hawksbill sea turtles nest only on beaches along the southeast coast of Florida and in the Florida Keys.

Hawksbill sea turtles occupy different habitats depending on their life history stage. After entering the sea, hawksbill sea turtles occupy pelagic waters and occupy weed lines that accumulate at convergence points. When they grow to about 20-25 cm carapace length, hawksbill sea turtles reenter coastal waters where they inhabit and forage in coral reefs as juveniles, subadults and adults. Hawksbill sea turtles also occur around rocky outcrops and high energy shoals, where sponges grow and provide forage, and they are known to inhabit mangrove-fringed bays and estuaries, particularly along the eastern shore of continents where coral reefs are absent.

Population Structure

Hawksbill sea turtles, like other sea turtles, are divided into regional groupings that represent major oceans or seas: the Atlantic Ocean, Pacific Ocean, Indian Ocean, Caribbean Sea and Mediterranean Sea. In these regions, the population structure of hawksbill turtles is usually based on the distribution of their nesting aggregations (Table 5).

Table 5. Nesting aggregations of hawksbill sea turtles that have been identified using molecular genetics (after Albreu and LeRoux 2006 and Spotila 2004).

Ocean Basin – Nesting Aggregations	**Estimated Number of Nesting Females**
Atlantic (eastern) – Democratic Republic of Sao Tomé and Principe and Equatorial Guinea (particularly, the Island of Bioko)	**200-400**
Atlantic (western) and Caribbean – Antigua, Barbados, Belize, Brazil, Costa Rica, Cuba, Dominican Republic, Guatemala, Jamaica, Martinique, Mexico, Puerto Rico, Turks and Caicos, U.S. Virgin Islands, and Venezuela	**5,000 – 6,000**
Indian Ocean – Andaman and Nicobar Islands, Australia, British Indian Ocean Territories (Cagos Peninsula and southern Maldives), Seychelles, Burma, East Africa, Egypt, Maldives, Oman, Saudi Arabia, Seychelles, Sudan, and Yemen	**6,000 – 7,000**
Pacific Ocean – Australia (Great Barrier Reef to Arnhem Land), Indonesia, Malaysia, Palau, Papua New Guinea, Phillipines, Solomon Islands, Thailand	**10,000**

Threats to the Species

The various habitat types hawksbill sea turtles occupy throughout their lives exposes these sea turtles to a wide variety of natural threats. The beaches on which hawksbill sea turtles nest and the nests themselves are threatened by hurricanes and tropical storms as well as the storm surges, sand accretion, and rainfall that are associated with hurricanes. Hatchlings are hunted by predators like herons, gulls, dogfish, and sharks. Adult hawksbill sea turtles are also killed by sharks and other large, marine predators.

Three human activities are known to threaten hawkbill sea turtles: overharvests of individual animals, incidental capture in commercial fisheries, and human development of coastlines. Historically, the primary cause of the global decline of hawkbill sea turtle populations was overharvests by humans for subsistence and commercial purposes. In the Atlantic, hawksbill sea turtles are still captured and killed in turtle fisheries in Colombia, Grenada, the Lesser Antilles, Nicaragua, St. Vincent and the Grenadines (Brautigam and Eckert 2006).

For centuries, hawksbill sea turtles have been captured for their shells, which have commercial value, rather than food (the meat of hawksbill sea turtles is considered to have a bad taste and can be toxic to humans) ((NMFS and USFWS 1993; NMFS and USFWS 1998d). Until recently, tens of thousands of hawksbills were captured and killed each year to meet demand for jewelry, ornamentation, and whole stuffed turtles (Milliken and Tokunga 1987 cited in Eckert 1993). In 1988, Japan's imports from Jamaica, Haiti and Cuba represented some 13,383 hawksbills: it is extremely unlikely that this volume could have originated solely from local waters (Greenpeace 1989 cited in Eckert 1993).

Although Japan banned the importation of turtle shell in 1994, domestic harvests of eggs and turtles continue in the United States, its territories, and dependencies, particularly in the Caribbean and Pacific Island territories. Large numbers of nesting and foraging hawksbill sea turtles are captured and killed for trade in Micronesia, the Mexican Pacific coast, southeast Asia

and Indonesia ((NMFS and USFWS 1993; NMFS and USFWS 1998d). In addition to the demand for the hawksbill's shell, there is a demand for other products including leather, oil, perfume, and cosmetics. Before the U.S. certified Japan under the Pelly Amendment, Japan had been importing about 20 metric tons of hawksbill shell per year, representing approximately 19,000 turtles.

The second most important threat to hawksbill sea turtles is the loss of nesting habitat caused by the expansion of resident human populations in coastal areas of the world and increased destruction or modification of coastal ecosystems to support tourism. Hawksbill sea turtles are also captured and killed in commercial fisheries. Along the Atlantic coast of the U.S., NMFS estimated that about 650 hawksbill sea turtles are captured in shrimp trawl fisheries each year in the Gulf of Mexico, with most of those sea turtles dying as a result of their capture. Each year, about 35 hawksbill sea turtles are captured in Atlantic pelagic longline fisheries. Although most of these turtles are released alive, these fisheries are expected to kill about 50 hawksbill sea turtles each year; the health effects of being captured on the sea turtles that survive remain unknown.

Like green sea turtles, hawksbill sea turtles are threatened by domestic or domesticated animals that prey on their nests; artificial lighting that disorients adult female and hatchling sea turtles, which can dramatically increase the mortality rates of hatchling sea turtles; beach replenishment; ingestion and entanglement in marine debris; and environmental contaminants.

Oil spills are a risk for all sea turtles. Several aspects of sea turtles life histories put them at risk, including the lack of avoidance behavior of oiled waters and indiscriminate feeding in convergence zones. Sea turtles are air breathers and all must come to the surface frequently to take a breath of air. In a large oil spill, these animals may be exposed to volatile chemicals during inhalation.

Additionally, sea turtles may experience oiling impacts on nesting beaches when they come ashore to lay their eggs, and their eggs may be exposed during incubation potentially resulting in increased egg mortality and/or possibly developmental defects in hatchlings. Hatchlings emerging from their nests may encounter oil on the beach and in the water as they begin their lives at sea.

External Effects: Oil and other chemicals on skin and body may result in skin and eye irritation, burns to mucous membranes of eyes and mouth, and increased susceptibility to infection.

Internal Effects: Inhalation of volatile organics from oil or dispersants may result in respiratory irritation, tissue injury, and pneumonia. Ingestion of oil or dispersants may result in gastrointestinal inflammation, ulcers, bleeding, diarrhea, and maldigestion. Absorption of inhaled and ingested chemicals may damage organs such as the liver or kidney, result in anemia and immune suppression, or lead to reproductive failure or death.

Status

Hawksbill sea turtles were listed as endangered under the ESA in 1970. Under Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, hawksbill sea turtles are identified as "most endangered."

Hawksbill sea turtles are solitary nesters, which makes it difficult to estimate the size of their populations. There are no global estimates of the number of hawksbill sea turtles, but a minimum of 15,000 to 25,000 females are thought to nest annually in more than 60 geopolitical entities (Groombridge and Luxmoore 1989). Moderate populations appear to persist around the Solomon Islands, northern Australia, Palau, Persian Gule islands, Oman, and parts of the Seychelles. In a more recent review, Groombridge and Luxmoore (1989) list Papua New Guinea, Queensland, and Western Australia as likely to host 500-1,000 nesting females per year, while Indonesia and the Seychelles may support >1,000 nesting females. The largest known nesting colony in the world is located on Milman Island, Queensland, Australia where Loop (1995) tagged 365 hawksbills nesting within an 11 week period. With the exception of Mexico, and possibly Cuba, nearly all Wider Caribbean countries are estimated to receive <100 nesting females per year.

Of the 65 geopolitical units on which hawksbill sea turtles nest and where hawksbill nesting densities can be estimated, 38 geopolitical units have hawksbill populations that are suspected or known to be declining. Another 18 geopolitical units have experienced well-substantiated declines (NMFS and USFWS 1995). The largest remaining nesting concentrations occur on remote oceanic islands off Australia (Torres Strait) and the Indian Ocean (Seychelles).

Hawksbill sea turtles, like green sea turtles, are thought to be declining globally as a direct consequence of a historical combination of overexploitation and habitat loss. However, like several of the species we have already discussed, the information available on the status and trend of hawksbill sea turtles do not allow us to make definitive statements about the global extinction risks facing these sea turtles or the risks facing particular populations (nesting aggregations) of these turtles. However, the limited data available suggests that several hawksbill sea turtles populations exist at sizes small enough to be classified as "small" populations (that is, populations that exhibit population dynamics that increase the extinction probabilities of the species or several of its populations) while others are large enough to avoid these problems. Exogenous threats such as overharvests and entanglement in fishing gear only increase their probabilities of becoming extinct in the foreseeable future.

Diving and Social Behavior

The duration of foraging dives in hawksbill sea turtles commonly depends on the size of the turtle: larger turtles dive deeper and longer. At a study site also in the northern Caribbean, foraging dives were made only during the day and dive durations ranged from 19-26 minutes in duration at depths of 8-10 m. At night, resting dives ranged from 35-47 minutes in duration (vanDam and Diez 1997).

Vocalizations and Hearing

There is no information on hawksbill sea turtle vocalizations or hearing. However, we assume that their hearing sensitivities will be similar to those of green and loggerhead sea turtle: their best hearing sensitivity will be in the low frequency range: from 200 to 400 Hz with rapid declines for tones at lower and higher frequencies. Their hearing will probably have a practical upper limit of about 1000 Hz (Bartol et al. 1999; Ridgway et al. 1969).

These hearing sensitivities are similar to the hearing sensitivities reported for two terrestrial species: pond turtles (*Pseudemys scripta*) and wood turtles (*Chrysemys inscuplta*). Pond turtles are reported to have best hearing responsiveness between 200 and 700 Hz, with slow declines below 100 Hz and rapid declines above 700 Hz and almost no sensitivity above 3000 Hz (Wever and Vernon 1956). Wood turtles are reported to have sensitivities up to about 500 Hz, followed by a rapid decline above 1000 Hz and almost no responses beyond 3000 or 4000 Hz (Patterson 1966).

5 ENVIRONMENTAL BASELINE

By regulation, environmental baselines for biological opinions include the past and present impacts of all state, Federal or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR §402.02). The environmental baseline for this Opinion includes the effects of a wide variety of natural phenomena and human activities in the action area.

A number of human activities have contributed to the current status of populations of large whales and sea turtles in the action area. Some of those activities, most notably commercial whaling, occurred extensively in the past, ended, and no longer appear to affect these whale populations, although the effects of these reductions likely persist today. Other human activities are ongoing and appear to continue to affect populations of endangered and threatened whale and sea turtle. The following discussion summarizes the principal phenomena that are known to affect the likelihood that these endangered and threatened species will survive and recover in the wild.

5.1 Natural Phenomena

The natural phenomena include changes in oceanic temperature regimes and ambient noises in the ocean environment which vary both in location and season. El Niño-Southern Oscillation (ENSO), resulting from the large-scale global interaction of atmospheric and oceanic circulation, is an inter-annual climatic phenomenon (approximately 3-8 years) that creates temperature fluctuations in the tropical surface waters of the Pacific Ocean. ENSO events can have a significant impact on ecosystems due to changing surface winds, ocean currents, water temperatures, ocean nutrient availability, storm frequency and magnitude.

Ambient noise levels are higher in the northern hemisphere, where sources of anthropogenic sounds are more pervasive. However, even in relatively quiet regions in the southern hemisphere, ambient noise levels will commonly vary by 20 dB and will vary by 30 dB with lower frequency because of biological sources and sea surface noise (Cato and McCauley. 2001). There are numerous ambient sources of noise that have frequencies that are comparable to SURTASS LFA sonar:

- *Wind and waves* are common and interrelated sources of ambient noise in all of the world's oceans. All other factors being equal, ambient noise levels tend to increase with increasing wind speed and wave height (Richardson et al. 1995). Noise generated by surface wave activity and biological sounds is the primary contributor over the frequency range from 300 Hz to 5 kHz. The wind-generated noise level decreases smoothly with increasing acoustic frequency (i.e., there are no spikes at any given frequency).
- *Precipitation.* At some frequencies, rain and hail will increase ambient noise levels. Significant noise is produced by rain squalls over a range of frequencies from 500 Hz to 15 kHz. Large storms with heavy precipitation can generate noise at frequencies as low as 100 Hz and significantly affect ambient noise levels at a considerable distance from a storm's center. Lightning strikes associated with storms are loud, explosive events that deliver an average of 100 kilojoules per meter (kJ/m) of energy (Considine 1995). Hill (1985) estimated the source level for cloud-to-water pulse to be 260.5 dB. It has been estimated that over the earth's oceans the frequency of lightning averages about 10 flashes per second, or 314 million strikes per year (Kraght 1995).
- *Seismic Phenomena*. In the Pacific Ocean, about 10,000 natural, seismic phenomena like earthquakes, underwater volcanic eruptions, and landslides occur each year (Fox et al. 2001). These phenomena produce sounds with source levels exceeding 210 dB.
- *Biological noises* are sounds created by animals in the sea and may contribute significantly to ambient noise in many areas of the oceans (Curtis et al. 1999). Because of the habits, distribution, and acoustic characteristics of these sound producers, certain areas of the oceans are louder than others. Only three groups of marine animals are known to make sounds: crustaceans (such as snapping shrimp), true fish, and marine mammals (Urick 1983). The most widespread, broadband noises from animal sources (in shallow water) are those produced by croakers (representative of a variety of fish classified as drumfish) (100 Hz to 10 kHz) and snapping shrimp (500 Hz to 20 kHz). Sound-producing fishes and crustaceans are restricted almost entirely to bays, reefs, and other coastal waters, although there are some pelagic, sound-producing fish. In oceanic waters, whales and other marine mammals are principal contributors to biological noise. For

example, dolphins produce whistles associated with certain behaviors, and the baleen whales are noted for their low frequency vocalizations.

5.2 Human Activities

Anthropogenic noises that could affect ambient noise arise from the following general types of activities in and near the sea, any combination of which can contribute to the total noise at any one place and time. These noises include transportation, dredging, construction; oil, gas, and mineral exploration in offshore areas; geophysical (seismic) surveys; sonars; explosions; and ocean research activities (Richardson et al. 1995).

5.2.1 Anthropogenic Noise

The marine mammals that occur in the action area are regularly exposed to several sources of natural and anthropogenic sounds. Anthropogenic noises that could affect ambient noise arise from the following general types of activities in and near the sea, any combination of which can contribute to the total noise at any one place and time. These noises include transportation, dredging, construction; oil, gas, and mineral exploration in offshore areas; geophysical (seismic) surveys; sonars; explosions; and ocean research activities (Richardson et al. 1995).

Noise in the marine environment has received a lot of attention in recent years and is likely to continue to receive attention in the foreseeable future. Several investigators have argued that anthropogenic sources of noise have increased ambient noise levels in the ocean over the last 50 years (Jasny et al. 2005; NRC 1994; NRC 2000; NRC 2003a; NRC 2005; Richardson et al. 1995). Much of this increase is due to increased shipping as ships become more numerous and of larger tonnage (NRC 2003a). Commercial fishing vessels, cruise ships, transport boats, airplanes, helicopters and recreational boats all contribute sound into the ocean (NRC 2003a). The military uses sound to test the construction of new vessels as well as for naval operations. In some areas where oil and gas production takes place, noise originates from the drilling and production platforms, tankers, vessel and aircraft support, seismic surveys, and the explosive removal of platforms (NRC 2003a). Many researchers have described behavioral responses of marine mammals to the sounds produced by helicopters and fixed-wing aircraft, boats and ships, as well as dredging, construction, geological explorations, etc. (Richardson et al. 1995). Most observations have been limited to short-term behavioral responses, which included cessation of feeding, resting, or social interactions. Several studies have demonstrated short-term effects of disturbance on humpback whale behavior (Baker et al. 1983; Bauer and Herman 1986; Hall 1982; Krieger and Wing 1984) 1984), but the long-term effects, if any, are unclear or not detectable. Carretta et al. (2001) and Jasny et al. (2005) identified the increasing levels of anthropogenic noise as a habitat concern for whales and other cetaceans because of its potential effect on their ability to communicate.

5.2.2 Surface Shipping

Surface shipping is the most widespread source of anthropogenic, low frequency (0 to 1,000 Hz) noise in the oceans (Simmonds and Hutchinson 1996). The Navy estimated that the 60,000

vessels of the world's merchant fleet annually emit low frequency sound into the world's oceans for the equivalent of 21.9 million days, assuming that 80 percent of the merchant ships at sea at any one time (Navy 2001b). The radiated noise spectrum of merchant ships ranges from 20 to 500 Hz and peaks at approximately 60 Hz. Ross (1976) has estimated that between 1950 and 1975 shipping had caused a rise in ambient ocean noise levels of 10 dB. He predicted that this would increase by another 5 dB by the beginning of the 21st century. The National Research Council (NRC 2003a) 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.

5.2.3 Seismic Surveys

Seismic survey airguns have source levels reaching and exceeding 250 dB (Richardson et al. 1995) with a "shot" every 15 seconds, or 240 shots per hour, 24 hours per day. Each airgun shot of a few milliseconds contains less acoustic energy than a single, 60-second SURTASS LFA sonar ping. Seismic survey airguns operate seven days a week. For example, a seismic survey vessel normally works for at least two weeks straight, producing almost 81,000 shots.

5.2.4 Fisheries

Foreign high-seas driftnet fishing in the North Pacific Ocean for squid, tuna and billfish ended with a United Nations moratorium in December, 1992. Except for observer data collected in 1990-1991, there is virtually no information on the incidental take of threatened and endangered species by the driftnet fisheries prior to the moratorium. The high seas squid driftnet fishery in the North Pacific was observed in Japan, Korea, and Taiwan, while the large-mesh fisheries targeting tuna and billfish were observed in the Japanese fleet (1990-91) and the Taiwanese fleet (1990). A combination of observer data and fleet effort statistics indicate that 4,373 turtles, mostly loggerheads and leatherbacks, were entangled by the combined fleets of Japan, Korea and Taiwan during June, 1990 through May, 1991, when all fleets were monitored. Of these incidental entanglements, an estimated 1,011 turtles were killed (77 percent survival rate).

Numerous longline fisheries occur in the Pacific Ocean. These fisheries have had significant impacts on threatened and endangered species. One of these, the Japanese tuna longliners in the Western Pacific Ocean and South China Sea has been estimated to capture 21,200 sea turtles, including green, leatherback turtle, loggerhead, olive ridley and hawksbill sea turtles each year. These interactions kill about 12,300 of these sea turtles each year.

Other fisheries include coastal fisheries off Japan, coastal setnet and gillnet fisheries off Taiwan, foreign and U.S. purse seine fisheries for tuna in the eastern tropical Pacific Ocean, and multi-gear fisheries in the North Pacific Ocean (Bering Sea, Aleutian Islands, and Gulf of Alaska). Several of these fisheries have been implicated in the declining trend of several threatened and endangered species (for example, Steller sea lions, which will be discussed in the following section).

5.2.5 Commercial and Private Marine Mammal Watching

In addition to being exposed to commercial vessel traffic, fishing vessels, and fishing gear, the endangered whales being considered in this Biological Opinion are also exposed to private and

commercial vessels engaged in marine mammal watching (within the Action Area and elsewhere within their range in the Pacific Ocean). A recent study of whale watch activities worldwide has found that the business of viewing whales and dolphins in their natural habitat has grown rapidly over the past decade into a billion dollar ($US) industry involving over 80 countries and territories and over 9 million participants (Hoyt 2001).

In 1988, a workshop sponsored by the Center for Marine Conservation and NOAA-Fisheries was held in Monterey, California to review and evaluate whale watching programs and management needs (CMC and NMFS 1988). That workshop produced several recommendations for addressing potential harassment of marine mammals during wildlife viewing activities that include developing regulations to restrict operating thrill craft near cetaceans, swimming and diving with the animals, and feeding cetaceans in the wild.

Since then, NMFS has promulgated regulations that specifically prohibit: (1) the negligent or intentional operation of an aircraft or vessel, or the doing of any other negligent or intentional act which results in disturbing or molesting a marine mammal; (2) feeding or attempting to feed a marine mammal in the wild; and (3) approaching humpback whales closer than 100 yards (91.4 m) in Hawaii and Alaska waters. In addition, NMFS launched an education and outreach campaign to provide commercial operators and the general public with responsible marine mammal viewing guidelines which in part state that viewers should: (1) remain at least 50 yards from dolphins, porpoise, seals, sea lions and sea turtles and 100 yards from large whales; (2) limit observation time to 30 minutes; (3) never encircle, chase or entrap animals with boats; (4) place boat engine in neutral if approached by a wild marine mammal; (5) leave the water if approached while swimming; and (6) never feed wild marine mammals. In January 2002, NMFS also published an official policy on human interactions with wild marine mammals which states that: "*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 with, 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 has several potential negative consequences for endangered whales and other marine mammals. One concern is that animals may become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle et al. 1993; Wiley et al. 1995). Another concern is that marine mammals may abandon waters that are important to their ecology if levels of disturbance associated with whale watching and research become too high. In the Notice of Availability of Revised Whale Watch Guidelines for Vessel Operations in the Northeastern United States (64 FR 29270; June 1, 1999), NMFS noted that whale watch vessel operators seek out areas where whales concentrate, which has led to numbers of vessels congregating around groups of whales that are foraging, rearing newborn calves, or engaged in courtship behavior.

Several investigators have studied the effects of whale watch vessels on marine mammals (Amaral and Carlson 2005; Au and Green 2000; Corkeron 1995; Erbe 2002b; Felix 2001; Magalhaes et al. 2002; Richter et al. 2006; Scheidat et al. 2004; Simmonds 2005; Watkins 1986; Williams et al. 2002). The whale's behavioral responses to whale watching vessels depended on the distance of the vessel from the whale, vessel speed, vessel direction, vessel noise, and the number of vessels. The whales' 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.

5.2.6 Scientific Research

Marine mammals have been the subject of field studies for decades. The primary objective of most of these studies has generally been monitoring populations or gathering data for behavioral and ecological studies. Over time, NMFS has issued dozens of permits for various non-lethal forms of "take" of marine mammals in the proposed action area from a variety of activities, including aerial and vessel surveys, photo-identification, remote biopsy sampling, and attachment of scientific instruments.

For example, existing permits authorized activities in 2012 allow investigators to harass, pursue, shoot, and wound about 675 endangered North Pacific right whales each year for photo-identification and behavioral observation; harass, pursue, and shoot up to 60 of these right whales per year to place tags; harass, pursue, shoot, and wound 108 animals to take biopsy samples. Since the right whale population in the North Pacific has been estimated to consist of between 29 and 100 individuals (fewer than 30 individual whales have been identified since the 1950s), existing permits allow investigators to harass each of these endangered whales several times for different research purposes.

Existing permits (activites anticipated in 2012) authorize investigators to make close approaches of other endangered whales species for photographic identification, behavioral observations, passive acoustic recording, aerial photogrammetry, and underwater observation. Existing permits authorize approximately 16,100 close approaches of blue whales, 22,000 close approaches of fin whales, 41,000 close approaches of humpback whales, 675 close approaches of north Pacific right whales, 3,900 close approaches of sei whales, and 17,500 close approaches of sperm whales per year in the Pacific Ocean for these purposes. In addition, existing permits authorize close approaches to take biopsy samples of 2,570 blue whales, 4,565 fin whales, 5,790 humpback whales, 108 North Pacific right whales, 592 sei whales, and 3,050 sperm whales per year in the Pacific Ocean.

In practice, the actual number of close approaches does not appear to have closely approximated the number of close approaches authorized by existing permits. Nevertheless, because existing permits authorize the number of close approaches, nothing prevents the different whale species from being exposed to those levels of close approaches by investigators each year.

After decades of this research, the cumulative impact of current research on the population ecology of endangered whales remains unknown (Moore et al. 2003). This is particularly problematic because so much research occurs in areas that are critical to the population ecology of whales, such as the calving areas in Hawaii and feeding areas in Alaska. Events or activities that disrupt the behavior of animals in these critical areas could have substantial, long-term consequences for their ecology.

5.2.7 The Impact of the Whalewatching and Research on Listed Resources

The primary lines of evidence that might suggest that existing levels of whale watching and close approaches for field investigations would not be expected to have adverse consequence for individual whales or populations of those whales consist of the trend of the whale populations and a few published papers. Specifically, several investigators offer the increasing trend of the whale populations, particularly populations of humpback whales, to conclude that current levels of research have not had adverse consequence.

This evidence is not compelling for several reasons. First, the trend of these whale populations remains uncertain (one of the objectives of the proposed investigations is to collect the data necessary to provide a basin-wide estimate of humpback whale populations) and changes in those trends may reflect improvements in sampling techniques or changes in their geographic distribution. Second, if we allow that whale abundance for some populations are increasing, those populations might recover at a faster rate without the chronic effects of human disturbance. Finally, the activities in question would have primarily sub-lethal consequences on individual whales (that is, they would affect their growth, health, or reproductive success) whose consequences on whale populations would be delayed in time and would be concealed by any imprecision in population estimates.

The second line of evidence consists of reports from investigators and published literature that suggests that the response of whales to research were short-lived, which we interpret to mean that the responses would not be expected to affect the fitness of individual whales. Annual reports from the North Gulf Oceanic Society and two other investigators reported that most whales did not react to approaches by their vessels or only small numbers of whales reacted. For example, in their 1999 report on their research activities, the North Gulf Oceanic Society noted that they observed signs that whales were “disturbed” in only 3 out of 51 encounters with whales and that the whales’ behavioral responses consisted of breaching, slapping tail and pectoral fin, and diving away from research vessel.

Gauthier and Sears (1999), Weinrich et al. (1992), Clapham and Mattila (1993), Clapham et al. (1993) concluded that close approaches for biopsy samples or tagging did cause humpback whales to respond or caused them to exhibit “minimal” responses when approaches were “slow and careful.” This caveat is important and is based on studies conducted by Clapham and Mattila (1993) of the reactions of humpback whales to biopsy sampling in breeding areas in the Caribbean Sea. These investigators concluded that the way a vessel approaches a group of whales had a major influence on the whale’s response to the approach; particularly cow and calf

pairs. Based on their experiments with different approach strategies, they concluded that experienced, trained personnel approaching humpback whales slowly would result in fewer whales exhibiting responses that might indicate stress.

Several lines of evidence suggest that the consequences of these human activities might be greater than we expect for individual whales, if not for whale populations. First, it is important to note that Clapham and Matilla (1993) noted that any human observations of a whale's behavioral response may not reflect a whale's actual experience, so our use of behavioral observations as indicators of a whale's response to research may or may not be correct. The whales in the action area may have habituated to being closely approached by researchers and whale watch vessels, which would suggest that the whales would not perceive these close approaches as potential threats and, therefore, would not respond behaviorally to close approaches or experience stress responses (Fowler 1999; Romero and Wikelski 2002).

Several investigators reported behavioral responses to close approaches that suggest that individual whales might experience stress responses. Baker et al. (1983) described two responses of whales to vessels, including: (1) "horizontal avoidance" of vessels 2,000 to 4,000 m away characterized by faster swimming and fewer long dives; and (2) "vertical avoidance" of vessels from 0 to 2,000 m away during which whales swam more slowly, but spent more time submerged. Watkins (1981c) found that both finback and humpback whales appeared to react to vessel approach by increasing swim speed, exhibiting a startled reaction, and moving away from the vessel with strong fluke motions. Bauer (1986) and Bauer and Herman (1986) studied the potential consequences of vessel disturbance on humpback whales wintering off Hawaii. They noted changes in respiration, diving, swimming speed, social exchanges, and other behavior correlated with the number, speed, direction, and proximity of vessels. Results were different depending on the social status of the whales being observed (single males when compared with cows and calves), but humpback whales generally tried to avoid vessels when the vessels were 0.5 to 1.0 kilometer from the whale. Smaller pods of whales and pods with calves seemed more responsive to approaching vessels.

Bauer (1986) and Bauer and Herman (1986) summarized the response of humpback whales to vessels in their summering areas and reached conclusions similar to those reached by Bauer and Herman (1986): these stimuli are probably stressful to the humpback whales in the action area, but the consequences of this stress on the individual whales remains unknown. Studies of other baleen whales, specifically bowhead and gray whales document similar patterns of short-term, behavioral disturbance in response to a variety of actual and simulated vessel activity and noise (Malme et al. 1983; Richardson et al. 1985). For example, studies of bowhead whales revealed that these whales oriented themselves in relation to a vessel when the engine was on, and exhibited significant avoidance responses when the vessel's engine was turned on even at distance of approximately 3,000 ft (900 m). Weinrich et al. (1992) associated "moderate" and "strong" behavioral responses with alarm reactions and stress responses, respectively.

Jahoda et al. (2003) studied the response of 25 fin whales in feeding areas in the Ligurian Sea to close approaches by inflatable vessels and biopsy samples. They concluded that close vessel approaches caused these fin whales to stop feeding and swim away from the approaching vessel. The fin whales also tended to reduce the time they spent at surface and increase their blow rates, suggesting an increase in their metabolic rates which might indicate a stress response to the approach. In their study, whales that had been disturbed while feeding remained disturbed indefinitely after the exposure ended. They recommended keeping vessels more than 200 m from whales and having approaching vessels move a low speeds to reduce visible reactions in these whales.

The low, relative frequency of "no responses": when compared with "moderate" and "strong" behavioral responses noted in the literature would suggest that most of the whales that might be exposed to close approaches in Hawaiian waters are not habituated to those approaches and would still perceive the close approaches as potential threats. If these responses are representative of the most serious consequences these whales might experience as a result of their exposure to close approaches, the different species of whale have been exposed to a large number of stressful stimuli each year for several years. Because of the duration of the existing permits, those whales will continue to experience stressful stimuli for several years into the future.

Using the results produced by Weinrich et al. (1992) as representative of the range and relative frequency of behavioral responses these whales might exhibit to these close approaches produces the results presented in Table 6.

Table 6. Response of different species of whales to the number of close approaches (using the results produced by Weinrich et al. (1992) as representative of the range and frequency of responses).

Species	Low-level	Moderate	Strong
Blue whale	1,806	4,084	377
Fin whale	3,666	8,290	766
Humpback whale	6,563	14,841	1,371
Northern right whale	107	242	22
Sei whale	804	1,818	168
Sperm whale	5,365	12,132	1,121

The values described in that table describe the number of times whales might exhibit "low-level," "moderate," and "strong" responses to the estimated number of close approaches described in Table 6. Beale and Monaghan (2004) concluded that the level of disturbance was a function of the distance of humans to the animals, the number of humans making a close approach, and the frequency of the approaches. Their results suggest that the aggregate effects of the various human activities in Hawaiian waters are probably greater than the effects of the different activities individually.

None of the existing studies examined the potential effects of numerous close approaches on whales or gathered information of levels of stress-related hormones in blood samples that are more definitive indicators of stress (or its absence) in animals. However, there is increasing evidence that wild animals respond to human disturbance in the same way that they respond to predators. These responses manifest themselves as stress responses (in which an animal perceives human activity as a potential threat and undergoes physiological changes to prepare for a flight or fight response or more serious physiological changes with chronic exposure to stressors), interruptions of essential behavioral or physiological events, alteration of an animal's time budget, or some combinations of these responses (Frid and Dill 2002; Romero 2004; Sapolsky 2000; Walker et al. 2005). These responses have been associated with abandonment of sites (Sutherland and Crockford 1993), reduced reproductive success (Giese 1996; Müllner et al. 2004), and the death of individual animals (Daan et al. 1996).

Of the evidence available, we must accept the empirical studies as more informative. We must provisionally assume that close approaches for research are likely to be stressful for some of the whales although the significance of this stress response or its consequences on the fitness of individual whales remains unknown. Recognizing that the existing research permits require investigators to adopt the procedures developed by Clapham and Mattila (1993) for biopsy sampling of humpback whales in the West Indies, we provisionally assume that current levels of close approaches produce the same results as Clapham and Matilla (1993): short- to mid-term stress responses that have are not likely to produce long-term behavioral changes that have fitness consequences for individual whales or that might exacerbate the response of these whales to other potential stressors like sonar, contaminants, and generalized human disturbance.

5.3 Natural Mortality

Natural mortality rates in cetaceans, especially large whale species, are largely unknown. Although factors contributing to natural mortality cannot be quantified at this time, there are a number of suspected causes, including parasites, predation, red tide toxins and ice entrapment. For example, the giant spirurid nematode (*Crassicauda boopis*) has been attributed to congestive kidney failure and death in some large whale species (Lambertsen 1986). A well-documented observation of killer whales attacking a blue whale off Baja, California proves that blue whales are at least occasionally vulnerable to these predators (Tarpy 1979). Other stochastic events, such as fluctuations in weather and ocean temperature affecting prey availability, may also contribute to large whale natural mortality.

Sea turtles are also affected by disease and environmental factors. Turtles can be injured by predators such as birds, fish, and sharks (George 1997). Hypothermic or cold stunning occurs when a turtle is exposed to cold water for a period of time. Cold stunned turtles often have decreased salt gland function which may lead to plasma electrolyte imbalance and a lowered immune response (George 1997).

5.4 Human-Induced Mortality

Large whale population numbers in the proposed action areas have historically been impacted by commercial exploitation, mainly in the form of whaling. Prior to current prohibitions on whaling, such as the International Whaling Commission's 1966 moratorium, most large whale species had been depleted to the extent it was necessary to list them as endangered under the Endangered Species Act of 1966. For example, from 1900 to 1965 nearly 30,000 humpback whales were captured and killed in the Pacific Ocean with an unknown number of additional animals captured and killed before 1900 (Perry et al. 1999a). Sei whales are estimated to have been reduced to 20 percent (8,600 out of 42,000) of their pre-whaling abundance in the North Pacific (Tillman 1977). In addition, 9,500 blue whales were reported killed by commercial whalers in the North Pacific between 1910-1965 (Ohsumi and Wada. 1972); 46,000 fin whales between 1947-1987 (Rice 1984); and 25,800 sperm whales (Barlow et al. 1997). North Pacific right whales once numbered 11,000 animals but commercial whaling has now reduced their population to 29-100 animals (Wada 1973).

Entrapment and entanglement in commercial fishing gear is one of the most frequently documented sources of human-caused mortality in large whale species and sea turtles. For example, in 1978, Nishimura and Nakahigashi (1990) estimated that 21,200 turtles, including greens, leatherback turtles, loggerheads, olive ridleys and hawksbills, were captured annually by Japanese tuna longliners in the Western Pacific and South China Sea, with a reported mortality of approximately 12,300 turtles per year. Using commercial tuna longline logbooks, research vessel data and questionnaires, Nishimura and Nakahigashi (1990) estimated that for every 10,000 hooks in the Western Pacific and South China Sea, one turtle is captured, with a mortality rate of 42 percent.

NMFS has observed 3,251 sets, representing approximately 3,874,635 hooks (data from February 1994 through December 31, 1999). The observed entanglement rate for sperm whales would equal about 0.31 whales per 1,000 sets or 0.0002 per 1,000 hooks. At those rates, we would expect about 200 sperm whales entanglements per 1,000 sets. However, only one sperm whale has been entangled in this gear; as a result, NMFS believes that the estimated entanglement rate substantially overestimates a sperm whale's actual probability of becoming entangled in this gear and the potential hazards longline gear poses to sperm whales.

Collisions with commercial ships are an increasing threat to many large whale species, particularly as shipping lanes cross important large whale breeding and feeding habitats or migratory routes. The number of observed physical injuries to humpback whales as a result of ship collisions has increased in Hawaiian waters (Glockner-Ferrari et al. 1987). On the Pacific coast, a humpback whale is probably killed about every other year by ship strikes (Barlow et al. 1997). From 1996-2002, eight humpback whales were reported struck by vessels in Alaskan waters. In 1996, a humpback whale calf was found stranded on Oahu with evidence of vessel collision (propeller cuts; NMFS unpublished data). From 1994 to 1998, two fin whales were presumed to have been killed in ship strikes.

Chronic exposure to the neurotoxins associated with paralytic shellfish poisoning (PSP) via zooplankton prey has been shown to have detrimental effects on marine mammals. Estimated ingestion rates are sufficiently high to suggest that the PSP toxins are affecting marine mammals, possibly resulting in lower respiratory function, changes in feeding behavior and lower reproduction fitness (Durbin et al. 2002). Other human activities, including discharges from wastewater systems, dredging, ocean dumping and disposal, aquaculture and additional impacts from coastal development are also known to impact marine mammals and their habitat. In the North Pacific, undersea exploitation and development of mineral deposits, as well as dredging of major shipping channels pose a continued threat to the coastal habitat of right whales. Point-source pollutants from coastal runoff, offshore mineral and gravel mining, at-sea disposal of dredged materials and sewage effluent, potential oil spills, as well as substantial commercial vessel traffic, and the impact of trawling and other fishing gear on the ocean floor are continued threats to marine mammals in the proposed action area.

The impacts from these activities are difficult to measure. However, some researchers have correlated contaminant exposure to possible adverse health effects in marine mammals. Studies of captive harbor seals have demonstrated a link between exposure to organochlorines (*e.g.*, DDT, PCBs, and polyaromatic hydrocarbons) and immunosuppression (De Swart et al. 1996; Harder et al. 1992; Ross et al. 1995). Organochlorines are chemicals that tend to bioaccumulate through the food chain, thereby increasing the potential of indirect exposure to a marine mammal via its food source. During pregnancy and nursing, some of these contaminants can be passed from the mother to developing offspring. Contaminants like 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 (O'Hara and Rice 1996; O'Hara et al. 1999; O'Shea and Brownell Jr. 1994).

The marine mammals that occur in the action area are regularly exposed to several sources of natural and anthropogenic sounds. Anthropogenic noises that could affect ambient noise arise from the following general types of activities in and near the sea, any combination of which can contribute to the total noise at any one place and time. These noises include transportation, dredging, construction; oil, gas, and mineral exploration in offshore areas; geophysical (seismic) surveys; sonars; explosions; and ocean research activities (Richardson et al. 1995).

5.4.1 Ship Strikes

Collisions with commercial ships are an increasing threat to many large whale species, particularly as shipping lanes cross important large whale breeding and feeding habitats or migratory routes. The number of observed physical injuries to humpback whales as a result of ship collisions has increased in Hawaiian waters (Glockner-Ferrari et al. 1987). On the Pacific coast, a humpback whale is probably killed about every other year by ship strikes (Barlow *et al*. 1997). From 1996-2002, eight humpback whales were reported struck by vessels in Alaskan waters. In 1996, a humpback whale calf was found stranded on Oahu with evidence of vessel

collision (propeller cuts; NMFS unpublished data). From 1994 to 1998, two fin whales were presumed to have been killed in ship strikes.

Collisions with commercial ships are an increasing threat to many large whale species, particularly because shipping lanes cross important large whale breeding and feeding habitats or migratory routes. Based on the data available from Douglas et al. (2008), Jensen and Silber (2004), and Laist et al. (2001), there have been at least 25 incidents in which marine mammals are known to have been struck by ships in the Puget Sound region and southwestern British Columbia. The marine mammals that were involved in almost half of these incidents died as a result of the strike and they suffered serious injuries in four of those strikes.

Fin whales were struck most frequently, accounting for almost 30 percent of the total number of incidents and two-thirds of the incidents in which the whale died as a result of the collision. Northern resident killer whales were struck slightly less frequently, although a cluster of ship strikes in 2006 accounted for four of the six ship strikes involving this population of killer whales. Humpback whales were third in frequency, followed by southern resident killer whales, offshore killer whales, and blue whales. About two-thirds (17 out of the 25) of the incidents occurred in waters off British Columbia, although the locations were variable.

Historical records suggest that ship strikes fatal to whales first occurred late in the 1800s as ships began to reach speeds of 13-15 knots, remained infrequent until about 1950, and then increased during the 1950s-1970s as the number and speed of ships increased. Of 11 species known to be hit by ships, fin whales are struck most frequently; right whales, humpback whales, sperm whales, and gray whales are hit commonly (Laist et al. 2001; Vanderlaan and Taggart 2007). In some areas, one-third of all fin whale and right whale strandings appear to involve ship strikes (Laist et al. 2001). All sizes and types of vessels can hit whales; most lethal or severe injuries are caused by ships 80 m or longer; whales usually are not seen beforehand or are seen too late to be avoided; and most lethal or severe injuries involve ships travelling 14 knots or faster (Laist et al. 2001) . Ship strikes can significantly affect small populations of whales, such as northern right whales in the western North Atlantic. In areas where special caution is needed to avoid such events, measures to reduce the vessel speed below 14 knots may be beneficial (Laist et al. 2001).

5.5 The Impact of the Baseline on Listed Resources

The information available does not allow us to assess the actual or probable effects of natural and anthropogenic phenomena on threatened or endangered species in the action area. The age composition, gender ratios, population abundance, and changes in that abundance over time remain unknown for threatened and endangered species in the action area of this consultation. Without this information or some surrogate information, it would be difficult, if not impossible, to reliably assess the impact of the activities identified in this *Environmental Baseline* on threatened and endangered species in the action area.

6 EFFECTS OF THE PROPOSED ACTION

NMFS assesses the probable direct and indirect effects of Federal actions and interrelated and interdependent actions on threatened and endangered species and designated critical habitat. The purpose of this assessment is to determine if it is reasonable to expect that (a) NMFS' proposed letters of authorization for the take of marine mammals incidental to the military readiness activities on the Mariana Island Range Complex including mitigative measures the Navy would employ to avoid the potential, adverse effects of the activities and (b) the U.S. Navy's military readiness activities will have direct or indirect effects on threatened and endangered species that appreciably reduce their likelihood of surviving and recovering in the wild (which is the jeopardy standard established by 50 CFR §402.02).

6.1 Stressors Associated with the Proposed Action

The primary stressors associated with the military readiness activities the U.S. Navy proposes to conduct in waters on and adjacent to the Mariana Islands Range Complex consist of:

1. Movement of surface vessels, submarines, and aircraft involved in training activities with the associated risk of disturbance;
2. Movement of surface vessels and submarines and the associated risk of collision with protected species;
3. Nonexplosive ordnance and gunfire and the associated risks of ordnance-related materials and disturbance;
4. Expended materials, including chemicals released from explosives, training targets, chaff, and flares;
5. Parachutes associated with flares and sonobuoys;
6. Pressure waves produced by underwater detonations;
7. Sound fields produced by the low-, mid-, and high-frequency active sonar systems used during training activities;
8. Sound fields produced by the underwater detonations the U.S. Navy would employ during training activities.

Below we discuss these stressors and the potential risks they posed to listed species. Next we evaluate the available evidence to determine the likelihood of listed species being exposed to these stressors. Our analysis assumed that these stressors pose no risk to listed species or critical habitat if these stressors do not co-occur with those species or critical habitat in space or time. We recognize that the sonar could have indirect, adverse effects on listed species or critical habitat by disrupting marine food chains, a species' predators, or a species' competitors; however, we did not identify situations where this concern might apply to species under NMFS' jurisdiction.

6.1.1 Traffic from Surface Vessels, Submarines and Aircraft

Most of the activities the U.S. Navy proposes to conduct in the Mariana Islands Range Complex involve some level of activity from surface vessels, submarines, or both. Carrier Strike Groups can include one aircraft carrier, one carrier air wing, four strike fighter squadrons, one electronic combat squadron, one airborne early warning squadron, two combat helicopter squadrons, two logistics aircraft, five surface combatant ships (guided missile cruisers, destroyers, and frigates), one attack submarine, and one logistics support ship. Expeditionary Strike Groups can include three amphibious ships, utility landing craft, air-cushioned landing craft, amphibious assault vehicle or expeditionary fighting vehicle, three surface combatant ships, three combat helicopter detachments, one attack submarine, one marine expeditionary unit (Special Operations Capable) of 2,200 Marines, ground combat and combat logistics elements, and composite aviation squadron of fixed-wing aircraft and helicopters. Surface Strike Groups can include three surface ships, surface combatants, amphibious ships, one combat helicopter detachment, and one attack submarine. An expeditionary strike force can combine more than one carrier strike group, expeditionary strike group, or surface strike group.

Because of the number of vessels involved in U.S. Navy training exercises, their speed, their use of course changes as a tactical measure, and sounds associated with their engines and displacement of water along their bowline, the available evidence leads us to expect marine mammals to treat Navy vessels as potential stressors. Further, without considering differences in sound fields associated with any active sonar used during Navy training activities, the available evidence suggests that major training exercises (for example, joint expeditionary exercises or joint mult-strike group exercises), unit-level, or intermediate-level exercises would represent different stress regimes because of differences in the number of vessels involved, vessel maneuvers, and vessel speeds.

The size of the vehicles involved in the proposed training activities would range from 362 ft (a nuclear submarine) to 1,092 ft (for a nuclear-powered aircraft carrier). A variety of smaller craft such as service vessels engaged in routine operations or employed as opposition forces during training events would also operate within the range complex. During training activities, ship speeds generally range from 10 to 14 knots; however, these vessels would also operate within the entire spectrum at higher speeds during specific events, such as pursuing and overtaking hostile vessels, evasive maneuvers, and maintenance or performance checks. The size and speeds of smaller vessels would vary. For example, rigid hull inflatable boats or RHIBS are 35 ft in length and can reach speeds greater than 40 knots.

Sounds emitted by large vessels can be characterized as low-frequency, continuous, or tonal and sound pressure levels at a source will vary according to speed, burden, capacity and length (Richardson et al. 1995). Vessels ranging from 135 to 337 m (Nimitz-class aircraft carriers, for example, have lengths of about 332 m) generate peak source sound levels from 169-200 dB between 8 Hz and 430 Hz. Given the sound propagation of low frequency sounds, a large vessel in this sound range can be heard 139-463 km away (Ross 1976 in (Polefka 2004).

The underwater noise generated by vessels may disturb animals when the animal perceives that an approach has started and during the course of the interaction. The combination of the physical presence of a surface vessel and the underwater noise generated by the vessel, or an interaction between the two may result in behavioral modifications of animals in the vicinity of the vessel or submarine (Goodwin and Cotton. 2004; Lusseau 2006). Several authors, however, suggest that the noise generated by the vessels is probably an important contributing factor to the responses of cetaceans to the vessels (Blane and Jaakson. 1994; Evans et al. 1992; Evans et al. 1994), so we may not be able to treat the effects of vessel traffic as independent of engine and other sounds associated with the vessels.

We recognize that Navy vessels almost certainly incorporate quieting technologies that reduce their acoustic signature (relative to the acoustic signature of similarly-sized vessels) in order to reduce their vulnerability to detection by enemy vessels. Nevertheless, we do not assume that any quieting technology would be sufficient to prevent marine mammals from detecting sounds produced by approaching Navy vessels and perceiving those sounds as predatory stimuli.

Disturbance Associated With Aircraft

Several of the activities the U.S. Navy proposes to conduct on the Mariana Islands Range Complex also involve some level of activity from aircraft that include helicopters, maritime patrols, and fighter jets. Low-flying aircraft produce sounds that marine mammals can hear when they occur at or near the ocean's surface. Helicopters generally tend produce sounds that can be heard at or below the ocean's surface more than fixed-wing aircraft of similar size and larger aircraft tend to be louder than smaller aircraft. Underwater sounds from aircraft are strongest just below the surface and directly under the aircraft. Sounds from aircraft would not have physical effects on marine mammals but represent acoustic stimuli (primarily low-frequency sounds from engines and rotors) that have been reported to affect the behavior of some marine mammals.

There are few studies of the responses of marine animals to air traffic and the few that are available have produced mixed results. Some investigators report some responses while others report no responses. Richardson et al. (Richardson et al. 1995) reported that there is no evidence that single or occasional aircraft flying above large whales and pinnipeds in-water cause long-term displacement of these mammals. Several authors have reported that sperm whales did not react to fixed-wing aircraft or helicopters in some circumstances (Au and Perryman 1982; Clarke 1956; Gambell 1968; Green et al. 1992) and reacted in others (Clarke 1956; Fritts et al. 1983; Mullin et al. 1991; Patenaude et al. 2002; Richter et al. 2006; Richter et al. 2003; Smultea et al. 2008; Wursig et al. 1998). Richardson et al. (Richardson et al. 1985) reported that bowhead whales (*Balaena mysticetus*) responded behaviorally to fixed-wing aircraft that were used in their surveys and research studies when the aircraft were less than 457 m above sea level; their reactions were uncommon at 457 m, and were undetectable above 610 m. They also reported that bowhead whales did not respond behaviorally to helicopter overflights at about 153 m above sea level.

Smultea et al. (2008) (Smultea et al. 2008)studied the response of sperm whales to low-altitude (233-269 m) flights by a small fixed-wing airplane Kauai and reviewed data available from either other studies. They concluded that sperm whales responded behaviorally to aircraft passes in about 12 percent of encounters. All of the reactions consisted of sudden dives and occurred when the aircraft was less than 360 m from the whales (lateral distance). They concluded that the sperm whales had perceived the aircraft as a predatory stimulus and responded with defensive behavior. In at least one case, Smultea and et al. (Smultea et al. 2008) reported that the sperm whales formed a semi-circular "fan" formation that was similar to defensive formations reported by other investigators.

6.1.2 Collision with Surface Vessels and Submarines

The movement of surface and subsurface vessels in waters that also might be occupied by endangered or threatened marine mammals and sea turtles (although the risk of striking sea turtles or fishes is smaller than the risk of striking endangered marine mammals) pose collision or ship strike hazards to those species.

Given the speeds at which these vessels are likely to move, they pose some risk of collisions between these ships and marine mammals or sea turtles (although the risks of striking sea turtles is smaller than the risks of striking endangered marine mammals). During training activities, ship speeds generally range from 10 to 14 knots; however, these vessels would also operate within the entire spectrum at lower and higher speeds during specific events, such as pursuing and overtaking hostile vessels, evasive maneuvers, and maintenance or performance checks. A variety of smaller craft such as service vessels engaged in routine operations or employed as opposition forces during training events would also be operated. For example, rigid hull inflatable boats (RHIBS) are 35 ft in length and can reach speeds greater than 40 knots.

The Navy's operational orders for ships that are underway are designed to prevent collisions between surface vessels participating in naval exercises and any endangered whales that might occur in the action area. These measures, which include marine observers on the bridge of ships, requirements for course and speed adjustments to maintain safe distances from whales, and having any ship that observes whales to alert other ships in the area, have historically been effective measures for avoiding collisions between surface vessels and whales.

6.1.3 Projectiles and Expended Ordnance

Many of the activities the U.S. Navy plans to conduct on the Mariana Islands Range Complex introduce expended ordnance and other fragments into the marine environment.

Bombs

The majority of the bombs the U.S. Navy would employ during training activities it conducts on the Mariana Islands Range Complex would be practice bombs that are not equipped with explosive warheads. Practice bombs entering the water would consist of materials like concrete, steel, and iron, and would not contain the combustion chemicals found in the warheads of explosive bombs. These components are consistent with the primary building blocks of artificial

reef structures. The steel and iron, although durable, would corrode over time, with no noticeable environmental impacts. The concrete is also durable and would offer a beneficial substrate for benthic organisms. After sinking to the bottom, the physical structure of bombs would be incorporated into the marine environment by natural encrustation and/or sedimentation (Navy 2006).

Missiles

Missiles would be fired by aircraft, ships, and Naval Special Warfare operatives at a variety of airborne and surface targets on the Mariana Islands Range Complex. In general, the single largest hazardous constituent of missiles is solid propellant, which is primarily composed of rubber (polybutadiene) mixed with ammonium perchlorate (for example, solid double-base propellant, aluminum and ammonia propellant grain, and arcite propellant grain). Hazardous constituents are also used in igniters, explosive bolts, batteries (potassium hydroxide and lithium chloride), and warheads (for example, PBX-N highexplosive components; PBXN-106 explosive; and PBX (AF)-108 explosive). Chromium or cadmium may also be found in anti-corrosion compounds coating exterior missile surfaces. In the event of an ignition failure or other launch mishap, the rocket motor or portions of the unburned propellant may cause environmental effects. Experience with Hellfire missiles has shown that if the rocket motor generates sufficient thrust to overcome the launcher hold-back, all of the rocket propellant is consumed. In the rare cases where the rocket does not generate sufficient thrust to overcome the holdback (hang fire or miss fire), some propellant may remain unburned but the missile remains on the launcher. Jettisoning the launcher is a possibility for hang fire or miss fire situations, but in most cases the aircraft returns to base where the malfunctioning missile is handled by explosive ordnance disposal personnel

Non-explosive practice missiles generally do not explode upon contact with the target or sea surface. The main environmental effect would be the physical structure of the missile entering the water. Practice missiles do not use rocket motors and, therefore, do not have potentially hazardous rocket fuel. Exploding warheads may be used in air-to-air missile exercises, but those missiles would explode at an offset to the target in the air, disintegrate, and fall into the ocean to avoid damaging the aerial target. High explosive missiles used in air-to-surface exercises explode near the water surface. For example, missiles employed during a HARMEX would detonate 30 - 60 ft (9.1 – 18.3 m) above the ocean surface.

The principal potential stressor from missiles would be unburned solid propellant residue. Solid propellant fragments would sink to the ocean floor and undergo changes in the presence of seawater. The concentration would decrease over time as the leaching rate decreased and further dilution occurred. The aluminum would remain in the propellant binder and eventually would be oxidized by seawater to aluminum oxide. The remaining binder material and aluminum oxide would pose no threat to the marine environment (Navy 2010b).

Targets

At-sea targets are usually remotely operated airborne, surface, or subsurface traveling units, most of which are designed to be recovered for reuse. Aerial and surface targets would be deployed annually on the Mariana Islands Range Complex. Small concentrations of fuel and ionic metals would be released during battery operation.

A typical aerial target drone is powered by a jet fuel engine, generates radio frequency (RF) signals for tracking purposes, and is equipped with a parachute to allow recovery. Drones also contain oils, hydraulic fluid, batteries, and explosive cartridges as part of their operating systems. There are also recoverable, remotely controlled target boats and underwater targets designed to simulate submarines. If severely damaged or displaced, targets may sink before they can be retrieved. Aerial targets employed on the Mariana Islands Range Complex would include AST/ALQ/ESM pods, Banner drones, BQM-74E drones, Cheyenne, Lear Jets, and Tactical Air-Launched Decoys, which are the only expended targets (these targets are non-powered, air-launched, aerodynamic vehicle).

Surface targets would include Integrated Maritime Portable Acoustic Scoring and Simulator Systems, Improved Surface Tow Targets, QST-35 Seaborne Powered Targets, and expendable marine markers (smoke floats). Expended surface targets commonly used in addition to marine markers include cardboard boxes, 55-gallon steel drums, and a 10-foot-diameter red balloon tethered by a sea anchor (also known as a “killer tomato”). Floating debris, such as Styrofoam, may be lost from target boats.

Most target fragments would sink quickly in the sea. Expended material that sinks to the sea floor would gradually degrade, be overgrown by marine life, and/or be incorporated into the sediments. Floating non-hazardous expended material may be lost from target boats and would either degrade over time or wash ashore as flotsam. Non-hazardous expended materials are defined as the parts of a device made of non-reactive material. Typical non-reactive material includes metals such as steel and aluminum; polymers, including nylon, rubber, vinyl, and plastics; glass; fiber; and concrete. While these items represent persistent seabed litter, their strong resistance to degradation and their chemical composition mean they do not chemically contaminate the surrounding environment by leaching heavy metals or organic compounds.

Gun Ammunition

Naval gun fire on the Mariana Islands Range Complex would use non-explosive and explosive 5-inch or 76 mm ordnance, 25 mm cannon, .50 cal or 7.62 mm ordnance. More than 80 percent of the 5-inch and 76-mm training rounds expended would be non-explosive and contain an iron shell with sand, iron grit, or cement filler. Rapid-detonating explosive would be used in explosive rounds. Unexploded shells and non-explosive practice munitions would not be recovered and would sink to the ocean floor. Solid metal components (mainly iron) of unexploded ordnance and non-explosive practice munitions would also sink.

High-explosive, 5-inch shells are typically fuzed to detonate within 3 ft of the water surface. Shell fragments rapidly decelerate through contact with the surrounding water and settle to the

sea floor. Unrecovered ordnance would also sink to the ocean floor. Iron shells and fragments would be corroded by seawater at slow rates, with comparably slow release rates. Over time, natural encrustation of exposed surfaces would occur, reducing the rate at which corrosion occurred. Rates of deterioration would vary, depending on the material and conditions in the immediate marine and benthic environment. However, the release of contaminants from unexploded ordnance, non-explosive practice munitions, and fragments would not result in measurable degradation of marine water quality.

The rapid-detonating explosive material of unexploded ordnance would not typically be exposed to the marine environment. Should the rapid-detonating explosive be exposed on the ocean floor, it would break down within a few hours (Navy 2001b). Over time, the rapid-detonating explosive residue would be covered by ocean sediments or diluted by ocean water

Chaff

Radio frequency chaff (chaff) is an electronic countermeasure designed to reflect radar waves and obscure aircraft, ships, and other equipment from radar-tracking sources. Chaff is non-hazardous and consists of aluminum-coated glass fibers (about 60 percent silica and 40 percent aluminum by weight) ranging in lengths from 0.3 to 3 inches with a diameter of about 40 micrometers. Chaff is released or dispensed from military vehicles in cartridges or projectiles that contain millions of chaff fibers. 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. It can travel considerable distances from its release point, depending on prevailing atmospheric conditions (Arfsten et al. 2002).

For each chaff cartridge used, a plastic end-cap and Plexiglas piston is released into the environment in addition to the chaff fibers. The end-cap and piston are both round and are 1.3 inches in diameter and 0.13 inches thick. The fine, neutrally buoyant chaff streamers act like particulates in the water, temporarily increasing the turbidity of the ocean's surface. However, they are quickly dispersed and turbidity readings return to normal. The end-caps and pistons would sink; however, some may remain at or near the surface if it were to fall directly on a dense Sargassum mat. The expended material could also be transported long distances before becoming incorporated into the bottom sediments.

Based on the dispersion characteristics of chaff, large areas of open water on the Mariana Islands Range Complex would be exposed to chaff, but the chaff concentrations would be low. 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) would be affected by deployment of a single cartridge containing 150 grams of chaff. The resulting chaff concentration would be about 5.4 grams per square nautical mile. This corresponds to fewer than 179,000 fibers per square nautical mile or fewer than 0.005 fibers per square foot, assuming that each canister contains five million fibers.

The probability of individual animals being struck by this ordnance or encountering chaff particles is sufficiently small to be treated as discountable, even after considering the amount of

ordnance the U.S. Navy would expend during the training activities it plans to conduct on the Mariana Islands Range Complex, As a result, we do not consider this category of potential stressors further in our analyses.

6.1.4 Chemical Constituents Of Explosives, Ordnance, Chaff, And Flares

The chemical products of deep underwater explosions are initially confined to a thin, circular area called a "surface pool." Young (1991b) estimated that 100 percent of the solid explosion products and 10 percent of the gases remain in the pool, which is fed by upwelling currents of water entrained by the rising bubble produced by a detonation (see Table 7). After the turbulence of an explosion has dispersed, the surface pool would stabilize and chemical products would become uniformly distributed within the pool. A surface pool is usually not visible after about five minutes. As a surface pool continues to expand, chemical products would be further diluted and become undetectable. Because of continued dispersion and mixing, there would be no buildup of explosion products in the water column.

The concentrations of chemicals associated with the explosive materials are not hazardous to marine mammals, sea turtles, their prey, competitors, or predators. At the concentrations associated with explosive ordnance the U.S. Navy proposes to use in its training exercises, these chemicals are not likely to have adversely affect the endangered or threatened species that are likely to occur on the Mariana Islands Range Complex, either through direct action on the organisms themselves, through their food, or as a result of their action on competitors, predators, or pathogens. As a result, we do not consider this category of potential stressors further in our analyses.

Table 7. Predicted concentrations of explosion products in seawater, compared with permissible concentrations (from U.S. Navy 2007).

Explosion Product	Predicted Concentration (mg/L)	Permissible Concentration (mg/L)
Carbon dioxide (CO2)	0.00262	1.0
Carbon monoxide (CO)	0.0293	0.552
Ammonia (NH3)	0.00230	0.092b
Ethane (C2H6)	0.00469	120
Propane (C3H8)	0.00135	120
Hydrogen cyanide (HCN)	0.000298	0.001 - 0.036
Methane (CH4)	0.000126	120
Methyl alcohol (CH3OH)	0.0000107	3.60
Formaldehyde (CH2O)	0.00000534	0.0414
Carbon (C)	0.143	NA
Acetylene (C2H2)	0.00000668	73

Phosphine (PH3)	0.00000935	0.0055
Aluminum oxide (Al2O3)	0.434	NA

6.1.5 Parachutes Associated With Flares And Sonobuoys

When AN/SQS-62 DICASS sonobuoys impact the water surface after being deployed from aircraft, their parachute assemblies of sonobuoys are jettisoned and sink away from the sonobuoy, while a float containing an antenna is inflated. The parachutes are made of nylon and are about 8 ft in diameter. At maximum inflation, the canopies are between 0.15 to 0.35 m^2 (1.6 to 3.8 squared ft). The shroud lines range from 0.30 to 0.53 m (12 to 21 inches) in length and are made of either cotton polyester with a 13.6 kilogram (30 pound) breaking strength or nylon with a 45.4 kilogram (100 pound) breaking strength. All parachutes are weighted with a 0.06 kilogram (2 ounce) steel material weight, which would cause the parachute to sink from the surface within about 15 minutes (although actual sinking rates would depend on ocean conditions and the shape of the parachute).

The system's subsurface assembly descends to a selected depth, the sonobuoy case falls away, and sea anchors deploy to stabilize the hydrophone (underwater microphone). The operating life of the seawater battery is about eight hours, after which the sonobuoy scuttles itself and sinks to the ocean bottom. For the sonobouys, the U.S. Navy calculated concentrations of metals released from batteries as 0.0011 mg/L lead, 0.000015mg/L copper, and 0.0000001mg/L silver.

6.1.6 Pressure Waves and Sound Field Produced by Underwater Detonations

The U.S. Navy plans to continue to employ several kinds of explosive ordnance on the Mariana Island Range Complex. Explosives detonated underwater introduce loud, impulsive, broadband sounds into the marine environment. At its source, the acoustic energy of an explosive is, generally, much greater than that of a sonar, so careful treatment of them is important, since they have the potential to injure. Three source parameters influence the effect of an explosive: the net effective weight of the explosive, the type of explosive material, and the detonation depth. The net explosive weight accounts for the first two parameters. The net explosive weight 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. 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). Since most of the explosives the Navy proposes to use on the Mariana Islands Range Complex are munitions that detonate essentially upon impact, the effective source depths are very shallow so the surface-image interference effect can be pronounced. In order to limit the cancellation effect (and thereby provide exposure estimates that tend toward the worst case), relatively deep detonation depths are used. To remain

consistent with previous models the Navy has used, the Navy used source depths of one foot for gunnery rounds. For missiles and bombs, the Navy used source depths of 2 m. For MK-48 torpedoes, which detonate immediately below a target's hull, the Navy used nominal depths of 50 ft for their analyses.

Explosive Source Associated with the Improved Extended Echo Ranging (IEER) System
One of the systems the U.S. Navy proposes to employ as part of the proposed active sonar training include explosive charges that provide a sound source. The AN/SSQ-110A Explosive Source Sonobuoy is composed of two sections, an active (explosive) section and a passive section. The lower, explosive section consists of two signal underwater sound 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 signal underwater sound charges explode, creating a loud acoustic signal.

The endangered or threatened species that might be exposed to explosions associated with this ordnance treat each in-water explosion as an independent event. The cumulative effect of a series of explosives can often be estimated by addition if the detonations are spaced widely in time and space which would provide marine animal's sufficient time to move out of an area affected by an explosion. As a result, the populations of animals that are exposed to in-water explosions are assumed to consist of different animals each time.

6.1.7 Sound Fields Produced By Active Sonar

The U.S. Navy plans to employ mid-and high-frequency sonar systems during several of the training events it proposes to conduct in the Mariana Islands Range Complex. Naval sonars operate on the same basic principle as fish-finders (which are also a kind of sonar): brief pulses of sound, or "pings," are projected into the ocean and an accompanying hydrophone system in the sonar device listens for echoes from targets such as ships, mines or submarines. Tactical military sonars are designed to search for, detect, localize, classify, and track submarines. The Navy typically employs two types of sonars during anti-submarine warfare exercises:

1. 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.

2. Active sonars generate and emit acoustic energy specifically for the purpose of obtaining information concerning a distant object from the received and processed reflected sound energy.

The simplest active sonars emit omnidirectional pulses or "pings" and calculate the length of time the reflected echoes return from the target object to determine the distance between the sonar source and a target. More sophisticated active sonar emits an omnidirectional ping and then scans a steered receiving beam to calculate the direction and distance of a target. More advanced sonars transmit multiple preformed beams, listening to echoes from several directions simultaneously and providing efficient detection of both direction and range. The types of sound

sources that would be used during military readiness activities on the Mariana Islands Range Complex include:

Sonar Systems Associated With Surface Ships

A variety of surface ships participate in Navy training exercises, including guided missile cruisers, destroyers, guided missile destroyers, and frigates. Some ships (e.g., aircraft carriers) do not have any onboard active sonar systems, other than fathometers. Others, like guided missile cruisers, are equipped with active as well as passive sonars for submarine detection and tracking. The primary surface ship sonars considered are

1. The AN/SQS-53 which is a large, active-passive, bow-mounted sonar that has been operational since 1975. AN/SQS-53 is the U.S. Navy's most powerful surface ship sonar and is installed on Ticonderoga (22 units) and Arleigh Burke I/II/IIIa (51 units) class vessels in the U.S. Navy (D'Spain et al. 2006b; Polmar 2001). This sonar transmits at a center frequency of 3.5 kHz at source levels of 235 dBRMS re: 1 µPa at 1 meter. The sonar has pulse durations between 1 and 2 seconds, with about 24-second intervals between pulses. AN/SQS-53 operates at depths of about 7 m.

The AN/SQS-53 is computer-controlled, hull-mounted surface-ship sonar that has both active and passive operating capabilities, providing precise information for anti-submarine warfare weapons control and guidance. The system is designed to perform direct-path anti-submarine warfare search, detection, localization, and tracking from a hull-mounted transducer array. The AN/SQS-53 sonar is installed on Arleigh Burke Class guided missile destroyers and Ticonderoga Class guided missile cruisers. The AN/SQS-53 Kingfisher is a modification that provides a surface ship with the ability to detect mine-like objects.

2. The AN/SQS-56 system is an active-passive keel-mounted sonar that has been operational since 1977. AN/SQS-56 is installed on FFG-7 (33 units) class guided missile frigates in the U.S. Navy (D'Spain et al. 2006b; Polmar 2001). This sonar transmits at a center frequency of 7.5 kHz and a source level of 225 dBRMS re: 1 µPa at 1 meter source level. This sonar also has pulse durations between 1 and 2 seconds, with about 24-second intervals between pulses. AN/SQS-56 operates at depths of about 6 m.

The duration, rise times, and wave form of sounds sonar transmitted from these sonar systems classified; however, the characteristics of the transmissions that were used during the Bahamas exercises might help illustrate attributes of the transmissions from these two sonar sources. During the Bahamas exercises, these two sonars transmitted 1 – 2 second pulses once every 24 seconds (D'Spain et al. 2006b). Pulses had rise times of 0.1 – 0.4 seconds and typically consisted of three waveforms with nominal bandwidths up to 100 Hz (D'Spain et al. 2006b). Both sonars create acoustic fields that are omnidirectional in azimuth, although AN/SQS-53 also can create beams covering 120˚ azimuthal sectors that can be swept from side to side during transits (D'Spain et al. 2006b). Waveforms of both sonar systems are frequency modulated with continuous waves (D'Spain et al. 2006b).

Sonar Systems Associated With Submarines

Tactical military submarines (i.e. 29 attack submarines as of 2008) equipped with hull-mounted mid-frequency use active sonar to detect and target enemy submarines and surface ships. The predominant active sonar system mounted on submarine is AN/BQQ-10 sonar that is used to detect and target enemy submarines and surface ships. Two other systems — AN/BQQ-5 and AN/BSY-1/2 — have operational parameters that would affect marine mammals in ways that are similar to the AN/BQQ-10. In addition, Seawolf Class attack submarines, Virginia Class attack submarines, Los Angeles Class attack submarines, and Ohio Class nuclear guided missile submarines also have the AN/BQS-15 sonar system, which uses high-frequency for under-ice navigation and mine-hunting.

1. AN/BQQ-10 is characterized as mid-frequency active sonar, although the exact frequency range is classified. The AN/BQQ-10 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.

2. 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 MK 2. This sonar system is characterized as mid-frequency active sonar, although the exact frequency range is classified. The AN/BQQ-5 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.

Sonar Systems Associated With Aircraft. Aircraft sonar systems that typically operate during Navy training exercises include sonobuoys and dipping sonar. Current dipping sonar systems used by the Navy are either AN/SQS-22 or AN/AQS -13. AN/AQS -13 is an older and less powerful dipping sonar system (maximum source level 215 dB re µPa-s2 at 1m) than the AN/AQS -22 (maximum source level 217 dB re µPa-s2 at 1m). In its modeling, the Navy assumed that all dipping sonar were AN/AQS -22. P-3 aircraft may deploy sonobuoys while helicopters may deploy sonobuoys or dipping sonars (the latter are used by carrier-based helicopters). Sonobuoys are expendable devices used by aircraft for the detection of underwater acoustic energy and for conducting vertical water column temperature measurements. Dipping sonar is an active or passive sonar device lowered on cable by helicopters to detect or maintain contact with underwater targets. In addition, the U.S. Navy employs tonal sonobuoys (DICASS, AN/SSQ-62) and the Improved Extended Echo Ranging (IEER) System discussed earlier.

1. The AN/SSQ-62C Directional Command Activated Sonobuoy System (DICASS) sonar system is part of a sonobuoy that operates under direct command of fixed-wing aircraft or helicopters. 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. After it enters the

water, the sonobuoy transmits sonar pulses (continuous waveform or linear frequency modulation) 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.

2. AN/SSQ-110A Explosive Source Sonobuoy is a commandable, air-dropped, high source level explosive sonobuoy. The AN/SSQ-110A explosive source sonobuoy 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 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 signal underwater sound 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 maritime patrol aircraft.

3. AN/SSQ-125 Advanced Extended Echo Ranging (AEER) Sonobuoy is a third generation of multi-static active acoustic search systems to be developed under the Extended Echo Ranging family of the systems and is being developed as the replacement for the AN/SSQ-110A. The AN/SSQ-125 sonobuoy is composed of two sections, the control section and the active source section. The control section is similar to the upper electronics package of the AN/SSQ-62 DICASS sonobuoy. The lower section consists of the active sonar source. The echoes from pings of the sonar are then analyzed on the aircraft to determine a submarine's position. The AN/SSQ-125 sonobuoy will be deployed by maritime patrol aircraft.

Torpedoes. Torpedoes (primarily MK-46 and MK-48) are the primary anti-submarine warfare weapon used by surface ships, aircraft, and submarines. The guidance systems of these weapons can be autonomous or electronic ally 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 guidance.

In addition to these torpedoes, the U.S. Navy can employ Acoustic Device Countermeasures in their training exercises, which include which include MK-1, MK-2, MK-3, MK-4, noise acoustic emitter, and the AN/SLQ-25A NIXIE. These countermeasures act as decoys by making sounds that simulate submarines to avert localization or torpedo attacks.

Targets. Anti-submarine warfare training targets are used to simulate target submarines. They are equipped with one or a combination of the following devices: (1) acoustic projectors emanating sounds to simulate submarine acoustic signatures; (2) echo repeaters to simulate the characteristics of the echo of a particular sonar signal reflected from a specific type of submarine; and (3) magnetic sources to trigger magnetic detectors.

Training targets include MK-30 anti-submarine warfare training targets, and MK-39 Expendable Mobile anti-submarine warfare training targets. Targets may be non-evading while operating on

specified tracks or they may be fully evasive, depending on the training requirements of the training operation.

6.1.8 Sound Fields from Underwater Detonations

Activities that involve at-sea explosives may affect ESA-listed species via the sound field produced during the explosion. Explosive sources having detonations in the water include: 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. Explosives detonated underwater introduce loud, impulsive, broadband sounds into the marine environment. At its source, the acoustic energy of an explosive is, generally, much greater than that of sonar, so careful treatment of them is important, since they have the potential to injure. Three source parameters influence the effect of an explosive: the net effective weight of the explosive, the type of explosive material, and the detonation depth. The net explosive weight accounts for the first two parameters. The net explosive weight 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. 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).

The shock wave and blast noise from explosions are of most concern to marine animals. Depending on the intensity of the shock wave and size and depth of the animal, an animal can be injured or killed. Further from the blast, an animal may suffer non-lethal physical effects. Outside of these zones of death and physical injuries, marine animals may experience hearing related effects with or without behavioral responses.

Explosive Source Associated With The Improved Extended Echo Ranging (IEER) System. One of the systems the Navy proposes to use as part of the proposed active sonar training is the AN/SSQ-110A explosive source sonobuoy that is composed of two sections, an active (explosive) section and a passive section. The lower, explosive section consists of two signal underwater sound 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 signal underwater sound charges explode, creating a loud acoustic signal.

6.2 Mitigative Measures to Minimize the Likelihood of Exposure

The Navy proposes to implement a suite of mitigation measures fundamentally designed to prevent marine mammals from being exposed to mid frequency active sonar at high received levels, that may also serve to minimize the likelihood of exposure to other stressors. The mitigation relies primarily on Navy lookouts, helicopter pilots, and other Navy assets to visually detect marine mammals so that the Navy can take action that are appropriate based on these

detections. To the degree that the Navy detects marine mammals visually, this mitigation strategy might reduce the number of marine mammals that are at risk of disturbance from surface vessels, at risk of collision with a surface vessel, exposed to mid-frequency active sonar or the intensity of their exposure, exposed to pressure waves or sound fields from underwater explosions.

However, the effectiveness of visual monitoring is limited to daylight hours, and its effectiveness declines during poor weather conditions (JNCC 2004). In line transect surveys, the range of effective visual sighting (the distance from the ship's track or the effective strip width) varies with an animal's size, group size, reliability of conspicuous behaviors (blows), pattern of surfacing behavior, and positions of the observers (which includes the observer's height above the water surface). For most large baleen whales, effective strip width can be about 3 km (1.6 nm) up through Beaufort 6 (Buckland and Borchers 1993). For harbor porpoises the effective strip width is about 250 m (273 yd), because they are much smaller and less demonstrative on the surface than baleen whales (Palka 1996).

Further, several studies of interactions between seismic surveys and marine mammals and a proposed low-frequency active sonar system and marine mammals concluded that dedicated marine mammal observers were more effective at detecting marine mammals, were more effective at detecting marine mammals at greater distances than Navy watchstanders (watchstanders of the Navies of other countries), were better at identifying the marine mammal to species, and reported a broader range of behaviors than other personnel (Stone 2000; Stone 2001; Stone 2003b). It is not clear, however, how the U.S. Navy's watchstanders and marine species observers, who are specifically trained to identify objects in the water surrounding Navy vessels compare with observers who are specifically trained to detect and identify marine mammals in marine water. NMFS is working with the Navy to determine the effectiveness of this component of Navy monitoring program and the degree to which it is likely to minimize the probability of exposing marine mammals to mid-frequency active sonar.

The information available leads us to conclude that the combinations of safety zones, altered vessel movement, and altered targeting of bombs, missiles, and other ordnance, triggered by visual observations would still allow some marine mammals and sea turtles to be at risk from vessel disturbance, vessel collision, disturbance from aircraft flights, nonexplosive ordnance and gunfire, expended materials, and sound fields from mid- and high-frequency active sonar transmissions.

6.2.1 Mitigation to Minimize Exposure to Low-Frequency Active Sonar

To avoid potential injuries to marine mammals (and possibly sea turtles), the Navy proposes to detect animals within an area they call the "LFA mitigation zone" (the area within the 180-dB isopleth of the SURTASS LFA sonar source sound field) before and during low frequency transmissions. NMFS Permits Division has also added an additional 1-kilometer buffer zone beyond the LFA mitigation zone.

Monitoring associated with the SURTASS LFA sonar system (a) commences at least 30 minutes before the first SURTASS LFA sonar transmission; (b) continue between pings; and (c) continues for at least 15 minutes after completion of a SURTASS LFA sonar transmission exercise or, if marine mammals are showing abnormal behavior patterns, for a period of time until those behavior patterns return to normal or until conditions prevent continued observations.

The Navy typically employs three monitoring techniques: (a) visual monitoring for marine mammals and sea turtles from the SURTASS LFA sonar vessel during daylight hours; (b) use of the passive (low frequency) SURTASS array to listen for sounds generated by marine mammals as an indicator of their presence; and use of high frequency active sonar (High Frequency Marine Mammal Monitoring [HF/M3] sonar) to detect, locate, and track marine mammals (and possibly sea turtles) that might be affected by low frequency transmissions near the SURTASS LFA sonar vessel and the sound field produced by the SURTASS LFA sonar source array.

Visual Monitoring

The U.S. Navy includes daytime observations from the SURTASS LFA sonar vessel for potentially affected species. This monitoring typically begins 30 minutes before sunrise, for ongoing transmissions, or 30 minutes before SURTASS LFA sonar is deployed and will continue until 30 minutes after sunset or until SURTASS LFA sonar array is recovered. Personnel trained in detecting and identifying marine animals make observations from the vessel and at least one observer, qualified by NMFS, trains, tests and evaluates other visual observers. If a marine mammal is detected within the 180-dB LFA mitigation zone or the 1 km (0.54 nm buffer zone extending beyond the LFA mitigation zone, SURTASS LFA sonar transmissions are immediately suspended. Transmissions do not resume less than 15 minutes after:

- All marine mammals have left the area of the LFA mitigation and buffer zones; and
- There is no further detection of any marine mammal within the LFA mitigation and buffer zones as determined by the visual and/or passive or active acoustic monitoring.

Passive Acoustic Monitoring

Passive acoustic monitoring for low frequency sounds generated by marine mammals is conducted when SURTASS is deployed and result in the following actions:

- If sounds are detected and estimated to be from a marine mammal, the technician will notify the Officer in Charge who will alert the HF/M3 sonar operator and visual observers;
- If a sound produced by a marine mammal is detected, the technician will attempt to locate the sound source using localization software; and
- If it is determined that the animal will pass within the LFA mitigation zone or 1-km buffer zone (prior to or during transmissions), then the Officer in Charge will

order the delay/suspension of transmissions when the animal is predicted to enter either of these zones.

High Frequency Active Acoustic Monitoring

The Navy conducts high frequency active acoustic monitoring (by using an enhanced, commercial-type high frequency sonar) to detect, locate, and track marine mammals (and possibly sea turtles) that could pass close enough to the SURTASS LFA sonar transmit array to exceed the 180-dB mitigation criterion. As described in the Description of the Proposed Action section of this Opinion, HF/M3 sonar operates with a similar power level, signal type, and frequency as high frequency "fish finder" type sonars used worldwide by both commercial and recreational fishermen.

The HF/M3 source is ramped-up slowly to operating levels over a period of no less than 5 minutes:

- No later than 30 minutes before the first SURTASS LFA sonar transmission;
- Prior to any SURTASS LFA sonar calibrations or tests that are not part of regular SURTASS LFA sonar transmissions; and
- Anytime after the HF/M3 source has been powered down for a period of time greater than 2 minutes.

The HF/M3 source does not increase its sound pressure level once a marine mammal is detected; ramp-up may proceed once marine mammals are no longer detected. The extent of the LFA mitigation zone (i.e., within the 180-dB sound field) is estimated by onboard acoustic modeling and environmental data collected in situ. When a marine animal is detected by the HF/M3 sonar, it automatically triggers an alert to the Watch Supervisor, who notifies the Officer in Charge. The Officer in Charge then orders the immediate delay or suspension of SURTASS LFA sonar transmissions until the animal is determined to have moved beyond the mitigation zone.

Analysis and testing of the HF/M3 sonar operating capabilities indicate that this system substantially increases the probability of detecting marine mammals within the LFA mitigation zone. It also provides an excellent monitoring capability (particularly for medium to large marine mammals) beyond the LFA mitigation zone, out to 2 to 2.5 km (1.08 to 1.35 nm). Recent testing of the HF/M3 sonar has demonstrated a probability of single-ping detection above 95 percent within the LFA mitigation zone for most marine mammals.

The SURTASS LFA sonar system is required to operate in a manner that would not cause sonar sound fields to exceed 180 dB (re 1 µParms) within "coastal exclusion zones" or within 1 kilometer of designated offshore areas that are designated as biologically important and NMFS' regulations establish a minimum coastal exclusion zone of 12 nautical miles of any coastline, including offshore islands, or designated offshore areas that are biologically important for marine mammals outside the 12 nautical mile coastal exclusion zone during seasons specified for a particular areas. When in the vicinity of known recreational and commercial dive sites,

SURTASS LFA sonar is required to operate to ensure that the sound field at these sites would not exceed 145 dB.

6.2.2 Mitigation Measures Minimize Exposure to Underwater Detonations

During the sinking exercises, the U.S. Navy proposes to conduct on the Mariana Islands Range Complex, the U.S. Navy plans to incorporate the monitoring protocols associated with the shock trials of the USS Winston Churchill. These monitoring protocols were studied extensively and those studies concluded that these monitoring protocols effectively insured that marine mammals or sea turtles did not occur within 3.7 km of the underwater detonations, which would prevent them from being exposed to shock waves at pressures that would cause serious injuries (Clarke and Norman 2005).

By incorporating safety zones, monitoring, and shut down procedures similar to those associated with the Winston Churchill shock trials into the protocols for its proposed sinking exercises, the U.S. Navy should prevent marine mammals and sea turtles from being exposed to energy from underwater detonations associated with the two proposed sinking exercises. Because they are likely to prevent endangered or threatened marine mammals and sea turtles from being exposed to shock waves or the sound fields associated with these exercises, endangered and threatened species that occur in the action area are not likely to be adversely affected by this component of the proposed action.

6.3 Exposure-Response-Risk Analysis

The narratives that follow present the results of our analyses of the effects of the military readiness activities that would be authorized by the proposed LOA on endangered and threatened species. The narratives are organized by species that are likely to be adversely affected by those military readiness activities; within each species or species group, each narrative is organized by exposure, response, and risk (jeopardy) analyses.

6.3.1 Blue Whale

The exposure-response-risk analysis for the blue whale in presented below.

Exposure Analysis

Blue whales undertake seasonal migrations and were historically hunted on their summer, feeding areas. Whalers located few blue whales in wintering areas from December to February. Observations made after whaling was banned revealed a similar pattern: blue whales spend most of the summer foraging at higher latitudes where the waters are more productive (Calambokidis 1995; Calambokidis et al. 1990; Scammon 1874 (1968); Sears 1990). Because of this migratory pattern, we assume that blue whales are more likely to occur on the Mariana Islands Range Complex during the winter months than during the summer month when they are most likely to occur on their summer, foraging range north of Japan, along the Aleutian Islands, and in the southern Bering Sea.

Exposure to Vessel Traffic. We did not estimate the number of blue whales or other endangered or threatened whales that might be exposed to vessel traffic independent of the number of

individuals that might be exposed to active sonar associated with those exercises because the data we would have needed to support those analyses were not available. Because of their seasonal occurrence on the Mariana Islands Range Complex, blue whales are not likely to be exposed to training exercises that occur in the summer months, such as one of the joint multi-strike group exercises; as a result, blue whales are more likely to be exposed to vessel traffic associated with unit-level training, which primarily involves single vessels.

Nevertheless, we assumed that any individuals of the endangered or threatened species that were likely to be exposed to active sonar at received levels equal to or greater than 190 dB might find themselves close enough to the bow of Navy vessels to have some risk of being struck. For the purposes of these analyses, we assumed that a whale that occurred within 560 m (1,968 ft) of a Navy vessel moving at speeds greater than 14 knots would have some risk of being struck. As a result, we assumed that one blue whale would occur close enough to a Navy vessel that is underway to have some risk of being struck by the vessel.

Exposure to Mid-frequency Active Sonar. Because of their seasonal occurrence on the Mariana Islands Range Complex, blue whales are not likely to be exposed to active sonar associated with training exercises that occur in the summer months, such as one of the joint multi-strike group exercises; as a result, blue whales are more likely to be exposed to active sonar associated with unit-level training, which primarily involves sonar transmissions from fewer sources and exposures that occur over shorter periods of time.

Based on the results of our exposure analyses, over the twelve month interval of the proposed LOA we would expect about 197 exposure events involving blue whales to result from the 184 hours of training the U.S. Navy plans to conduct with AN/SQS-53, the 32 hours of training with AN/SQS-56, the 157 hours of training with AN/AQS-22, and the 6 hours of training with AN/BQQ-10 on the Mariana Islands Range Complex during the winter months (from mid-November through mid-May).

Of this total, about 139 exposure events (about 71 percent) would occur at received levels of lower than 140 dB, when blue whales would be between 36 and 125 kilometers (between about 22 and 78 miles) from the source of a sonar ping. Another 34 of these exposure events (about 17 percent) would occur at received levels between 140 and 150 dB or distances between 15 and 36 km (between about 9.3 and 22.4 miles) from the source of a sonar ping. In total, we would expect about 87 percent of these 197 exposure events to occur at received levels less than 150 dB and distances greater than 15 km from a sonar source. About 16 exposure events would occur at received levels between 150 and 160 dB. About 8 of the 197 exposure events (about 3.6 percent) would occur at received levels between 160 and greater than 190 dB, when blue whales would occur within 5 km (about 3.1 miles) of the source of a sonar ping.

The U.S. Navy estimated that 128 blue whales might be exposed to active sonar associated with the training activities it proposes to conduct on the Mariana Islands Range Complex and exhibit behavioral responses that would qualify as “take,” in the form of behavioral harassment, as a

result of that exposure. The U.S. Navy estimated that another two blue whales would be exposed to mid-frequency active sonar and experience temporary threshold shifts as a result of that exposure.

Exposure to Low-frequency Active Sonar. The U.S. Navy's exposure models identified about 23 instances in which blue whales might be exposed to SURTASS LFA sonar transmissions at received levels between 120 and 180 dB on the Mariana Islands Range Complex each year. We assume that these whales would be exposed during the winter months and would not be exposed within 12 nautical miles of any coastline, including offshore islands, or designated offshore areas that are biologically important for marine mammals outside the 12 nautical mile coastal exclusion zone during seasons specified for a particular areas.

Exposure to Underwater Detonations. Based on the results of the U.S. Navy's models, we would not expect blue whales to be exposed to underwater detonations on the Mariana Islands Range Complex at received levels greater than or equal to 177 dB sound exposure level SEL, at received levels greater than or equal to 182 dB SEL or 23 psi-ms (these two received levels are considered thresholds for Level B "take" or behavioral harassment by NMFS' Permits Division), at received levels that would be expected to cause them to experience 50 percent tympanic membrane rupture, or at received levels that would be expected to produce slight lung injury as a result of their exposure (these two received levels are considered thresholds for Level A "take" or injury by NMFS' Permits Division).

Response Analysis

Assuming that whales that occur within 560 m (1,968 ft) of Navy vessels moving at speeds greater than 14 knots would have some risk of being struck by the vessel; one blue whale might occur close enough to a Navy vessel that is underway to have some risk of being struck. Nevertheless, the low frequency of collisions between ships and large whales on the Mariana Islands Range Complex suggests that a collision is not likely to when these whales occurs this close to a Navy vessel. As a result, the evidence available does not lead us to expect a blue whale to be struck by a Navy vessel on the Mariana Islands Range Complex over the twelve-month interval of the proposed LOA.

Of the estimated exposure events involving mid-frequency active sonar, about 139 exposure events (about 71 percent) would occur at received levels of lower than 140 dB, when blue whales would be between 36 and 125 km (between about 22 and 78 miles) from the source of a sonar ping. Another 34 of these exposure events (about 17 percent) would occur at received levels between 140 and 150 dB or distances between 15 and 36 km (between about 9.3 and 22.4 miles) from the source of a sonar ping. In total, we would expect about 87 percent of these 197 exposure events to occur at received levels less than 150 dB and distances greater than 15 km from a sonar source. About 24 of the 197 exposure events (about 3.6 percent) would occur at received levels between 150 and greater than 190 dB, when blue whales would occur within 15 km (about 3.1 miles) of the source of a sonar ping.

Blue whale vocalizations include a variety of sounds described as low frequency moans or long pulses in the 10-100 Hz band (Clark and Fristrup 1997; Cummings and Thompson 1971; McDonald et al. 1995; Rivers 1997; Thompson and Friedl 1982). The most typical signals are very long, patterned sequences of tonal infrasonic sounds in the 15-40 Hz range. Ketten (2002; 1997) reports the frequencies of maximum energy between 12 and 18 Hz. Short sequences of rapid calls in the 30-90 Hz band are associated with animals in social groups. The context for the 30-90 Hz calls suggests that blue whales use these calls to communicate but they do not appear to be related to the reproductive ecology of blue whales. Blue whale moans within the frequency range of 12.5-200 Hz, with pulse duration up to 36 seconds, have been recorded off Chile (Cummings and Thompson 1971). The whale produced a short, 390 Hz pulse during the moan.

While we recognize that animal hearing evolved separately from animal vocalizations and, as a result, it may be inappropriate to make inferences about an animal's hearing sensitivity from their vocalizations, we have no data on blue whale hearing. As a result, we assume that blue whale vocalizations are partially representative of their hearing sensitivities. This assumption and the evidence available lead us to conclude that blue whales are not likely to respond if they are exposed to high-frequency sound sources associated with the proposed training activities because of their hearing sensitivities.

We would not expect the 139 blue whales that find themselves between 36 and 125 km from the source of a mid-frequency active sonar ping to devote attentional resources to those sounds, even though received levels might be as high as 140 dB (at 36 km). Although blue whales appear to be able to hear mid-frequency (1 kHz–10 kHz) sounds, this frequency range appears to lie at the periphery of their hearing range and blue whales are less likely to devote attentional resources to stimuli in this frequency range. Similarly, we would not expect the 34 blue whales that find themselves between 15 and 36 km from a sonar transmission to change their behavioral state, despite being exposed to received levels ranging from 140 and 150 dB; these whales might engage in low-level avoidance behavior or short-term vigilance behavior.

Closer to a source of active sonar, we would expect blue whales to engage in a different suite of behavioral responses. Based on our review of the relative frequency of physical, physiological, and behavioral responses of cetaceans that have been exposed to active sonar, we would expect 19 instances (of the 24 instances in which blue whales might occur within 15 km of a sonar ping) in which blue whales would either ignore the stimulus, change their location to avoid continued exposure to the sound, make vocal adjustments to calls or other vocalizations (for example, increasing the amplitude or repetition rates of their vocalizations or the timing of their vocalization), or engage in minor changes in their behavior. In five of the 24 instances in which blue whales might occur within 15 km of a sonar ping, we would expect blue whale to engage in evasive behavior or change their behavioral state. We would also expect the 23 instances in which blue whales might be exposed to SURTASS LFA sonar transmissions at received levels between 120 and 180 dB on the Mariana Islands Range Complex to cause the blue whales to engage in evasive behavior or change their behavioral state.

Because of the mitigation measures the U.S. Navy plans to employ before engaging in sinking exercises or underwater detonations, we would not expect blue whales to be exposed to underwater detonations on the Mariana Islands Range Complex at received levels that would be expected to cause them to experience 50 percent tympanic membrane rupture or that would be expected to produce slight lung injury as a result of their exposure.

Risk Analysis

Based on our response analyses, over the next 12 months we expect the training activities the U.S. Navy plans to conduct to result in 28 events (five from mid-frequency sonar and 23 related to SURTASS LFA sonar) in which individual blue whales might be exposed to active sonar and engage in evasive behavior or changes in their behavioral state over the twelve month interval of the proposed LOA as a result of that exposure. If these 28 exposure events involve different blue whales, only a small percentage of the blue whales that occur off the Mariana Islands would engage in evasive behavior or changes in their behavioral state. If the 28 exposure events involve the same blue whales exposed multiple times, which would produce the worst possible outcome, those 28 instances of evasive behavior or changes in behavioral state over a twelve-month period are not likely to kill, injure, change the energy or time budget, or cause sustained physiological stress responses that might result in stress pathology in animals with the energy reserves of that single blue whale. As a result, we do not expect those exposure events to cause blue whales to strand, suffer injury, die, or experience measurable changes in their energy or time budgets, engage in life history trade-offs, or change their social interactions. As a result, we would not expect blue whales exposed to active sonar to experience acute reductions in their reproductive success over the next calendar year or in the reproductive success we would expect in future years.

Instead, blue whales are likely to incur "canonical costs" as a result of these 28 exposure events; however, we do not expect 28 exposure events that result in short-term evasive behavior or changes in behavioral state to translate into acute reductions in the current or expected future reproductive success of these blue whales. Therefore, we would not expect the military readiness activities the U.S. Navy proposes to conduct on the Mariana Islands Range Complex to affect the performance of the populations those blue whales represent or the species those population comprise. By extension, we would not expect those military readiness activities to appreciably reduce the blue whales' likelihood of surviving and recovering in the wild.

6.3.2 Fin Whale

The exposure-response-risk analysis for the fin whale in presented below.

Exposure Analysis

Like blue whales, fin whales also undertake seasonal migrations and were historically hunted on their summer, feeding areas. Whalers located few blue whales in wintering areas from December to February. Observations made after whaling was banned revealed a similar pattern: fin whales spend most of the summer foraging north of 20°N latitude where the waters are more productive (Miyashita et al. 1995; NMFS 2010d; Scammon 1874 (1968)). Investigators who compiled

observations of cetaceans in the North Pacific Ocean that had been made from commercial fisheries vessels from 1964 through 1990 reported that no fin whales had been sighted south of 20°N in August but were sighted more commonly north of 40°N during that month (Miyashita et al. 1995). Because of this migratory pattern, we assume that fin whales are more likely to occur on the Mariana Islands Range Complex during the winter months than during the summer month when they are most likely to occur on their summer, foraging range north of Japan, along the Aleutian Islands, and in the southern Bering Sea.

Exposure to Vessel Traffic. We did not estimate the number of fin whales that might be exposed to vessel traffic independent of the number of individuals that might be exposed to active sonar associated with those exercises because the data we would have needed to support those analyses were not available. Because of their seasonal occurrence on the Mariana Islands Range Complex, fin whales are not likely to be exposed to training exercises that occur in the summer months, such as one of the joint multi-strike group exercises; as a result, they are more likely to be exposed to vessel traffic associated with unit-level training, which primarily involves single vessels.

Nevertheless, using the approach we described for blue whales (see the preceding narrative) we assumed that two fin whales would occur close enough to a Navy vessel that is underway to have some risk of being struck by the vessel. Nevertheless, the low frequency of collisions between ships and large whales on the Mariana Islands Range Complex suggests that a collision is not likely to occur each time one of these whales occurs this close to a Navy vessels.

Exposure to Mid-frequency Active Sonar. Because of their seasonal occurrence on the Mariana Islands Range Complex, fin whales are not likely to be exposed to active sonar associated with training exercises that occur in the summer months, such as one of the joint multi-strike group exercises; as a result, they are more likely to be exposed to active sonar associated with unit-level training, which primarily involves sonar transmissions from fewer sources and exposures that occur over shorter periods of time.

Based on the results of our exposure analyses, over the twelve month interval of the proposed LOA we would expect about 590 exposure events involving fin whales to result from the 184 hours of training the U.S. Navy plans to conduct with AN/SQS-53, the 32 hours of training with AN/SQS-56, the 157 hours of training with AN/AQS-22, and the 6 hours of training with AN/BQQ-10 on the Mariana Islands Range Complex during the winter months (from mid-November through mid-May).

Of this total, about 418 exposure events (about 71 percent) would occur at received levels of lower than 140 dB, when fin whales would occur between 36 and 125 km (between about 22 and 78 miles) from the source of a sonar ping. Another 101 of these exposure events (about 17 percent) would occur at received levels between 140 and 150 dB or distances between 15 and 36 km (between about 9.3 and 22.4 miles) from the source of a sonar ping. In total, we would expect about 87 percent of these 197 exposure events to occur at received levels less than 150 dB and

distances greater than 15 km from a sonar source. About 48 of the 590 exposure events would occur at received levels between 150 and 160 dB, when fin whales would occur within 15 km (about 9.3 miles) of the source of a sonar ping. About 24 of the 590 exposure events (about 3.6 percent) would occur at received levels between 160 and greater than 190 dB, when fin whales would occur within 5 km (about 3.1 miles) of the source of a sonar ping.

The U.S. Navy estimated that 180 fin whales might be exposed to active sonar associated with the training activities it proposes to conduct on the Mariana Islands Range Complex and exhibit behavioral responses that would qualify as "take," in the form of behavioral harassment, as a result of that exposure. The U.S. Navy estimated that another two fin whales would be exposed to mid-frequency active sonar and accumulate sufficient energy to experience temporary threshold shifts as a result of that exposure.

Exposure to Low-frequency Active Sonar. The U.S. Navy's exposure models identified about 69 instances in which fin whales might be exposed to SURTASS LFA sonar transmissions at received levels between 120 and 180 dB on the Mariana Islands Range Complex each year. We assume that these whales would be exposed during the winter months and would not be exposed within 12 nautical miles of any coastline, including offshore islands, or designated offshore areas that are biologically important for marine mammals outside the 12 nautical mile coastal exclusion zone during seasons specified for a particular areas.

Exposure to Underwater Detonations. Based on the results of the U.S. Navy's models, we would not expect fin whales to be exposed to underwater detonations on the Mariana Islands Range Complex at received levels greater than or equal to 177 dB sound exposure level SEL, at received levels greater than or equal to 182 dB SEL or 23 psi-ms (these two received levels are considered thresholds for Level B "take" or behavioral harassment by NMFS' Permits Division), at received levels that would be expected to cause them to experience 50 percent tympanic membrane rupture, or at received levels that would be expected to produce slight lung injury as a result of their exposure (these two received levels are considered thresholds for Level A "take" or injury by NMFS' Permits Division).

Response Analysis

Assuming that whales that occur within 560 m (1,968 ft) of Navy vessels moving at speeds greater than 14 knots would have some risk of being struck by the vessel; two fin whales might would occur close enough to a Navy vessel that is underway to have some risk of being struck. Nevertheless, the low frequency of collisions between ships and large whales on the Mariana Islands Range Complex suggests that a collision is not likely to when these whales occurs this close to a Navy vessel. As a result, the evidence available does not lead us to expect a fin whale to be struck by a Navy vessel on the Mariana Islands Range Complex over the twelve-month interval of the proposed LOA.

Closer to a source of active sonar, we would expect fin whales to engage in a different suite of behavioral responses. Based on the results of our exposure analyses, over the twelve month

interval of the proposed LOA we would expect about 590 exposure events involving fin whales to result from the 184 hours of training the U.S. Navy plans to conduct with AN/SQS-53, the 32 hours of training with AN/SQS-56, the 157 hours of training with AN/AQS-22, and the 6 hours of training with AN/BQQ-10 on the Mariana Islands Range Complex during the winter months (from mid-November through mid-May). During the next winter, we would also expect about 69 instances in which fin whales might be exposed to SURTASS LFA sonar transmissions at received levels between 120 and 180 dB on the Mariana Islands Range Complex.

Fin whales produce a variety of low-frequency sounds in the 10-200 Hz band (Edds 1988; Thompson and Cummings 2000; Watkins 1981a; Watkins et al. 1987). The most typical signals are long, patterned sequences of short duration (0.5-2s) infrasonic pulses in the 18-35 Hz range (Patterson and Hamilton 1964). Estimated source levels are as high as 190 dB (McDonald et al. 1995; Patterson and Hamilton 1964; Thompson et al. 1992; Watkins et al. 1987). In temperate waters intense bouts of long patterned sounds are very common from fall through spring, but also occur to a lesser extent during the summer in high latitude feeding areas (Clarke and Charif 1998). Short sequences of rapid pulses in the 20-70 Hz band are associated with animals in social groups (McDonald et al. 1995). Each pulse lasts on the order of one second and contains twenty cycles (Tyack 1999).

While we recognize that animal hearing evolved separately from animal vocalizations and, as a result, it may be inappropriate to make inferences about an animal's hearing sensitivity from their vocalizations, we have no data on fin whale hearing. As a result, we assume that fin whale vocalizations are partially representative of their hearing sensitivities. This assumption and the evidence available lead us to conclude that fin whales are not likely to respond to high-frequency sound sources associated with the proposed training activities because of their hearing sensitivities.

Based on in-situ observations of the responses of 122 minke whales, 2,259 fin whales, 833 right whales, and 603 humpback whales exposed to human activities in waters off Cape Cod, whales appeared to respond to acoustic stimuli within their range of hearing. Whales appeared not to notice the sounds that were of relatively low amplitude at the whales' location or that had the most energy at frequencies below or above their hearing capacities. The whales appeared to ignore most sounds in the background of ambient noise, including the sounds from distant human activities, even though these sounds may have had considerable energies at frequencies well within the whale's range of hearing (Watkins 1986). In particular, whales responded negatively to underwater sounds that appeared to be unexpected, too loud, suddenly louder or different or were perceived as being associated with a potential threat (such as the noise of a rapidly approaching ship or outboard on a collision course). Furthermore, whales' assessments of relative movements of a sound source also apparently influenced their reactions (for example, a vessel moving on a parallel course with the whales usually caused less reaction than the same vessel at the same distance that was approaching on a collision course. Whales often ignored continuous sound sequences, such as echosounder signals that gradually increased in amplitude as a vessel slowly approached (perhaps because these sounds were expected).

Based on this body of evidence, we would not expect fin whales to devote attentional resources to the sounds they receive from sonar pings in the 417 instances in which fin whales might find themselves between 36 and 125 km from the source of a mid-frequency active sonar, even though received levels might be as high as 140 dB (at 36 km). Although fin whales appear to be able to hear mid-frequency (1 kHz–10 kHz) sounds, this frequency range appears to lie at the periphery of their hearing range and fin whales are less likely to devote attentional resources to stimuli in this frequency range. Similarly, we would not expect fin whales to change their behavioral state when exposed to sonar pings in the 101 instances in which they might find themselves between 15 and 36 km from a sonar transmission, despite being exposed to received levels ranging from 140 and 150 dB; these whales might engage in low-level avoidance behavior or short-term vigilance behavior.

Based on our review of the relative frequency of physical, physiological, and behavioral responses of cetaceans that have been exposed to active sonar, we would expect 56 instances (of the 71 instances in which fin whales might occur within 15 km of a sonar ping) in which fin whales either ignore the stimulus, change their location to avoid continued exposure to the sound, make vocal adjustments to calls or other vocalizations (for example, increasing the amplitude or repetition rates of their vocalizations or the timing of their vocalization), or engage in minor changes in their behavior. In 15 of the 71 instances in which fin whales might occur within 15 km of a sonar ping, we would expect the fin whale to engage in evasive behavior or change their behavioral state. We would also expect the 69 instances in which fin whales might be exposed to SURTASS LFA sonar transmissions at received levels between 120 and 180 dB on the Mariana Islands Range Complex to cause the fin whales to engage in evasive behavior or change their behavioral state.

Because of the mitigation measures the U.S. Navy plans to employ before engaging in sinking exercises or underwater detonations, we would not expect fin whales to be exposed to underwater detonations on the Mariana Islands Range Complex at received levels that would be expected to cause them to experience 50 percent tympanic membrane rupture or that would be expected to produce slight lung injury as a result of their exposure.

Risk Analysis

Based on our response analyses, we expect the training activities the U.S. Navy plans to conduct to result in 84 instances in which individual fin whales might be exposed to active sonar and engage in evasive behavior or changes in their behavioral state over the twelve month interval of the proposed LOA as a result of that exposure. If these 84 exposure events involve different fin whales, only a small percentage of the fin whales that occur off the Mariana Islands would engage in evasive behavior or changes in their behavioral state. If the 84 exposure events involve the same fin whales exposed multiple times, which would produce the worst possible outcome, 84 instances of evasive behavior or changes in behavioral state over a twelve-month period are not likely to kill, injure, change the energy or time budget, or cause sustained physiological stress responses that might result in stress pathology in animals with the energy reserves of fin whales. As a result, although these 84 exposure events are likely to represent significant adverse

experiences in the lives of the whales that would be exposed, we do not expect those exposure events to cause fin whales to strand, suffer injury, die, or otherwise experience acute reductions in their reproductive success over the next calendar year or in the reproductive success we would expect in future years.

Similar to blue whales, we would expect fin whales to incur "canonical costs" as a result of these 84 exposure events; however, we do not expect 84 exposure events that result in short-term evasive behavior or changes in behavioral state to translate into "biologically significant" reductions in the current or expected future reproductive success of these blue whales. Therefore, we would not expect the military readiness activities the U.S. Navy proposes to conduct on the Mariana Islands Range Complex to affect the performance of the populations those fin whales represent or the species those population comprise. By extension, we would not expect those military readiness activities to appreciably reduce the fin whales' likelihood of surviving and recovering in the wild.

6.3.3 Humpback Whale

The exposure-response-risk analysis for the humpback whale in presented below.

Exposure Analysis

A "population" of humpback whales winters in an area extending roughly from the South China Sea east through the Philippines, Ryukyu Retto, Ogasawara Gunto, Mariana Islands, and Marshall Islands (Rice 1998). Based on whaling records, humpback whales wintering in this area have also occurred in the southern Marianas from November through the month of May (Eldredge 1991). There are several recent records of humpback whales in the Mariana Islands, at Guam, Rota, and Saipan during January through March (Darling and Mori 1993; Eldredge 1991; Eldredge 2003). Most contemporary reports of humpback whales in the Marianas place them there from February and March (Fulling et al. 2011) (SRS-Parsons 2007). During the remainder of the year, humpback whales are most likely to occur on their summer, feeding range in the Kuril Islands, Bering Sea, Aleutian Islands, Kodiak, Southeast Alaska, and British Columbia (Angliss and Outlaw 2008; Calambokidis et al. 2001; Calambokidis et al. 1997).

Although humpback whales, particularly juvenile whales, might choose to leave their summer foraging range prematurely or that a humpback whale from wintering areas in the South Pacific (French Polynesia, the Cook islands, Tonga, New Zealand and New Caledonia) (Garrigue et al. 2002) it is not likely; virtually no humpback whales, however, are reported to have left their foraging areas prematurely and there are no reports of humpback whales migrating to the Marianas from their wintering areas in the South Pacific. As a result, we would only expect humpback whales to occur on the Mariana Islands Range Complex during the winter months, which would prevent them from being exposed to the major training events the U.S. Navy conducts on the range complex during the summer (joint multi-strike group exercises such as Valiant Shield). As a result, humpback whales are more likely to be exposed to unit-level training exercises, which the U.S. Navy conducts throughout the year.

Exposure to Vessel Traffic. Like blue and fin whales, we did not estimate the number of humpback whales that might be exposed to vessel traffic independent of the number of individuals that might be exposed to active sonar associated with those exercises because the data we would have needed to support those analyses were not available. Nevertheless, using the approach we described for blue whales we assumed that 53 humpback whales would occur close enough to a Navy vessel that is underway to have some risk of being struck by the vessel. Nevertheless, the low frequency of collisions between ships and large whales on the Mariana Islands Range Complex suggests that a collision is not likely to occur each time one of these whales occurs this close to a Navy vessels.

Exposure to Mid-frequency Active Sonar. Because of their seasonal occurrence on the Mariana Islands Range Complex, humpback whales are not likely to be exposed to mid-frequency active sonar associated with training exercises that occur in the summer months, such as one of the joint multi-strike group exercises; as a result, humpback are more likely to be exposed to this active sonar associated with unit-level training, which primarily involves sonar transmissions from fewer sources and exposures that occur over shorter periods of time.

Based on the results of our exposure analyses, over the twelve month interval of the proposed LOA we would expect about 13,571 exposure events involving humpback whales to result from the 184 hours of training the U.S. Navy plans to conduct with AN/SQS-53, the 32 hours of training with AN/SQS-56, the 157 hours of training with AN/AQS-22, and the 6 hours of training with AN/BQQ-10 on the Mariana Islands Range Complex during the winter months (from mid-November through mid-May).

Of this total, about 9,604 exposure events (about 71 percent) would occur at received levels of lower than 140 dB, when humpback whales would occur between 36 and 125 km (between about 22 and 78 miles) from the source of a sonar ping. Another 2,327 of these exposure events (about 17 percent) would occur at received levels between 140 and 150 dB or distances between 15 and 36 km (between about 9.3 and 22.4 miles) from the source of a sonar ping. In total, we would expect about 87 percent of these 13,571 exposure events to occur at received levels less than 150 dB and distances greater than 15 km from a sonar source. About 531 of the 13,571 exposure events (about 3.6 percent) would occur at received levels between 160 and greater than 190 dB, when humpback whales would occur within 5 km (about 3.1 miles) of the source of a sonar ping.

The U.S. Navy estimated that 795 humpback whales might be exposed to active sonar associated with the training activities it proposes to conduct on the Mariana Islands Range Complex and exhibit behavioral responses that would qualify as “take,” in the form of behavioral harassment, as a result of that exposure. The U.S. Navy estimated that another 10 humpback whales would be exposed to mid-frequency active sonar and accumulate sufficient energy to experience temporary threshold shifts as a result of that exposure.

Exposure to Low-frequency Active Sonar. Because of their seasonal occurrence on the Mariana Islands Range Complex, humpback whales are not likely to be exposed to low-frequency active

sonar associated with training exercises that occur in the summer months, such as one of the joint multi-strike group exercises; as a result, humpback whales are more likely to be exposed to active sonar associated with unit-level training, which primarily involves sonar transmissions from fewer sources and exposures that occur over shorter periods of time.

The U.S. Navy's exposure models identified about 1,740 instances in which humpback whales might be exposed to SURTASS LFA sonar transmissions at received levels between 120 and 180 dB on the Mariana Islands Range Complex each year. We assume that these whales would be exposed during the winter months and would not be exposed within 12 nautical miles of any coastline, including offshore islands, or designated offshore areas that are biologically important for marine mammals outside the 12 nautical mile coastal exclusion zone during seasons specified for a particular areas.

Exposure to Underwater Detonations. Based on the results of the U.S. Navy's models, we would expect one humpback whale to be exposed to underwater detonations on the Mariana Islands Range Complex at received levels greater than or equal to 182 dB SEL or 23 psi-ms, which NMFS' Permits Division considers as a threshold for Level B "take" or behavioral harassment. We would not expect humpback whales to be exposed to underwater detonations at received levels that would be expected to cause them to experience 50 percent tympanic membrane rupture or at received levels that would be expected to produce slight lung injury as a result of their exposure (these two received levels are considered thresholds for Level A "take" or injury by NMFS' Permits Division).

We would treat these exposure estimates to be minimal estimates because some humpback whales are likely to be exposed to the sound fields produced by underwater detonations at lower received levels; that is, at received levels that would be expected to cause whales to change their behavioral state even if those changes in behavior might not qualify as "take" as that term is defined by the MMPA.

Response Analysis

Assuming that whales that occur within 560 m (1,968 ft) of Navy vessels moving at speeds greater than 14 knots would have some risk of being struck by the vessel; 53 humpback whales might would occur close enough to a Navy vessel that is underway to have some risk of being struck. Nevertheless, the low frequency of collisions between ships and large whales on the Mariana Islands Range Complex suggests that a collision is not likely to when these whales occurs this close to a Navy vessel. As a result, the evidence available does not lead us to expect a humpback whale to be struck by a Navy vessel on the Mariana Islands Range Complex over the twelve-month interval of the proposed LOA.

Based on the results of our exposure analyses, over the twelve month interval of the proposed LOA we would expect about 13,571 exposure events involving humpback whales to result from the 184 hours of training the U.S. Navy plans to conduct with AN/SQS-53, the 32 hours of training with AN/SQS-56, the 157 hours of training with AN/AQS-22, and the 6 hours of

training with AN/BQQ-10 on the Mariana Islands Range Complex during the winter months (from mid-November through mid-May). During the coming winter, we would also expect about 1,740 instances in which humpback whales might be exposed to SURTASS LFA sonar transmissions at received levels between 120 and 180 dB on the Mariana Islands Range Complex.

Of the exposure events involving mid-frequency active sonar, about 9,604 exposure events would occur at received levels of lower than 140 dB, when humpback whales would occur between 36 and 125 km (between about 22 and 78 miles) from the source of a sonar ping. Another 2,327 of these exposure events (about 17 percent) would occur at received levels between 140 and 150 dB or distances between 15 and 36 km (between about 9.3 and 22.4 miles) from the source of a sonar ping. In total, we would expect about 87 percent of these 13,571 exposure events to occur at received levels less than 150 dB and distances greater than 15 km from a sonar source. About 531 of the 13,571 exposure events (about 3.6 percent) would occur at received levels between 160 and greater than 190 dB, when humpback whales would occur within 5 km (about 3.1 miles) of the source of a sonar ping.

Humpback whales produce a wide variety of sounds. During the winter, breeding season male humpback whales sing long, complex songs, with frequencies in the 25-5000 Hz range and intensities as high as 181 dB (Payne and McVay 1971; Thompson et al. 1986; Winn et al. 1970). Animals in mating groups produce a variety of sounds (Silber 1986; Tyack 1981; Tyack 1983). Source levels average 155 dB and range from 144 to 174 dB (Thompson et al. 1979). The songs appear to have an effective range of approximately 10 to 20 km. Assuming that humpback whale vocalizations are partially representative of their hearing sensitivities, we assume that humpback whales are more likely to hear sounds in the frequency range of mid-frequency active sonar than blue, fin, or sei whales.

Humpback whales have been observed to react to low frequency industrial noises at estimated received levels of 115-124 dB (Malme et al. 1985), and to conspecific calls at received levels as low as 102 dB (Frankel et al. 1995). However, humpback whales do not appear to be as responsive to anthropogenic sounds on their breeding areas, Humpback whales on breeding areas did not stop singing in response to underwater explosions (Payne and McVay 1971) and breeding humpbacks showed only a slight statistical reaction to playbacks of 60 - 90 Hz sounds with a received level of up to 190 dB (Frankel and Clark 1998a). We assume that humpback whales engaged in reproductive activity will focus most or all of their attentional resources on vocalizations, other environmental cues, the process of giving birth to calves, or feeding calves that have just been born.

Based on observations of the responses of fin, humpback, and minke whales to anthropogenic sounds in Cape Cod Bay (discussed in the preceding narrative on fin whales) and the other evidence available to us, we would not expect humpback whales to devote attentional resources to the sounds they receive from sonar pings in the 9,538 instances in which humpback whales might find themselves between 36 and 125 km from the source of a mid-frequency active sonar,

even though received levels might be as high as 140 dB (at 36 km). Similarly, we would expect humpback whales to hear sonar pings in the 2,311 instances in which they might find themselves between 15 and 36 km from a sonar ping, although we would not expect these whales to devote attentional resources to those sounds for the reasons we just discussed.

Like blue and fin whales, we would expect humpback whales to engage in a different suite of behavioral responses closer to a source of active sonar. Based on our review of the relative frequency of physical, physiological, and behavioral responses of cetaceans that have been exposed to active sonar, we would expect about 1,306 instances (of the 1,640 instances in which humpback whales might occur within 15 km of a sonar ping) in which humpback whales either ignore the stimulus, change their location to avoid continued exposure to the sound, make vocal adjustments to calls or other vocalizations (for example, increasing the amplitude or repetition rates of their vocalizations or the timing of their vocalization), or engage in minor changes in their behavior. In 334 of the 1,640 instances in which humpback whales might occur within 15 km of a sonar ping, we would expect the humpback whale to engage in evasive behavior or change their behavioral state, which would have consequences for the fitness of those whales.

We would also expect the 1,740 instances in which humpback whales might be exposed to SURTASS LFA sonar transmissions at received levels between 120 and 180 dB on the Mariana Islands Range Complex to cause the humpback whales to engage in evasive behavior or change their behavioral state, which would have consequences for the fitness of those whales.

Because of the mitigation measures the U.S. Navy plans to employ before engaging in sinking exercises or under-water detonations, we would not expect humpback whales to be exposed to underwater detonations at received levels that would be expected to cause them to experience 50 percent tympanic membrane rupture or at received levels that would be expected to produce slight lung injury as a result of their exposure (these two received levels are considered thresholds for Level A “take” or injury by NMFS’ Permits Division). However, we would expect one humpback whale to be exposed to underwater detonations on the Mariana Islands Range Complex at received levels greater than or equal to 182 dB SEL or 23 psi-ms, which NMFS’ Permits Division considers as a threshold for Level B “take” or behavioral harassment.

Risk Analysis

Based on our response analyses, over the next 12 months we expect the training activities the U.S. Navy plans to conduct to result in 2,074 events in which individual humpback whales might be exposed to active sonar and engage in evasive behavior or changes in their behavioral state over the twelve month interval of the proposed LOA as a result of that exposure. If these 2,074 events involve different blue whales, only a small percentage of the humpback whales that occur off the Mariana Islands would engage in evasive behavior or changes in their behavioral state. If the 2,074 exposure events involve the same humpback whales exposed multiple times, which would produce the worst possible outcome, 2,074 instances of evasive behavior or changes in behavioral state over the four to six-month period in which these whales might occur off the Mariana Islands. If these instances occurred over a four-month period, it would be the equivalent

of about 518 instances of evasive behavior or changes in behavioral state each month for four-months, or an average of 17 instances per day or 1 instance every 83 minutes for four months. If a single stimulus caused an individual animal to change its behavioral state this frequently for four months, the animal might exhibit symptoms of chronic disturbance that would be expected to reduce the animal's fitness. However, this scenario is highly improbable because it would require humpback whales to remain at particular locations in the sound field produced by active sonar for months.

Of the two scenarios we just discussed, the first scenario is more likely because interactions between humpback whales and U.S. Navy vessels more closely approximate random interactions. In such a scenario, 2,074 instances in which humpback whales engage in evasive behavior or changes in behavioral state are likely to represent significant adverse experiences in the lives of the whales that would be exposed, but are not likely to kill, injure, change the energy or time budget, or cause sustained physiological stress responses that might result in stress pathology in animals with the energy reserves of humpback whales. As a result, we do not expect humpback whales to strand, suffer injury, die, or otherwise experience acute reductions in their reproductive success over the next calendar year or in the reproductive success we would expect in future years.

Like blue and fin whales, we would expect humpback whales to incur "canonical costs" as a result of these 2,074 exposure events; however, we do not expect 28 exposure events that result in short-term evasive behavior or changes in behavioral state to translate into "biologically significant" reductions in the current or expected future reproduct¬ive success of these humpback whales. Therefore, we would not expect the military readiness activities the U.S. Navy proposes to conduct on the Mariana Islands Range Complex to affect the performance of the populations those humpback whales represent or the species those population comprise. By extension, we would not expect those military readiness activities to appreciably reduce the humpback whales' likelihood of surviving and recovering in the wild.

6.3.4 Sei Whale

The exposure-response-risk analysis for the sei whale in presented below.

Exposure Analysis

Sei whales occur throughout the North Pacific Ocean and 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 (Gregr and Trites. 2001; Kenney and Winn. 1987). During marine mammal and sea turtles surveys conducted in the Mariana Islands from January through April 2007, sei whales were observed in the offshore areas of Guam and the Mariana Islands south to nearly 10° N (Fulling et al. 2011) (SRS-Parsons 2007). During these surveys, sei whales were most commonly observed in waters between 3,164 and 9,322 m (10,381 – 30,583 ft) in depth; all of these sightings were south of Saipan (about 15°N).

Exposure to Vessel Traffic. Like the three whales we have discussed thus far, we did not estimate the number of sei whales that might be exposed to vessel traffic independent of the number of individuals that might be exposed to active sonar associated with those exercises because the data we would have needed to support those analyses were not available. Nevertheless, using the approach we just described for blue whales (see the preceding narrative) we assumed that two sei whales would occur close enough to a Navy vessel that is underway to have some risk of being struck by the vessel. Nevertheless, the low frequency of collisions between ships and large whales on the Mariana Islands Range Complex suggests that a collision is not likely to occur each time one of these whales occurs this close to a Navy vessels.

Exposure to Mid-frequency Active Sonar. Because of their seasonal occurrence on the Mariana Islands Range Complex, sei whales are also not likely to be exposed to active sonar associated with training exercises that occur in the summer months, such as one of the joint multi-strike group exercises; as a result, sei whales are more likely to be exposed to active sonar associated with unit-level training, which primarily involves sonar transmissions from fewer sources and exposures that occur over shorter periods of time.

Based on the results of our exposure analyses, over the twelve month interval of the proposed LOA we would expect about 570 exposure events involving sei whales to result from the 184 hours of training the U.S. Navy plans to conduct with AN/SQS-53, the 32 hours of training with AN/SQS-56, the 157 hours of training with AN/AQS-22, and the 6 hours of training with AN/BQQ-10 on the Mariana Islands Range Complex during the winter months (from mid-November through mid-May).

Of this total, about 404 exposure events (about 71 percent) would occur at received levels of lower than 140 dB, when sei whales would occur between 36 and 125 km (between about 22 and 78 miles) from the source of a sonar ping. Another 98 of these exposure events (about 17 percent) would occur at received levels between 140 and 150 dB or distances between 15 and 36 km (between about 9.3 and 22.4 miles) from the source of a sonar ping. In total, we would expect about 87 percent of the 570 exposure events to occur at received levels less than 150 dB and distances greater than 15 km from a sonar source. About 47 of the 570 exposure events would occur at received levels between 150 and 160 dB, when sei whales would occur within 15 km (about 9.3 miles) of the source of a sonar ping. About 22 of the 570 exposure events (about 3.6 percent) would occur at received levels between 160 and greater than 190 dB, when sei whales would occur within 5 km (about 3.1 miles) of the source of a sonar ping.

The U.S. Navy estimated that 319 sei whales might be exposed to active sonar associated with the training activities it proposes to conduct on the Mariana Islands Range Complex and exhibit behavioral responses that would qualify as “take,” in the form of behavioral harassment, as a result of that exposure. The U.S. Navy estimated that another 6 sei whales would be exposed to mid-frequency active sonar and accumulate sufficient energy to experience temporary threshold shifts as a result of that exposure.

Exposure to Low-frequency Active Sonar. The U.S. Navy's exposure models identified about 65 instances in which sei whales might be exposed to SURTASS LFA sonar transmissions at received levels between 120 and 180 dB on the Mariana Islands Range Complex each year. We assume that these whales would be exposed during the winter months and would not be exposed within 12 nautical miles of any coastline, including offshore islands, or designated offshore areas that are biologically important for marine mammals outside the 12 nautical mile coastal exclusion zone during seasons specified for a particular areas.

Exposure to Underwater Detonations. Based on the results of the U.S. Navy's models, we would not expect sei whales to be exposed to underwater detonations on the Mariana Islands Range Complex at received levels greater than or equal to 177 dB sound exposure level SEL, at received levels greater than or equal to 182 dB SEL or 23 psi-ms (these two received levels are considered thresholds for Level B "take" or behavioral harassment by NMFS' Permits Division), at received levels that would be expected to cause them to experience 50 percent tympanic membrane rupture, or at received levels that would be expected to produce slight lung injury as a result of their exposure (these two received levels are considered thresholds for Level A "take" or injury by NMFS' Permits Division).

Response Analysis

Assuming that whales that occur within 560 m (1,968 ft) of Navy vessels moving at speeds greater than 14 knots would have some risk of being struck by the vessel; two sei whales might would occur close enough to a Navy vessel that is underway to have some risk of being struck. Nevertheless, the low frequency of collisions between ships and large whales on the Mariana Islands Range Complex suggests that a collision is not likely to when these whales occurs this close to a Navy vessel. As a result, the evidence available does not lead us to expect a sei whale to be struck by a Navy vessel on the Mariana Islands Range Complex over the twelve-month interval of the proposed LOA.

Based on the results of our exposure analyses, over the twelve month interval of the proposed LOA we would expect about 570 exposure events involving sei whales to result from the 184 hours of training the U.S. Navy plans to conduct with AN/SQS-53, the 32 hours of training with AN/SQS-56, the 157 hours of training with AN/AQS-22, and the 6 hours of training with AN/BQQ-10 on the Mariana Islands Range Complex during the winter months (from mid-November through mid-May). During the coming winter, we would also expect about 65 instances in which sei whales might be exposed to SURTASS LFA sonar transmissions at received levels between 120 and 180 dB on the Mariana Islands Range Complex.

Of the exposure events involving mid-frequency active sonar, about 404 exposure events (about 71 percent) would occur at received levels of lower than 140 dB, when sei whales would occur between 36 and 125 km (between about 22 and 78 miles) from the source of a sonar ping. Another 98 of these exposure events (about 17 percent) would occur at received levels between 140 and 150 dB or distances between 15 and 36 km (between about 9.3 and 22.4 miles) from the source of a sonar ping. In total, we would expect about 87 percent of the 570 exposure events to

occur at received levels less than 150 dB and distances greater than 15 km from a sonar source. About 47 of the 570 exposure events would occur at received levels between 150 and 160 dB, when sei whales would occur within 15 km (about 9.3 miles) of the source of a sonar ping. About 22 of the 570 exposure events (about 3.6 percent) would occur at received levels between 160 and greater than 190 dB, when sei whales would occur within 5 km (about 3.1 miles) of the source of a sonar ping.

As discussed in the Status of the Species section of this Opinion, we have almost no information on vocalizations produced by sei whales. Based on their anatomical and physiological similarities to both blue and fin whales, we assume that the hearing thresholds of sei whales will be similar as well and will be centered on low-frequencies in the 10-200 Hz. That is, we assume that, like blue and fin whales, sei whales exposed to these received levels of active mid-frequency sonar are not likely to respond if they are exposed to mid-frequency (1 kHz–10 kHz) sounds. Furthermore, we assume that sei whale vocalizations are partially representative of their hearing sensitivities so we assume that sei whales are not likely to respond to high-frequency sound sources associated with the proposed training activities because of their hearing sensitivities.

Based on observations of the responses of fin, humpback, and minke whales to anthropogenic sounds in Cape Cod Bay (discussed in the preceding narrative on fin whales) and the other evidence available to us, we would not expect sei whales to devote attentional resources to the sounds they receive from sonar pings in the 404 instances in which sei whales might find themselves between 36 and 125 km from the source of a mid-frequency active sonar, even though received levels might be as high as 140 dB (at 36 km). We assume that sei whales, like blue and fin whales, hear mid-frequency (1 kHz–10 kHz) sounds although sounds in this frequency range lie at the periphery of their hearing range. As a result, we assume that sei whales are less likely to devote attentional resources to stimuli in this frequency range. Similarly, we would not expect sei whales to change their behavioral state when exposed to sonar pings in the 98 instances in which they might find themselves between 15 and 36 km from a sonar transmission, despite being exposed to received levels ranging from 140 and 150 dB; these whales might engage in low-level avoidance behavior or short-term vigilance behavior.

Like the whales we have discussed earlier, we would expect sei whales to engage in a different suite of behavioral responses closer to a source of active sonar. Based on our review of the relative frequency of physical, physiological, and behavioral responses of cetaceans that have been exposed to active sonar, we would expect 55 instances (of the 69 instances in which sei whales might occur within 15 km of a sonar ping) in which sei whales either ignore the stimulus, change their location to avoid continued exposure to the sound, make vocal adjustments to calls or other vocalizations (for example, increasing the amplitude or repetition rates of their vocalizations or the timing of their vocalization), or engage in minor changes in their behavior. In 14 of the 69 instances in which sei whales might occur within 15 km of a sonar ping, we would expect the sei whale to engage in evasive behavior or change their behavioral state, which would have consequences for the fitness of those whales. We would also expect the 65 instances

in which sei whales might be exposed to SURTASS LFA sonar transmissions at received levels between 120 and 180 dB on the Mariana Islands Range Complex to cause the sei whales to engage in evasive behavior or change their behavioral state, which would have consequences for the fitness of those whales.

Because of the mitigation measures the U.S. Navy plans to employ before engaging in sinking exercises or underwater detonations, we would not expect sei whales to be exposed to underwater detonations on the Mariana Islands Range Complex at received levels that would be expected to cause them to experience 50 percent tympanic membrane rupture or that would be expected to produce slight lung injury as a result of their exposure.

Risk Analysis

Based on our response analyses, we expect the training activities the U.S. Navy plans to conduct to result in 79 events in which individual sei whales might be exposed to active sonar and engage in evasive behavior or changes in their behavioral state over the twelve month interval of the proposed LOA as a result of that exposure. If these 79 exposure events involve different sei whales, only a small percentage of the sei whales that occur off the Mariana Islands would engage in evasive behavior or changes in their behavioral state. If the 84 exposure events involve the same sei whales exposed multiple times, which would produce the worst possible outcome, 84 instances of evasive behavior or changes in behavioral state over a twelve-month period are not likely to kill, injure, change the energy or time budget, or cause sustained physiological stress responses that might result in stress pathology in animals with the energy reserves of sei whales. As a result, although these 79 exposure events are likely to represent significant adverse experiences in the lives of the whales that would be exposed, we do not expect those exposure events to cause sei whales to strand, suffer injury, die, or otherwise experience acute reductions in their reproductive success over the next calendar year or in the reproductive success we would expect in future years.

Like blue and fin whales, we would expect sei whales to incur “canonical costs” as a result of these 79 exposure events; however, we do not expect 79 exposure events that result in short-term evasive behavior or changes in behavioral state to translate into “biologically significant” reductions in the current or expected future reproductive success of these sei whales. Therefore, we would not expect the military readiness activities the U.S. Navy proposes to conduct on the Mariana Islands Range Complex to affect the performance of the populations those sei whales represent or the species those population comprise. By extension, we would not expect those military readiness activities to appreciably reduce the sei whales’ likelihood of surviving and recovering in the wild.

6.3.5 Sperm Whale

The exposure-response-risk analysis for the sperm whale in presented below.

Exposure Analysis

Based on whaling records, sperm whales occur in waters off the Mariana Islands archipelago throughout the year (Miyashita et al. 1995; Miyashita and Kato. 1995) (Townsend 1935). During

marine mammal and sea turtles surveys conducted in the Mariana Islands from January through April 2007 (Fulling et al. 2011) (SRS-Parsons 2007), sperm whales were encountered (visually or acoustically) more frequently than any other cetacean; they were detected acoustically three times more than they were observed. During these surveys, sperm whales were most commonly observed in waters between 809 to 9,874 m (2,670-32,584 ft) in depth; however, sperm whales are also known to occur in water less than 100 m (330 ft) in depth (Scott and Sadove 1997) (Croll et al. 1999b). During these surveys, sperm whales were most commonly observed in waters between 809 to 9,874 m (2,670-32,584 ft) in depth; however, sperm whales are also known to occur in water less than 100 m (330 ft) in depth (Scott and Sadove 1997) (Croll et al. 1999b).

Because they occur in the Mariana Islands archipelago throughout the year, we assume that sperm whales would be exposed to U.S. Navy's training activities in any month of the year; however, because of their tendency to remain in deep, pelagic waters, we assume that sperm whales would not be exposed to training activities that would occur in coastal features of the Mariana Islands (such as Apra Harbor or Agat Bay) or in coastal areas associated with the islands.

Exposure to Vessel Traffic. Like the whales we have discussed thus far, we did not estimate the number of sperm whales that might be exposed to vessel traffic independent of the number of individuals that might be exposed to active sonar associated with those exercises because the data we would have needed to support those analyses were not available. Nevertheless, using the approach we described for blue whales (see the preceding narrative) we assumed that 60 sperm whales would occur close enough to an underway Navy vessel to have some risk of being struck by the vessel. Nevertheless, the low frequency of collisions between ships and large whales on the Mariana Islands Range Complex suggests a collision is not likely to occur each time one of these whales occurs this close to a Navy vessels.

Exposure to Mid-Frequency Active Sonar. Based on the results of our exposure analyses, over the twelve month interval of the proposed LOA we would expect about 15,186 exposure events involving sperm whales to result from the 184 hours of training the U.S. Navy plans to conduct with AN/SQS-53, the 32 hours of training with AN/SQS-56, the 157 hours of training with AN/AQS-22, and the 6 hours of training with AN/BQQ-10 on the Mariana Islands Range Complex during the winter months (from mid-November through mid-May).

Of this total, about 10,747 exposure events (about 71 percent) would occur at received levels of lower than 140 dB, when sperm whales would occur between 36 and 125 km (between about 22 and 78 miles) from the source of a sonar ping. Another 2,604 of these exposure events (about 17 percent) would occur at received levels between 140 and 150 dB or distances between 15 and 36 km (between about 9.3 and 22.4 miles) from the source of a sonar ping. In total, we would expect about 87 percent of the 15,186 exposure events to occur at received levels less than 150 dB and distances greater than 15 km from a sonar source. About 594 of the 15,186 exposure events

(about 3.9 percent) would occur at received levels between 160 and greater than 190 dB, when sperm whales would occur within 5 km (about 3.1 miles) of the source of a sonar ping.

The U.S. Navy estimated that 806 sperm whales might be exposed to active sonar associated with the training activities it proposes to conduct on the Mariana Islands Range Complex and exhibit behavioral responses that would qualify as "take," in the form of behavioral harassment, as a result of that exposure. The U.S. Navy estimated that another 10 sperm whales would be exposed to mid-frequency active sonar and accumulate sufficient energy to experience temporary threshold shifts as a result of that exposure; one of these sperm whales would experience permanent threshold shift as a result of that exposure.

Exposure to Low-frequency Active Sonar. The U.S. Navy's exposure models identified about 153 instances in which sperm whales might be exposed to SURTASS LFA sonar transmissions at received levels between 120 and 180 dB on the Mariana Islands Range Complex each year. We assume that these whales would be exposed during the winter months and would not be exposed within 12 nautical miles of any coastline, including offshore islands, or designated offshore areas that are biologically important for marine mammals outside the 12 nautical mile coastal exclusion zone during seasons specified for a particular areas.

Exposure to Underwater Detonations. Based on the results of the U.S. Navy's models, we would expect six or seven sperm whales to be exposed to underwater detonations on the Mariana Islands Range Complex at received levels greater than or equal to 177 dB SEL and two or three sperm whales to be exposed at received levels greater or equal to 182 dB SEL or 23 psi-ms, which NMFS' Permits Division considers as a threshold for Level B "take" or behavioral harassment. We would not expect sperm whales to be exposed to underwater detonations at received levels that would be expected to cause them to experience 50 percent tympanic membrane rupture or at received levels that would be expected to produce slight lung injury as a result of their exposure (these two received levels are considered thresholds for Level A "take" or injury by NMFS' Permits Division).

As with the whale species we discussed earlier, we would treat these exposure estimates to be minimal estimates because some sperm whales are likely to be exposed to the sound fields produced by underwater detonations at lower received levels; that is, at received levels that would be expected to cause whales to change their behavioral state even if those changes in behavior might not qualify as "take" as that term is defined by the MMPA.

Response Analysis

Assuming that whales that occur within 560 m (1,968 ft) of Navy vessels moving at speeds greater than 14 knots would have some risk of being struck by the vessel; 60 sperm whales might would occur close enough to a Navy vessel that is underway to have some risk of being struck. Nevertheless, the low frequency of collisions between ships and large whales on the Mariana Islands Range Complex suggests that a collision is not likely to when these whales occurs this close to a Navy vessel. As a result, the evidence available does not lead us to expect a sperm

whale to be struck by a Navy vessel on the Mariana Islands Range Complex over the twelve-month interval of the proposed LOA.

Based on the results of our exposure analyses, during the 12-month interval beginning in August 2010 and ending in August 2011 we would expect about 15,186 exposure events involving sperm whales to result from the 184 hours of training the U.S. Navy plans to conduct with AN/SQS-53, the 32 hours of training with AN/SQS-56, the 157 hours of training with AN/AQS-22, and the 6 hours of training with AN/BQQ-10 on the Mariana Islands Range Complex during the winter months (from mid-November through mid-May). Over the next winter, we would also expect about 153 instances in which sperm whales might be exposed to SURTASS LFA sonar transmissions at received levels between 120 and 180 dB on the Mariana Islands Range Complex.

Of the exposure events involving mid-frequency active sonar, about 10,747 exposure events (about 71 percent) would occur at received levels of lower than 140 dB, when sperm whales would occur between 36 and 125 km (between about 22 and 78 miles) from the source of a sonar ping. Another 2,604 of these exposure events (about 17 percent) would occur at received levels between 140 and 150 dB or distances between 15 and 36 km (between about 9.3 and 22.4 miles) from the source of a sonar ping. In total, we would expect about 87 percent of the 570 exposure events to occur at received levels less than 150 dB and distances greater than 15 km from a sonar source. About 594 of the 15,186 exposure events (about 3.9 percent) would occur at received levels between 160 and greater than 190 dB, when sperm whales would occur within 5 km (about 3.1 miles) of the source of a sonar ping.

If exposed to mid-frequency sonar transmissions, sperm whales are likely to hear and respond to those transmissions. The only data on the hearing range of sperm whales are evoked potentials from a stranded neonate (Carder and Ridgway 1990). These data suggest that neonatal sperm whales respond to sounds from 2.5-60 kHz. Sperm whales also produce loud broad-band clicks from about 0.1 to 20 kHz (Goold and Jones 1995; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997). These clicks were estimated to have source levels at 171 dB re 1 µPa (Levenson 1974). Current evidence suggests that the disproportionately large heads of sperm whales are adaptations that allow them to produce these vocalizations (Cranford 1992; Norris and Harvey 1972). This suggests that the production of these loud low-frequency clicks is extremely important to the survival of individual sperm whales. The function of these vocalizations is relatively well-studied (Goold and Jones 1995; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997): long series of monotonous regularly spaced clicks are associated with feeding and are thought to help sperm whales echolocate while the distinctive, short, patterned series of clicks, called codas, are associated with social behavior and interactions within social (Weilgart and Whitehead 1993).

Based on the frequencies of their vocalizations, sonar transmissions might temporarily reduce the active space of sperm whale vocalizations. Most of the energy of sperm whales clicks is concentrated at 2 to 4 kHz and 10 to 16 kHz, which overlaps with the mid-frequency sonar.

Other studies indicate sperm whales' wide-band clicks contain energy between 0.1 and 20 kHz (Goold and Jones 1995; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997). Ridgway and Carder (Ridgway and Carder 2001) measured low-frequency, high amplitude clicks with peak frequencies at 500 Hz to 3 kHz from a neonate sperm whale.

There is some evidence of disruptions of clicking and behavior from sonars (Goold 1999; Watkins 1985; Watkins and Schevill 1975), pingers (Watkins and Schevill 1975), the Heard Island Feasability Test (Bowles et al. 1994), and the Acoustic Thermometry of Ocean Climate (Costa et al. 1998). Sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders (Watkins and Schevill 1975). Goold (Goold 1999) reported six sperm whales that were driven through a narrow channel using ship noise, echo-sounder, and fishfinder emissions from a flotilla of 10 vessels. Watkins and Scheville (Watkins and Schevill 1975) showed that sperm whales interrupted click production in response to pinger (6 to 13 kHz) sounds. They also stopped vocalizing for brief periods when codas were being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995).

As discussed previously, sperm whales have been reported to have reacted to military sonar, apparently produced by a submarine, by dispersing from social aggregations, moving away from the sound source, remaining relatively silent and becoming difficult to approach (Watkins 1985). Captive bottlenose dolphins and a white whale exhibited changes in behavior when exposed to 1 sec pulsed sounds at frequencies similar to those emitted by multi-beam sonar that is used in geophysical surveys (Ridgway and Carder 1997; Schlundt et al. 2000), and to shorter broadband pulsed signals (Finneran et al. 2000; Finneran et al. 2002). Behavioral changes typically involved what appeared to be deliberate attempts to avoid the sound exposure or to avoid the location of the exposure site during subsequent tests (Finneran et al. 2002; Schlundt et al. 2000). Dolphins exposed to 1-sec intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 µPa rms and belugas did so at received levels of 180 to 196 dB and above. Received levels necessary to elicit such reactions to shorter pulses were higher (Finneran et al. 2000; Finneran et al. 2002). Test animals sometimes vocalized after exposure to pulsed, mid-frequency sound from a watergun (Finneran et al. 2002). In some instances, animals exhibited aggressive behavior toward the test apparatus (Ridgway and Carder 1997; Schlundt et al. 2000). The relevance of these data to free-ranging odontocetes is uncertain. In the wild, cetaceans sometimes avoid sound sources well before they are exposed to the levels listed above, and reactions in the wild may be more subtle than those described by Ridgway et al. (Ridgway and Carder 1997) and Schlundt et al. (Schlundt et al. 2000).

Published reports identify instances in which sperm whales have responded to an acoustic source and other instances in which they did not appear to respond behaviorally when exposed to seismic surveys. Mate et al. (Mate et al. 1994) reported an opportunistic observation of the number of sperm whales to have decreased in an area after the start of airgun seismic testing. However, Davis et al. (Davis et al. 2000a) noted that sighting frequency did not differ significantly among the different acoustic levels examined in the northern Gulf of Mexico,

contrary to what Mate et al. (Mate et al. 1994) reported. Sperm whales may also have responded to seismic airgun sounds by ceasing to call during some (but not all) times when seismic pulses were received from an airgun array >300 km away (Bowles et al. 1994).

A recent study offshore of northern Norway indicated that sperm whales continued to call when exposed to pulses from a distant seismic vessel. Received levels of the seismic pulses were up to 146 dB re 1 µPa peak-to-peak (Madsen et al. 2002). Similarly, a study conducted off Nova Scotia that analyzed recordings of sperm whale sounds at various distances from an active seismic program did not detect any obvious changes in the distribution or behavior of sperm whales (McCall-Howard 1999). Recent data from vessel-based monitoring programs in United Kingdom waters suggest that sperm whales in that area may have exhibited some changes in behavior in the presence of operating seismic vessels (Stone 1997; Stone 1998; Stone 2000; Stone 2001; Stone 2003a). However, the compilation and analysis of the data led the author to conclude that seismic surveys did not result in observable effects to sperm whales (Stone 2003b). The results from these waters seem to show that some sperm whales tolerate seismic surveys.

Sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins 1985; Watkins and Schevill 1975). They also stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995).

Preliminary data from an experimental study of sperm whale reactions to seismic surveys in the Gulf of Mexico and a study of the movements of sperm whales with satellite-linked tags in relation to seismic surveys show that during two controlled exposure experiments in which sperm whales were exposed to seismic pulses at received levels up to 148 dB re 1 µPa over octave band with most energy, the whales did not avoid the vessel or change their feeding efficiency (NRC 2003b). Although the sample size is small (4 whales in 2 experiments), the results are consistent with those off northern Norway.

Other studies identify instances in which sperm whales did not respond to anthropogenic sounds. Sperm whales did not alter their vocal activity when exposed to levels of 173 dB re 1 µPa from impulsive sounds produced by 1 g TNT detonators (Madsen and Mohl 2000). Richardson et al. (Richardson et al. 1995) citing a personal communication with J. Gordon suggested that sperm whales in the Mediterranean Sea continued calling when exposed to frequent and strong military sonar signals. When Andre et al. (Andre and Jurado 1997) exposed sperm whales to a variety of sounds to determine what sounds may be used to scare whales out of the path of vessels, sperm whales were observed to have startle reactions to 10 kHz pulses (180 db re 1 µPa at the source), but not to the other sources played to them.

These studies suggest that the behavioral responses of sperm whales to anthropogenic sounds are highly variable, but do not appear to result in the death or injury of individual whales or result in reductions in the fitness of individuals involved. Responses of sperm whales to anthropogenic sounds probably depend on the age and sex of animals being exposed, as well as other factors.

There is evidence that many individuals respond to certain sound sources, provided the received level is high enough to evoke a response, while other individuals do not.

Based on observations of the responses of fin, humpback, and minke whales to anthropogenic sounds in Cape Cod Bay (discussed in the narrative on fin whales) and the other evidence available to us, we would not expect sperm whales to devote attentional resources to the sounds they receive from sonar pings in the 10,734 instances in which sperm whales might find themselves between 36 and 125 km from the source of a mid-frequency active sonar, even though received levels might be as high as 140 dB (at 36 km). Similarly, we would not expect sperm whales to change their behavioral state when exposed to sonar pings in the 2,601 instances in which they might find themselves between 15 and 36 km from a sonar transmission, despite being exposed to received levels ranging from 140 and 150 dB; these whales might engage in low-level avoidance behavior or short-term vigilance behavior.

Based on our review of the relative frequency of physical, physiological, and behavioral responses of cetaceans that have been exposed to active sonar, we would expect 1,461 instances (of the 1,835 instances in which sperm whales might occur within 15 km of a sonar ping) in which sperm whales either ignore the stimulus, change their location to avoid continued exposure to the sound, make vocal adjustments to calls or other vocalizations (for example, increasing the amplitude or repetition rates of their vocalizations or the timing of their vocalization), or engage in minor changes in their behavior. In 374 of the 1,835 instances in which sperm whales might occur within 15 km of a sonar ping, we would expect the sperm whale to engage in evasive behavior or change their behavioral state, which would have consequences for the fitness of those whales. We would also expect the 153 instances in which sperm whales might be exposed to SURTASS LFA sonar transmissions at received levels between 120 and 180 dB on the Mariana Islands Range Complex to cause the sperm whales to engage in evasive behavior or change their behavioral state, which would have consequences for the fitness of those whales.

Because of the mitigation measures the U.S. Navy plans to employ before engaging in sinking exercises or under-water detonations, we would not expect sperm whales to be exposed to underwater detonations at received levels that would be expected to cause them to experience 50 percent tympanic membrane rupture or at received levels that would be expected to produce slight lung injury as a result of their exposure (these two received levels are considered thresholds for Level A “take” or injury by NMFS’ Permits Division). However, we would expect three sperm whales to be exposed to underwater detonations on the Mariana Islands Range Complex at received levels greater than or equal to 182 dB SEL or 23 psi-ms, which NMFS’ Permits Division considers as a threshold for Level B “take” or behavioral harassment.

Risk Analysis

Based on our response analyses, we expect the training activities the U.S. Navy plans to conduct to result in 527 events in which individual sperm whales might be exposed to active sonar and

engage in evasive behavior or changes in their behavioral state over the twelve month interval of the proposed LOA as a result of that exposure.

If these 527 exposure events involve different sperm whales, only a small percentage of the sperm whales that occur off the Mariana Islands would engage in evasive behavior or changes in their behavioral state. If the 527 exposure events involve the same sperm whales exposed multiple times, which would produce the worst possible outcome, 527 instances of evasive behavior or changes in behavioral state over a twelve-month period are not likely to kill, injure, change the energy or time budget, or cause sustained physiological stress responses that might result in stress pathology in animals with the energy reserves of sperm whales. As a result, although these 527 exposure events are likely to represent significant adverse experiences in the lives of the whales that would be exposed, we do not expect those exposure events to cause sperm whales to strand, suffer injury, die, or otherwise experience acute reductions in their reproductive success over the next calendar year or in the reproductive success we would expect in future years.

Like the whales we have discussed thus far, we would expect sperm whales to incur "canonical costs" as a result of these 527 exposure events; however, we do not expect 527 exposure events that result in short-term evasive behavior or changes in behavioral state to translate into "biologically significant" reductions in the current or expected future reproductive success of these sperm whales. Therefore, we would not expect the military readiness activities the U.S. Navy proposes to conduct on the Mariana Islands Range Complex to affect the performance of the populations those sperm whales represent or the species those population comprise. By extension, we would not expect those military readiness activities to appreciably reduce the sperm whales' likelihood of surviving and recovering in the wild.

6.3.6 Green Sea Turtles

The exposure-response-risk analysis for sea turtles in presented below.

Exposure Analysis

Of the four species of turtles that have been reported to occur in the Mariana Islands archipelago or in waters off of the archipelago, only green and hawksbill sea turtles have been reported in almost every survey of sea turtles conducted in the Mariana Islands since the mid-1990s (Dollar and Stefansson 2000; Eldredge 2003; Kolinski 2001; Kolinski et al. 2006; Kolinski et al. 2004; NMFS and USFWS 1998c; Pultz et al. 1999). Green sea turtles are the most abundant sea turtles found in the Mariana Islands archipelago; in addition to foraging in the archipelago, these sea turtles also nest in the archipelago. Within the archipelago, green sea turtles have been reported to nest on Aguijan, Farallon de Medinilla, Guam, Rota, Saipan, and Tinian (Dollar and Stefansson 2000; Eldredge 2003; Kolinski 2001; Kolinski et al. 2006; Kolinski et al. 2004; NMFS and USFWS 1998c; Pultz et al. 1999). Throughout the archipelago, green sea turtles appear to concentrate in waters less than 50 m (164 ft) deep, which provide the reefs, reef flats, and seagrass beds where the sea turtles typically forage or rest.

Between 1,000 and 2,000 green sea turtles were estimated to occur in the southern Mariana Islands archipelago, with more than half of these turtles occurring along the coast of Tinian (54 percent) or Saipan (38 percent) (Kolinski et al. 2006; Kolinski et al. 2004). On Aguijan, fourteen green sea turtles were observed during surveys that covered about 95 percent of the island's coastline in March 2001 (Kolinski et al. 2004). Of these, twelve (86 percent) were juveniles with two adults. On Farallon de Medinilla, at least nine green sea turtles were observed during surveys conducted in 1999 and 2000, while at least 12 green turtles were observed during surveys in 2001.

A report compiled information on green sea turtle nesting sites in Oceana that found in the Northern Mariana Islands, green turtle nesting occurs from March through August with some year round nesting documented (Maison et al. 2010). It is estimated that possibly fewer than 10 individual turtles nest annually on the islands of Saipan, Tinian and Rota (NMFS and USFWS 1998c). Surveys of the northern islands, Alamagan, Pagan, Agrigan, and Asuncion, were sponsored by the Department of Defense and organized by the USFWS from May – June 2010. Turtle nesting activity was only observed on Agrigan, with seven nests documented (Maison et al. 2010).

Monitoring of nesting activity on Saipan since 1999 and has documented four to eighteen nests laid per year (Maison et al. 2010). At least five beaches on Saipan have been monitored somewhat consistently over the past five years: Bird Island, Wing, Tank, Lao Lao Bay, and Obyan beaches (Ilo et al. 2005; Kolinski 2001; Maison et al. 2010). Nesting likely occurs on all or most of the accessible beaches on Tinian (Pultz et al. 1999), with six beaches occurring on Navy lands monitored for turtle nesting activity by Navy personnel: Chulu, Lamlam, Babui, Chiget, Dangkulo (Long Beach), and Masalok (Vogt 2009). Eleven beaches on Rota are known to support nesting: Songton, Teteto, Mochong, Sagua (Kokomo), Coral Garden, Okgok, Apanon, and Gaonan (the Cave Beaches), Uyulan, Tatgua, and Latte Stone (Lalayak or I Batko) (Ilo et al. 2005), of which two beaches had confirmed nesting activity in 2009 (Okgok and Tagua)(Maison et al. 2010).

On Rota, the green sea turtle population was estimated at 92 turtles in 2001 (Kolinski et al. 2004) and 118 turtles in September 2003 (Kolinski et al. 2006). Coastal habitats associated with this island were estimated to support about six percent of the 1,000 to 2,000 green sea turtles that we estimated to occur in the southern Mariana Islands archipelago (Kolinski et al. 2006; Kolinski et al. 2004). On Saipan, sixty percent of the green sea turtles observed in surveys conducted in August 1999 were observed along the eastern coast of the island, which is relatively uninhabited. The highest concentrations were located at Central Naftan, Forbidden Island, North Naftan, the Kingfisher Golf Course, and the Balisa Area of the island's west coast.

On Tinian, 832 green sea turtles were estimated to inhabit coastal waters in 2001 (Kolinski et al. 2006), which the highest abundance reported from the Mariana Archipelago. Based on nesting surveys conducted on Tinian, green sea turtles appear to nest on most, if not all, beaches on the island (NMFS and USFWS 1998c), although green sea turtle nests are most common on Unai Barcinas, Unai Dankulo (Long Beach), Unai Leprosarium, and Unai Lamlam (Pultz et al. 1999).

Although green sea turtles nest in the Mariana Islands archipelago, most of the green sea turtles that are observed in the archipelago are juvenile or sub-adult sea turtles (Kolinski 2001; NMFS and USFWS 1998c; Pultz et al. 1999), so the archipelago appears to support a small adult nesting population and a large juvenile rearing population. Adults that migrate to the Mariana Islands to nest appear to originate elsewhere in the western Pacific.

On Guam, green sea turtles have been reported from coastal waters throughout the year and aggregations of foraging or resting green sea turtles have been reported from seagrass beds and reef flats in Inner Apra Harbor (Smith et al. no date), Apra Harbor, Cocos Lagoon, in deeper waters south of Falcona Beach, Hilaan, Tarague Beach (Wiles et al. 1995), and on the Explosive Ordnance Beach on Andersen Air Force Base (Guam Division of Aquatic and Wildlife Resources 2000). Recreational SCUBA divers have reported green sea turtles at numerous dive sites along the coast of Guam, including Ane Caverns, Boulder Alley, Gab Gab I, Napoleon Cut, and the Wall (Navy 2010b). Green sea turtles have been reported to have nested at eight separate beaches on Guam: Asiga Beach, Falcona Beach, Ritidian Beach, Tarague Beach, Urunao Point, as well as the beaches along Cocos Island and Sella Bay (Gutierrez 2004; Pritchard 1995; Wiles et al. 1995).

Exposure to Training Activities. Because they tend to occur near the coast of islands in the Mariana Islands archipelago, green sea turtles are not likely to be exposed to stressors associated with air warfare or electronic combat, surface warfare, or joint multi-strike group exercises, which would occur more than 12 nautical miles from land (with the exception of small arms gunnery exercises). The available data do not allow us to assess the probability of ships striking sea turtles; however, because there are few reports of green sea turtles found dead with strike-related injuries in the Mariana Islands, the probability of a Navy vessel striking a green sea turtle appear to be very small.

The primary site for the amphibious assault (Marine Air Ground Task Force) exercises the U.S. Navy proposes to conduct on the Mariana Islands Range Complex is Unai Chulu Beach on the island of Tinian where green sea turtles are likely to nest. This beach is a secondary site for the amphibious raids (Marine Air Ground Task Force) the U.S. Navy proposes to conduct on the Mariana Islands Range Complex. Adult green sea turtles that might arrive on this beach to nest would be potentially exposed to human disturbance associated with these training activities; any nests that might occur on this beach during such an exercise has some probably of being trampled or destroyed.

Apra Harbor is a primary site for the amphibious raids (Marine Air Ground Task Force) the U.S. Navy proposes to conduct on the Mariana Islands Range Complex. This harbor is a secondary site for the amphibious assaults (Marine Air Ground Task Force) the U.S. Navy proposes to conduct on the Mariana Islands Range Complex. Although green sea turtles are not known to nest in this area, they forage and rest in several areas of the harbor and are likely to be exposed to human disturbance associated with these training activities.

Exposure to Low-frequency Active Sonar. The SURTASS LFA sonar system generally operates in deeper, pelagic waters, and NMFS regulations require the U.S. Navy to operate SURTASS LFA sonar so that the sound field produced by this sonar do not exceed 180 dB (re 1 µParms) within 12 nautical miles (about 22 km) of any coastline, including offshore islands, or designated offshore areas that are biologically important for marine mammals. Because of this distance, the majority of the green sea turtles that occur in the Mariana Islands archipelago are not likely to be exposed to active sonar transmissions produced with the SURTASS LFA sonar system at received levels greater than 130 dB (assuming cylindrical and spherical spreading and ignoring the effect of shallow water and ambient noise on transmissions).

Exposure to Mid-frequency Active Sonar. Anti-submarine warfare exercises would occur more than 3 nautical miles (about 5 km) from shore. Because of this distance, hawksbill sea turtles are not likely to be exposed to mid-frequency active sonar associated with anti-submarine warfare at received levels greater than 160 dB. Because joint multi-strike group exercises would occur more than 12 nautical miles (about 22 km) from land, juvenile, sub-adult, and nesting adult green sea turtles are not likely to be exposed to mid-frequency active sonar associated with those exercises at received levels greater than 150 dB. More importantly, because they tend to remain in relatively shallow coastal waters where sounds produced by rain, wind, and waves, juvenile, sub-adult, and nesting adult green sea turtles are not likely to be aware of energy produced by mid-frequency active sonar from sources more than 3 or 12 nautical miles offshore.

Exposure to Underwater Detonations. Because the U.S. Navy plans to conduct sinking exercises more than 50 nautical miles (92 km) from land, green sea turtles are not likely to be exposed to shock waves or sound fields associated with those training exercises. However, because the primary site for the floating mine neutralization and underwater demolition exercises the U.S. Navy proposes to conduct on the Mariana Islands Range Complex is Agat Bay on Guam where green sea turtles are likely to forage and rest, these sea turtles would have some risk of being exposed to shock waves and sound fields associated with these training exercises.

However, the U.S. Navy proposes to establish 700-yard (640 meter) exclusion zones for sea turtles (and marine mammals) for all mine warfare and mine countermeasure training activities. Thirty-minutes before a detonation, U.S. Navy personnel involved in the training exercises must determine that the area is clear of marine mammals and sea turtles. If an animal is present within the area, the U.S. Navy proposes to pause the exercise until the animal leaves the area on its own. These measures should prevent green sea tutles from being exposed to pressure waves associated with underwater detonations.

Response Analysis

The primary site for the amphibious assault (Marine Air Ground Task Force) exercises the U.S. Navy proposes to conduct on the Mariana Islands Range Complex is Unai Chulu Beach on the island of Tinian where green sea turtles are likely to nest. This beach is a secondary site for the amphibious raids (Marine Air Ground Task Force) the U.S. Navy proposes to conduct on the Mariana Islands Range Complex. Adult green sea turtles that might arrive on this beach to nest

would be potentially exposed to human disturbance associated with these training activities; any nests that might occur on this beach during such an exercise has some probably of being trampled or destroyed.

Apra Harbor is a primary site for the amphibious raids (Marine Air Ground Task Force) the U.S. Navy proposes to conduct on the Mariana Islands Range Complex. This harbor is a secondary site for the amphibious assaults (Marine Air Ground Task Force) the U.S. Navy proposes to conduct on the Mariana Islands Range Complex. Although green sea turtles are not known to nest in this area, they forage and rest in several areas of the harbor and are likely to be exposed to human disturbance associated with these training activities.

Because of the distance between the locations in which the U.S. Navy is likely to conduct anti-submarine warfare exercises, joint multi-strike group exercises, sinking exercises and operate SURTASS LFA sonar and the coastal locations in which green sea turtles are most likely to occur, the majority of the green sea turtles that occur in the Mariana Islands archipelago are not likely to be exposed to active sonar transmissions or the sounds of underwater detonations associated with these training activities. Because they tend to remain in relatively shallow coastal waters where sounds produced by rain, wind, and waves, juvenile, sub-adult, and nesting adult green sea turtles are not likely to be aware of energy produced by mid-frequency active sonar from these training activities.

However, because the primary site for the floating mine neutralization and underwater demolition exercises the U.S. Navy proposes to conduct on the Mariana Islands Range Complex is Agat Bay on Guam where green sea turtles are likely to forage and rest, these sea turtles would have some risk of being exposed to shock waves and sound fields associated with these training exercises. Nevertheless, because the U.S. Navy proposes to establish 700-yard (640 m or about 2,100 ft) exclusion zones for sea turtles (and marine mammals) for all mine warfare and mine countermeasure training activities, these sea turtles are not likely to be killed or injured as a result of their exposure to pressure waves produced by these detonations.

Klima et al. (1988) conducted an experiment in which Kemp's ridley and loggerhead turtles were placed in cages at four distances from an oil platform to be removed with explosives. The cages were submerged to a depth of 4.52 m (15 ft) over the 9 meter (30 foot) sea bottom just prior to the simultaneous explosion of four 50.75 lb charges of nitromethane placed inside the platform pilings at a depth of 4.88 m (16 ft) below the mudline. Loggerhead and Kemp's ridley turtles at 228.6 m (750 ft) and 365 m (1,200 ft), as well as one loggerhead at 914 m (3,000 ft) were rendered unconscious. The Kemp's ridley turtle closest to the explosion (range of 228.6 m) was slightly injured, with an everted cloacal lining; ridleys at ranges of 365 m, 546 m, and 914 m were apparently unharmed. All loggerheads displayed abnormal pink coloration caused by dilated blood vessels at the base of the throat and flippers, a condition that persisted for about 3 weeks.

O'Keeffe and Young (1984) analyzed data from three underwater shock tests carried out off Panama City, Florida in 1981. During each test, a charge equivalent of 1,200 lb of TNT was detonated at mid-depth in water about 36.6 m (120 ft) deep. At least three turtles were noted in the area following the detonations. One turtle at a range of 152 to 213 m (500 to 700 ft) was killed. A second turtle at a range of 365 m received minor injuries. A third turtle at 609.6 m (2,000 ft) was apparently unaffected. At a depth of 18 m (60 ft), calculated shock wave pressures were 239, 161, 85, and 47 psi at ranges of 152, 213, 365, and 609.6 m, respectively.

Based on a parametric evaluation of the effects of charge weight and depth using the Goertner (1982) model, Young (1991a) concluded that a conservative safe range for non-injury to a small mammal (representative of a dolphin calf) was approximated by R=578w0.28 (R is in feet and w is in pounds of explosive). O'Keeffe and Young (1984) proposed that a safe range for turtles from an underwater explosion could be expressed by R = 200 w1/3. This equation was subsequently modified by Young (1991a) based on safe ranges established by NMFS for platform removal operations using explosives. The revised equation is R = 560 w1/3. Assuming that the U.S. Navy proposes to detonation 5 to 20 lb charges (NEW) during mine neutralization or underwater demolition exercises, the equation proposed by O'Keefe and Young (1984) would produce safe ranges of 104.24 m (for 5 lb charges) and 165.47 m (for 20 lb charges). The modified equation proposed by Young (1991a) would produce safe ranges of 291.87 m (for 5 lb charges) and 463.32 m (for 20 lb charges). The U.S. Navy proposes to use a safe range of 640 m, which is more than 27 percent greater than the largest of these safe ranges and is greater than the distance at which sea turtles appeared to have been unaffected by the detonations conducted on the Mariana Islands Range Complex. As a result, we would conclude that green sea turtles are not likely to experience physical injury, physiological stress responses, or changes in behavioral states as a result of being exposed to pressure waves associated with underwater detonations on the Mariana Islands Range Complex.

Risk Analysis

Sea turtles that occur on the Mariana Islands Range Complex might encounter one or more of the parachutes after they have been jettisoned from these sonobuoys and could become entangled as a result. We cannot, however, determine whether such interactions are probable, given the relatively small number of sonobuoys that would be employed in each of the exercises, the relatively large geographic area involved, and the relatively low densities of endangered or threatened sea turtles on the range complex.

Nevertheless, we conclude that training exercises and other activities the U.S. Navy plans to conduct in the Mariana Islands Range Complex from August 2011 through August 2012 are not likely to interact with sufficient number of adult or sub-adult green sea turtles, if they interact with green sea turtles at all, to reduce the viability of the nesting aggregations those green sea turtles represent by reducing the population dynamics, behavioral ecology, and social dynamics of those populations (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations). As a result, those activities would not be expected to

appreciably reduce the likelihood of green sea turtles surviving and recovering in the wild by reducing their reproduction, numbers, or distribution.

6.3.7 Hawksbill Sea Turtles

The exposure-response-risk analysis for sea turtles in presented below.

Exposure Analysis

Of the four species of turtles that have been reported to occur in the Mariana Islands region, surveys that have been conducted in the region over the past decade hawksbill sea turtles are the only sea turtle, other than green sea turtles, that have been reported in the action area (Dollar and Stefansson 2000; Eldredge 2003; Kolinski 2001; Kolinski et al. 2006; Kolinski et al. 2004; NMFS and USFWS 1998c; Pultz et al. 1999) (NMFS and USFWS 1998d). Nevertheless, hawksbill sea turtles sightings are relatively uncommon in the Mariana Islands archipelago, even in surveys that focus on sea turtles (Eldredge 2003; Kolinski 2001; Kolinski et al. 2006; Kolinski et al. 2004; NMFS and USFWS 1998c; Pultz et al. 1999).

Historically, hawksbill sea turtles were reported to have been uncommon, but not rare, on the island of Guam (Wiles et al. 1995); these turtles nested between Urunao Point and Tarague Beach in 1984 and at Sumay Cove, Apra Harbor in 1991 and 1992 (NMFS and USFWS 1998d). Hawksbill sea turtles were reported to have been common in Cocos Lagoon (on the southern tip of Guam) during surveys conducted on the island in the mid-1970s (Randall et al. 1975). Between 1989 and 1991, hawksbill sea turtles represented about 13 percent of the sea turtles observed along the coast of Guam from Tanguisso Beach to Pago Bay (Wiles et al. 1995). Hawksbill sea turtles are regularly observed inside Apra Harbor, particularly in Sasa Bay in which sponges, their preferred food, are common (Kolinski 2001; Wiles et al. 1995).

Hawksbill sea turtles also occur along the coasts of Farallon de Medinilla, Rota, and Tinian. The U.S. Navy observed two juvenile hawksbill sea turtles during surveys in waters off Farallon de Medinilla in 2004 (Navy 2004). In 1996, a hawksbill sea turtle had been exposed to shock wave associated with a detonation of unexploded ordinance off the island of Rota; the turtle was recovered near the explosion sight and subsequently died from internal injuries resulting from its exposure to the blast. And hawksbill turtles are reported to occur regularly off Tinian (Wiles et al. 1989), although they have not been reported during several surveys conducted in those waters (Kolinski 2001; Pultz et al. 1999; Wiles et al. 1995).

Exposure to Training Activities. Because they tend to occur near the coast of islands in the Mariana Islands archipelago, hawksbill sea turtles are not likely to be exposed to stressors associated with air warfare or electronic combat, surface warfare, or joint multi-strike group exercises, which would occur more than 12 nautical miles from land (with the exception of small arms gunnery exercises), The available data do not allow us to assess the probability of ships striking hawksbill sea turtles; however, because there are few reports of hawksbill sea turtles found dead with strike-related injuries in the Mariana Islands, the probability of a Navy vessel striking a hawksbill sea turtle appear to be very small.

Apra Harbor is a secondary site for the amphibious raids (Marine Air Ground Task Force) the U.S. Navy proposes to conduct on the Mariana Islands Range Complex. This harbor is a secondary site for the amphibious assaults (Marine Air Ground Task Force) the U.S. Navy proposes to conduct on the Mariana Islands Range Complex. Although hawksbill sea turtles are not known to nest in this area, they forage and rest in several areas of the harbor and are likely to be exposed to human disturbance associated with these training activities.

Exposure to Low-frequency Active Sonar. The SURTASS LFA sonar system generally operates in deeper, pelagic waters, and NMFS regulations require the U.S. Navy to operate SURTASS LFA sonar so that the sound field produced by this sonar do not exceed 180 dB (re 1 µParms) within 12 nautical miles (about 22 km) of any coastline, including offshore islands, or designated offshore areas that are biologically important for marine mammals. Because of this distance, hawksbill sea turtles are not likely to be exposed to active sonar transmissions produced with the SURTASS LFA sonar system at received levels greater than 130 dB (assuming cylindrical and spherical spreading and ignoring the effect of shallow water and ambient noise on transmissions).

Exposure to Mid-frequency Active Sonar. Hawksbill sea turtles tend to occur near the coast of islands in the Mariana Islands archipelago and anti-submarine warfare exercises would occur more than 3 nautical miles (about 5 km) from shore. Because of this distance, hawksbill sea turtles are not likely to be exposed to mid-frequency active sonar associated with anti-submarine warfare at received levels greater than 160 dB. Because joint multi-strike group exercises would occur more than 12 nautical miles (about 22 km) from land, hawksbill sea turtles are not likely to be exposed to mid-frequency active sonar associated with those exercises at received levels greater than 150 dB. More importantly, because they tend to remain in relatively shallow coastal waters where sounds produced by rain, wind, and waves, hawksbill sea turtles are not likely to be aware of energy produced by mid-frequency active sonar from sources more than 3 or 12 nautical miles offshore.

Exposure to Underwater Detonations. Because the U.S. Navy plans to conduct sinking exercises more than 50 nautical miles (92 km) from land, hawksbill sea turtles are not likely to be exposed to shock waves or sound fields associated with those training exercises. However, because the primary site for the floating mine neutralization and underwater demolition exercises the U.S. Navy proposes to conduct on the Mariana Islands Range Complex is Agat Bay on Guam where hawksbill sea turtles are likely to forage and rest, these sea turtles would have some risk of being exposed to shock waves and sound fields associated with these training exercises.

However, the U.S. Navy proposes to establish 700-yard (640 meter) exclusion zones for sea turtles (and marine mammals) for all mine warfare and mine countermeasure training activities. Thirty-minutes before a detonation, U.S. Navy personnel involved in the training exercises must determine that the area is clear of marine mammals and sea turtles. If an animal is present within the area, the U.S. Navy proposes to pause the exercise until the animal leaves the area on its own.

These measures should prevent green sea turtles from being exposed to pressure waves associated with underwater detonations.

Exposure to Parachutes. When AN/SQS-62 DICASS sonobuoys impact the water surface after being deployed from aircraft, their parachute assemblies of sonobuoys deployed by aircraft are jettisoned and sink away from the sonobuoy, while a float containing an antenna is inflated. The parachutes are made of nylon and are about 8 ft in diameter. At maximum inflation, the canopies are between 0.15 to 0.35 m^2 (1.6 to 3.8 squared ft). The shroud lines range from 0.30 to 0.53 m (12 to 21 inches) in length and are made of either cotton polyester with a 13.6 kilogram (30 pound) breaking strength or nylon with a 45.4 kilogram (100 pound) breaking strength. All parachutes are weighted with a 0.06 kilogram (2 ounce) steel material weight, which would cause the parachute to sink from the surface within about 15 minutes, although actual sinking rates depend on ocean conditions and the shape of the parachute.

The subsurface assembly descends to a selected depth, and the sonobuoy case falls away and sea anchors deploy to stabilize the hydrophone (underwater microphone). The operating life of the seawater battery is eight hours, after which the sonobuoy scuttles itself and sinks to the ocean bottom. For the sonobouys, concentrations of metals released from batteries were calculated to be 0.0011 mg/L lead, 0.000015mg/L copper, and 0.0000001mg/L silver.

Sea turtles that occur on the Mariana Islands Range Complex might encounter one or more of the parachutes after they have been jettisoned from these sonobuoys and could become entangled as a result. We cannot, however, determine whether such interactions are probable, given the relatively small number of sonobuoys that would be employed in each of the exercises, the relatively large geographic area involved, and the relatively low densities of endangered or threatened sea turtles on the range complex.

Response Analysis

Because they tend to occur near the coast of islands in the Mariana Islands archipelago, hawksbill sea turtles are not likely to be exposed to stressors associated with air warfare or electronic combat, surface warfare, or joint multi-strike group exercises, which would occur more than 12 nautical miles from land (with the exception of small arms gunnery exercises),

Apra Harbor is a secondary site for the amphibious raids (Marine Air Ground Task Force) the U.S. Navy proposes to conduct on the Mariana Islands Range Complex. This harbor is a secondary site for the amphibious assaults (Marine Air Ground Task Force) the U.S. Navy proposes to conduct on the Mariana Islands Range Complex. Although hawksbill sea turtles are not known to nest in this area, they forage and rest in several areas of the harbor and are likely to be exposed to human disturbance associated with these training activities.

Because of the distance between the locations in which the U.S. Navy is likely to conduct anti-submarine warfare exercises, joint multi-strike group exercises, sinking exercises and operate SURTASS LFA sonar and the coastal locations in which hawksbill sea turtles are most likely to occur, the majority of the hawksbill sea turtles that occur in the Mariana Islands archipelago are

not likely to be exposed to active sonar transmissions or the sounds of underwater detonations associated with these training activities. Because they tend to remain in relatively shallow coastal waters where sounds produced by rain, wind, and waves, juvenile, sub-adult, and nesting adult hawksbill sea turtles are not likely to be aware of energy produced by mid-frequency active sonar from these training activities.

However, because the primary site for the floating mine neutralization and underwater demolition exercises the U.S. Navy proposes to conduct on the Mariana Islands Range Complex is Agat Bay on Guam where hawksbill sea turtles are likely to forage and rest, these sea turtles would have some risk of being exposed to shock waves and sound fields associated with these training exercises. Nevertheless, because the U.S. Navy proposes to establish 700-yard (640 m or about 2,100 ft) exclusion zones for sea turtles (and marine mammals) for all mine warfare and mine countermeasure training activities, these sea turtles are not likely to be killed or injured as a result of their exposure to pressure waves produced by these detonations.

As discussed previously, Klima et al. (1988) conducted an experiment in which Kemp's ridley and loggerhead turtles were placed in cages at four distances from a oil platform to be removed with explosives. The cages were submerged to a depth of 4.52 m (15 ft) over the 9 meter (30 foot) sea bottom just prior to the simultaneous explosion of four 50.75 lb charges of nitromethane placed inside the platform pilings at a depth of 4.88 m (16 ft) below the mudline. Loggerhead and Kemp's ridley turtles at 228.6 m (750 ft) and 365 m (1,200 ft), as well as one loggerhead at 914 m (3,000 ft) were rendered unconscious. The Kemp's ridley turtle closest to the explosion (range of 228.6 m) was slightly injured, with an everted cloacal lining; ridleys at ranges of 365 m, 546 m, and 914 m were apparently unharmed. All loggerheads displayed abnormal pink coloration caused by dilated blood vessels at the base of their throats and flippers for about 3 weeks.

O'Keeffe and Young (1984) analyzed data from three underwater shock tests carried out off Panama City, Florida in 1981. During each test, a charge equivalent of 1,200 lb of TNT was detonated at mid-depth in water about 36.6 m (120 ft) deep. At least three turtles were noted in the area following the detonations. One turtle at a range of 152 to 213 m (500 to 700 ft) was killed. A second turtle at a range of 365 m received minor injuries. A third turtle at 609.6 m (2,000 ft) was apparently unaffected. At a depth of 18 m (60 ft), calculated shock wave pressures were 239, 161, 85, and 47 psi at ranges of 152, 213, 365, and 609.6 m, respectively.

Based on a parametric evaluation of the effects of charge weight and depth using the Goertner (1982) model, Young (1991a) concluded that a conservative safe range for non-injury to a small mammal (representative of a dolphin calf) was approximated by R=578w0.28 (R is in feet and w is in pounds of explosive). O'Keeffe and Young (1984) proposed that a safe range for turtles from an underwater explosion could be expressed by R = 200 w1/3. This equation was subsequently modified by Young (1991a) based on safe ranges established by NMFS for platform removal operations using explosives. The revised equation is R = 560 w1/3. Assuming that the U.S. Navy proposes to detonate 5 to 20 lb charges (NEW) during mine neutralization or

underwater demolition exercises, the equation proposed by O'Keefe and Young (1984) would produce safe ranges of 104.24 m (for 5 lb charges) and 165.47 m (for 20 lb charges). The modified equation proposed by Young (1991a) would produce safe ranges of 291.87 m (for 5 lb charges) and 463.32 m (for 20 lb charges). The U.S. Navy proposes to use a safe range of 640 m, which is more than 27 percent greater than the largest of these safe ranges and is greater than the distance at which sea turtles appeared to have been unaffected by the detonations conducted on the Mariana Islands Range Complex. As a result, we would conclude that hawksbill sea turtles are not likely to experience physical injury, physiological stress responses, or changes in behavioral states as a result of being exposed to pressure waves associated with underwater detonations on the Mariana Islands Range Complex.

Risk Analysis

Sea turtles that occur on the Mariana Islands Range Complex might encounter one or more of the parachutes after they have been jettisoned from these sonobuoys and could become entangled as a result. We cannot, however, determine whether such interactions are probable, given the relatively small number of sonobuoys that would be employed in each of the exercises, the relatively large geographic area involved, and the relatively low densities of endangered or threatened sea turtles on the range complex.

Nevertheless, we conclude that training exercises and other activities the U.S. Navy plans to conduct in the Mariana Islands Range Complex from August 12, 2011 through August 11, 2012 are not likely to interact with sufficient number of adult or sub-adult hawksbill sea turtles, if they interact with hawksbill sea turtles at all, to reduce the viability of the nesting aggregations those hawksbill sea turtles represent by reducing the population dynamics, behavioral ecology, and social dynamics of those populations (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations). As a result, those activities would not be expected to appreciably reduce the likelihood of hawksbill sea turtles surviving and recovering in the wild by reducing their reproduction, numbers, or distribution.

6.4 Cumulative Effects

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

During this consultation, NMFS searched for information on future State, tribal, local, or private actions that were reasonably certain to occur in the action area. Most of the action area includes federal military reserves or is outside of territorial waters of the United States of America, which would preclude the possibility of future state, tribal, or local action that would not require some form of federal funding or authorization. NMFS conducted electronic searches of business journals, trade journals, and newspapers using *First Search*, Google, and other electronic search engines. Those searches produced no evidence of future private action in the action area that would not require federal authorization or funding and is reasonably certain to occur. As a result,

NMFS is not aware of any actions of this kind that are likely to occur in the action area during the foreseeable future.

7 CONCLUSION

After reviewing the current status of blue whales, fin whales, humpback whales, sei whales, sperm whales, green sea turtles, and hawksbill sea turtles, the environmental baseline for the action area, the effects of the military readiness activities the U.S. Navy proposes to conduct on the Mariana Islands Range Complex over the twelve month interval of the proposed LOA and the LOA itself, and the cumulative effects, it is NMFS' biological opinion that the Navy's proposed activities are not likely to jeopardize the continued existence of these threatened and endangered species under NMFS jurisdiction.

Because critical habitat that has been designated for endangered or threatened species does not occur in the action area, it is not likely to be adversely affected by the military readiness activities the U.S. Navy proposes to conduct on the Mariana Islands Range Complex and the LOA NMFS' Permits, Conservation, and Education Division proposes to issue.

8 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibits the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2) of the ESA, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of an Incidental Take Statement (ITS).

The measures described below, which are non-discretionary, must be implemented by NMFS' Permits, Conservation and Education Division so they become binding conditions of any permit issued to the U.S. Navy, as appropriate, in order for the exemption in section 7(o)(2) to apply. NMFS' Permits, Conservation, and Education Division has a continuing duty to regulate the activity covered by this Incidental Take Statement. If NMFS' Permits, Conservation and Education Division (1) fails to require the U.S. Navy to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

8.1 Amount or Extent of Take Anticipated

The effects analysis contained in this Opinion concluded that individual blue whales, fin whales, humpback whales, sei whales, sperm whales, and listed sea turtles have small probabilities of being exposed to the active sonar, sound fields associated with underwater detonations, or noise and other environmental cues associated with the movement of surface vessels. In some instances, we concluded that this exposure was likely to result in evasive behavior or changes in behavioral state, which we would consider "harassment" for the purposes of this ITS.

The instances of harassment identified in Table 8 would generally represent changes from foraging, resting, milling, and other behavioral states that require lower energy expenditures compared to traveling, avoidance, and behavioral states that require higher energy expenditures. Therefore, they would represent significant disruptions of the normal behavioral patterns of the animals that have been exposed. No whales are likely to die or be wounded as a result of their exposure to the training activities the U.S. Navy plans to conduct on the Mariana Islands Range Complex. Therefore, for the purposes of this Opinion and ITS, we assume that the training activities the U.S. Navy proposes to conduct on the Mariana Islands Range Complex is likely to result in the following incidental "take":

Table 8. The number of endangered whales that are likely to be "taken" in the form of harassment or harm as a result of their exposure to U.S. Navy training activities on the Mariana Islands Range Complex.

Species	Mid-Frequency Active Sonar	Underwater Detonations	Total	SURTASS LFA [1]
Blue whale	5	0	5	23
Fin whale	15	0	15	69
Humpback whale	334	1	335	1,740
Sei whale	14	0	14	65
Sperm whale	374	7	381	153

[1] *Take of endangered whales incidental to SURTASS LFA sonar are addressed in separate MMPA authorizations and biological opinions.*

Although we have identified the number of instances in which endangered whales might be "taken" incidental to being exposed to low-frequency active sonar associated with the SURTASS LFA sonar system, this ITS does not exempt the "take" of endangered whales or sea turtles associated with that sonar because that take is authorized in a separate MMPA authorization and is exempted in a separate biological opinion on that authorization.

"Take" of these species will have been exceeded if these estimates are exceeded or if the monitoring program associated with the training activities detects any individuals of these species that have been harmed, injured, or killed as result of exposure to active sonar transmissions or underwater detonations.

SeaTurtles

We did not conduct computer simulations for sea turtles because the data necessary to develop computer models were not available. In the Exposure Analysis subsection of this Opinion, we established that we could not assign numerical limits for take estimates. Rather than specifying an amount of take for sea turtles, this incidental take statement specifies an extent of take as follows:

Adult and sub-adult sea turtles may be taken, in the form of harassment, outside of the 640-meter exclusion zone the U.S. Navy proposes to establish for all mine warfare and mine countermeasure training activities. Take will have been exceeded if monitoring associated with these detonations identifies sea turtles within that exclusion zone while underwater detonations have occurred or if sea turtles are harmed, injured, or killed in association with at least one underwater detonation despite the existence of the exclusion zone.

8.2 Effect of the Take

In the accompanying Opinion, NMFS determined that this level of harassment is not likely to jeopardize the continued existence to the endangered or threatened species for which "take" would be exempted by this ITS. The proposed action is not likely to result in destruction or adverse modification of critical habitat. Studies of marine mammals and active sonar transmissions have shown behavioral responses by blue whales, fin whales, gray whales, and humpback whales to active sonar transmissions. Although the biological significance of the animal's behavioral responses remains uncertain, the best scientific and commercial data available leads us to conclude that exposing these endangered and threatened species to active sonar transmissions might disrupt one or more behavioral patterns that are essential to an individual animal's life history or to the animal's contribution to a population. For the proposed action, behavioral responses that result from active sonar transmissions and any associated disruptions are expected to be temporary and would not affect the reproduction, survival, or recovery of these species.

8.3 Reasonable and Prudent Measures

The National Marine Fisheries Service believes the following reasonable and prudent measures are necessary and appropriate to minimize the impacts of incidental take on threatened and endangered species:

1. The authorization shall be valid for a period 12 August 2011 through 11 August 2012.

2. The authorization shall be valid only for the unintentional taking of endangered or threatened sea turtles and the species of marine mammals identified in 50 CFR §216.180(b) and condition 3(b) of the Authorization governing the taking of these animals incidental to the activity specified and shall be valid only for takings consistent with the terms and conditions set out in 50 CFR §216.182 and the terms of NMFS' Letters of Authorization.

3. NMFS' Permits, Conservation and Education Division shall require the U.S. Navy to implement a program to mitigate the potential effects of the proposed activities on threatened or endangered species as specified in the final regulations for the Taking of Marine Mammals Incidental to the Navy's training in the Mariana Island Range Complex (50 CFR §218 Subpart L).

4. The U.S. Navy shall employ the mitigation measures included as part of its proposed action and the mitigation measures required by the 2011-2012 Letter of Authorization.

5. NMFS' Permits, Conservation and Education Division shall require the U.S. Navy to implement a program to monitor potential interactions between LFA sonar transmissions and threatened or endangered species.

8.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Endangered Species Act of 1973, as amended, NMFS' Permits, Conservation and Education Division and the U.S. Navy must comply with the following terms and conditions, which implements the reasonable and prudent measures described above and outlines the reporting requirements required by the section 7 regulations (50 CFR §402.14(i)).

(a) Personnel Training:

(1) All commanding officers (COs), executive officers (XOs), lookouts, Officers of the Deck (OODs), junior OODs (JOODs), maritime patrol aircraft aircrews, and Anti-submarine Warfare (ASW)/Mine Warfare (MIW) helicopter crews shall complete the NMFS-approved Marine Species Awareness Training (MSAT) by viewing the U.S. Navy MSAT digital versatile disk (DVD). All bridge lookouts shall complete both parts one and two of the MSAT; part two is optional for other personnel.

(2) Navy lookouts shall undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (Naval Education and Training Command [NAVEDTRA] 12968-D).

(3) Lookout training shall include on-the-job instruction under the supervision of a qualified, experienced lookout. Following successful completion of this supervised training period, lookouts shall 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.

(4) Lookouts shall be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of protective measures if marine species are spotted.

(5) All lookouts onboard platforms involved in ASW training events will review the NMFS-approved Marine Species Awareness Training material prior to use of mid-frequency active sonar.

(6) All COs, XOs, and officers standing watch on the bridge will have reviewed the Marine Species Awareness Training material prior to a training event employing the use of MFAS/HFAS.

(b) General Operating Procedures (for all training types):

(1) Prior to major exercises, a Letter of Instruction, Mitigation Measures Message or Environmental Annex to the Operational Order shall be issued to further disseminate the personnel training requirement and general marine species protective measures.

(2) COs shall make use of marine species detection cues and information to limit interaction with marine mammals to the maximum extent possible consistent with safety of the ship.

(3) While underway, surface vessels shall have at least two lookouts with binoculars; surfaced submarines shall 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.

(4) On surface vessels equipped with a multi-function active sensor, pedestal mounted "Big Eye" (20x110) binoculars shall be properly installed and in good working order to assist in the detection of marine mammals in the vicinity of the vessel.

(5) Personnel on lookout shall employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).

(6) After sunset and prior to sunrise, lookouts shall employ Night Lookouts Techniques in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).

(7) While in transit, naval vessels shall be alert at all times, use extreme caution, and proceed at a "safe speed", which means the speed at which the CO can maintain crew safety and effectiveness of current operational directives, so that the vessel can take action to avoid a collision with any marine mammal.

(8) When marine mammals have been sighted in the area, Navy vessels shall increase vigilance and take all reasonable actions to avoid collisions and close interaction of naval assets and marine mammals. Such action may include changing speed and/or direction and are dictated by environmental and other conditions (e.g., safety, weather).

(9) Navy aircraft participating in exercises at-sea shall conduct and maintain surveillance for marine mammals as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.

(10) All marine mammal detections shall 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.

(11) 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.

(c) Operating Procedures (for Anti-submarine Warfare Operations):

(1) On the bridge of surface ships, there shall always be at least three people on watch whose duties include observing the water surface around the vessel.

(2) All surface ships participating in ASW training events shall have, in addition to the three personnel on watch noted in (i), at least two additional personnel on watch as lookouts at all times during the exercise.

(3) 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.

(4) Personnel on lookout shall be responsible for reporting all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the Officer of the Deck, 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 mammal that may need to be avoided.

(5) All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) shall monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action.

(6) During mid-frequency active sonar operations, personnel shall utilize all available sensor and optical systems (such as night vision goggles) to aid in the detection of marine mammals.

(7) Aircraft with deployed sonobuoys shall use only the passive capability of sonobuoys when marine mammals are detected within 200 yds (183 m) of the sonobuoy.

(8) Helicopters shall observe/survey the vicinity of an ASW exercise for 10 minutes before the first deployment of active (dipping) sonar in the water.

(9) Helicopters shall not dip their sonar within 200 yards of a marine mammal and shall cease pinging if a marine mammal closes within 200 yards after pinging has begun.

(10) Safety Zones— When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) the Navy shall ensure that sonar transmission levels are limited to at least 6 dB below normal operating levels if any detected marine mammals are within 1000 yards (914 m) of the sonar window or dome (i.e., limit to at most 229 dB for AN/SQS-53 and 219 for AN/SQS-56, etc.).

(i) Ships and submarines shall continue to limit maximum transmission levels by this 6-dB factor until the animal has been seen to leave the 1000-yd safety zone, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (1829 m) beyond the location of the last detection.

(ii) When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) the Navy shall ensure that sonar transmission levels are limited to at least 10 dB below normal operating levels if any detected marine mammals are within 500 yards (457 m) of the sonar window or dome. Ships and submarines shall 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 yds (1829 m) beyond the location of the last detection.

(iii) When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) the Navy shall ensure that sonar transmission ceases if any detected marine mammals are within 200 yards (about 182 m) of the sonar window or dome. Sonar shall 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 yds (1829 m) beyond the location of the last detection.

(iv) 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.

(v) If the need for power-down should arise (as detailed in 218.114(a)(3)(x)) when the Navy was operating a hull-mounted or sub-mounted source above 235 db (infrequent), the Navy shall 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).

(11) 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.

(12) Active sonar levels (generally)—Navy shall operate active sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.

(13) Submarine sonar operators will review detection indicators of close-aboard marine mammals prior to the commencement of ASW training events involving MFAS.

(d) Operating Procedures for Underwater Detonations (up to 10-lb charges):

(1) Exclusion Zones - All demolitions and ship mine countermeasures training exercises involving the use of explosive charges must include exclusion zones for marine mammals to prevent physical and/or acoustic effects to those species. These exclusion zones shall extend in a 700-yard arc radius around the detonation site. Should a marine mammal be present within the surveillance area, the explosive event shall not be started until the animal leaves the area.

(2) Pre-Exercise Surveys - For Demolition and Ship Mine Countermeasures Operations, pre-exercise surveys shall be conducted within 30 minutes prior to the commencement of the scheduled explosive event. The survey may be conducted from the surface, by divers, and/or from the air, and personnel shall be alert to the presence of any marine mammal. Should such an animal be present within the survey area, the explosive event shall not be started until the animal voluntarily leaves the area. The Navy will ensure the area is clear of marine mammals for a full 30 minutes prior to initiating the explosive event. Personnel will record any marine mammal observations during the exercise as well as measures taken if species are detected within the exclusion zone.

(3) Post-Exercise Surveys - Surveys within the same exclusion zone radius shall also be conducted within 30 minutes after the completion of the explosive event.

(4) Reporting - If there is evidence that a marine mammal may have been stranded, injured or killed by the action, Navy training activities shall be immediately suspended and the situation immediately reported by the participating unit to the Officer in Charge of the Exercise (OCE), who will follow Navy procedures for reporting the incident to Commander, Pacific Fleet, Commander, Navy Region Marianas, Environmental Director, and the chain-of-command. The situation shall also be reported to NMFS (see Stranding Plan for details).

(e) Sinking Exercise:

(1) All weapons firing shall be conducted during the period 1 hour after official sunrise to 30 minutes before official sunset.

(2) An exclusion zone with a radius of 1.0 nm (1.9 km) will be established around each target. An additional buffer of 0.5 nm (0.9 km) will be added to account for errors, target drift, and animal movements. Additionally, a safety zone, which will extend beyond the buffer zone by an additional 0.5 nm (0.9 km), would be surveyed. Together, the zones extend out 2 nm (3.7 km) from the target.

(3) A series of surveillance over-flights shall be conducted within the 2-nm zone around the target prior to and during the exercise, when feasible. Survey protocol shall be as follows:

(i) Overflights within the 2-nm zone around the target shall 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 environ-mental conditions of the day. These environmental conditions include the angle of sun inclination, amount of daylight, cloud cover, visibility, and sea state.

(ii) All visual surveillance activities shall 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.

(iii) In addition to the overflights, the 2-nm zone around the target shall be monitored by passive acoustic means, when assets are available. This passive acoustic monitoring would be maintained throughout the exercise. Additionally, passive sonar onboard submarines may be utilized to detect any vocalizing marine mammals in the area. The OCE will be informed of any aural detection of marine mammals and will include this information in the determination of when it is safe to commence the exercise.

(iv) On each day of the exercise, aerial surveillance of the 2-nm zone around the target shall commence 2 hours prior to the first firing.

(v) The results of all visual, aerial, and acoustic searches shall be reported immediately to the OCE. No weapons launches or firing may commence until the OCE declares the 2-nm zone around the target free of marine mammals.

(vi) If a marine mammal is observed within the 2-nm zone around the target, 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 can be assumed to have left the 2-nm zone around the target. The OCE will determine if the marine mammal is in danger of being adversely affected by commencement of the exercise.

(vii) During breaks in the exercise of 30 minutes or more, the 2-nm zone around the target shall again be surveyed for any marine mammal. If marine mammals are sighted within the 2-nm zone around the target, the OCE shall be notified, and the procedure described above shall be followed.

(viii) Upon sinking of the vessel, a final surveillance of the 2-nm zone around the target shall be monitored for 2 hours, or until sunset, to verify that no marine mammals were harmed.

(4) Aerial surveillance shall 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 shall be used. These aircraft shall 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. Surveys of the 2-nm zone around the target 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.

(5) Every attempt shall be made to conduct the exercise in sea states that are ideal for marine mammal sighting, Beaufort Sea State 3 or less. In the event of a 4 or above, survey efforts shall be increased within the 2-nm zone around the targets. This shall be accomplished through the use of an additional aircraft, if available, and conducting tight search patterns.

(6) The exercise shall not be conducted unless the 2-nm zone around the target could be adequately monitored visually. Should low cloud cover or surface visibility prevent adequate visual monitoring as described previously, the exercise shall be delayed until conditions improved, and all of the above monitoring criteria could be met.

(7) In the event that any marine mammals are observed to be harmed in the area, a detailed description of the animal shall be taken, the location noted, and if possible, photos taken of the marine mammal. This information shall be provided to NMFS via the Navy's regional environmental coordinator for purposes of identification (see the Stranding Plan for detail).

(8) An after action report detailing the exercise's 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 shall be submitted to NMFS.

(f) Surface-to-Surface Gunnery (up to 5-inch Explosive Rounds)

(1) For exercises using targets towed by a vessel, target-towing vessels shall maintain a trained lookout for marine mammals when feasible. If a marine mammal is sighted in the vicinity, the tow vessel will immediately notify the firing vessel, which will suspend the exercise until the area is clear.

(2) A 600 yard (585 m) radius buffer zone will be established around the intended target.

(3) 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. Due to the distance between the firing position and the buffer zone, lookouts are only expected to visually detect breaching whales, whale blows, and large pods of dolphins and porpoises.

(4) The exercise will be conducted only when the buffer zone is visible and marine mammals are not detected within it.

(g) Surface-to-Surface Gunnery (non-explosive rounds)

(1) A 200-yd (183 m) radius buffer zone shall be established around the intended target.

(2) From the intended firing position, trained lookouts shall survey the buffer zone for marine mammals prior to commencement and during the exercise as long as practicable.

(3) If available, target towing vessels shall maintain a lookout (unmanned towing vessels will not have a lookout available). If a marine mammal is sighted in the vicinity of the exercise, the tow vessel shall immediately notify the firing vessel in order to secure gunnery firing until the area is clear.

(4) The exercise shall be conducted only when the buffer zone is visible and marine mammals are not detected within the 2-nm zone around the target.

(h) Surface-to-Air Gunnery (Explosive and Non-explosive Rounds)

(1) Vessels will orient the geometry of gunnery exercises in order to prevent debris from falling in the area of sighted marine mammals.

(2) Vessels will attempt to recover any parachute deploying aerial targets to the extent practicable (and their parachutes if feasible) to reduce the potential for entanglement of marine mammals.

(3) Target towing aircraft shall maintain a lookout if feasible. 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.

(i) Air-to-Surface Gunnery (Explosive and Non-explosive Rounds)

(1) A 200 yard (183 m) radius buffer zone will be established around the intended target.

(2) If surface vessels are involved, lookout(s) will visually survey the buffer zone for marine mammals to and during the exercise.

(3) Aerial surveillance of the buffer zone for marine mammals will be conducted prior to commencement of the exercise. Aerial surveillance altitude of 500 ft to 1,500 ft (152 – 456 m) is optimum. 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.

(4) The exercise will be conducted only if marine mammals are not visible within the buffer zone.

(j) Small Arms Training (Grenades, Explosive and Non-explosive Rounds)

- Lookouts will visually survey for marine mammals. Weapons will not be fired in the direction of known or observed marine mammals.

(k) Air-to-Surface At-sea Bombing Exercises (explosive bombs and rockets):

(1) If surface vessels are involved, trained lookouts shall survey for marine mammals. Ordnance shall not be targeted to impact within 1,000 yds (914 m) of known or observed marine mammals.

(2) A 1,000 yd (914 m) radius buffer zone shall be established around the intended target.

(3) Aircraft shall visually survey the target and buffer zone for marine mammals prior to and during the exercise. The survey of the impact area shall be made by flying at 1,500 ft (457 m) or lower, if safe to do so, and at the slowest safe speed. When safety or other considerations require the release of weapons without the releasing pilot having visual

sight of the target area, a second aircraft, the "wingman," will clear the target area and perform the clearance and observation functions required before the dropping plane may release its weapons. Both planes must have direct communication to assure immediate notification to the dropping plane that the target area may have been fouled by encroaching animals or people. The clearing aircraft will assure it has visual site of the target area at a maximum height of 1500 ft. The clearing plane will remain within visual sight of the target until required to clear the area for safety reasons. Survey aircraft shall employ most effective search tactics and capabilities. Survey aircraft should employ most effective search tactics and capabilities.

(4) The exercise will be conducted only if marine mammals are not visible within the buffer zone.

(l) Air-to-Surface At-Sea Bombing Exercises (Non-explosive Bombs and Rockets)

(1) If surface vessels are involved, trained lookouts will survey for marine mammals. Ordnance shall not be targeted to impact within 1,000 yards (914 m) of known or observed or marine mammals.

(2) A 1,000 yard (914 m) radius buffer zone will be established around the intended target.

(3) 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. When safety or other considerations require the release of weapons without the releasing pilot having visual sight of the target area, a second aircraft, the "wingman," will clear the target area and perform the clearance and observation functions required before the dropping plane may release its weapons. Both planes must have direct communication to assure immediate notification to the dropping plane that the target area may have been fouled by encroaching animals or people. The clearing aircraft will assure it has visual site of the target area at a maximum height of 1500 ft. The clearing plane will remain within visual sight of the target until required to clear the area for safety reasons. Survey aircraft shall employ most effective search tactics and capabilities.

(4) The exercise will be conducted only if marine mammals and are not visible within the buffer zone.

(m) Air-to-Surface Missile Exercises (explosive and non-explosive):

(1) Aircraft will visually survey the target area for marine mammals. Visual inspection of the target area will be made by flying at 1,500 (457 m) ft 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.

(2) Explosive ordnance shall not be targeted to impact within 1,800 yds (1646 m) of sighted marine mammals.

(n) Aircraft Training Activities Involving Non-Explosive Devices:

An exclusion zone of 200 yds (~ 183 m) around the target location shall be clear of marine mammals and around the target location. Pre- and post-surveillance and reporting requirements outlined for underwater detonations shall be implemented during Mining Training Activities.

(o) Extended Echo Ranging/Improved Extended Echo Ranging and Advanced Extended Echo-ranging (EER/IEER/AEER)

- The following mitigation measures shall be used with the employment of IEER/AEER sonobuoys:

(1) Crews shall conduct visual reconnaissance of the drop area prior to laying their intended sonobuoy pattern. This search shall be conducted at an altitude below 500 yd (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.

(2) For IEER (AN/SSQ-110A), crews shall conduct a minimum of 30 minutes of visual and aural monitoring of the search area prior to commanding the first post detonation. This 30-minute observation period may include pattern deployment time.

(3) For any part of the intended sonobuoy pattern where a post (source/receiver sonobuoy pair) will be deployed within 1,000 yd (914 m) of observed marine mammal activity, the Navy shall deploy the receiver ONLY (i.e., not the source) 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 source sonobuoy (AN/SSQ-110A/SSQ-125) will be co-located with the receiver.

(4) When operationally feasible, Navy crews shall conduct continuous visual and aural monitoring of marine mammal activity. This shall include monitoring of own-aircraft sensors from the time of the first sensor placement until the aircraft have left the area and are out of RF range of these sensors.

(5) Aural Detection - If the presence of marine mammals is detected aurally, then that shall 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.

(6) Visual Detection - If marine mammals are visually detected within 1,000 yd (914 m) of the explosive source sonobuoy (AN/SSQ-110A/SSQ-125) intended for use, then that payload shall not be activated. 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 914 m (1,000 yd) safety buffer.

(7) For IEER (AN/SSQ-110A), aircrews shall 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 shall refrain from using the "Scuttle" command when two payloads remain at a given post. Aircrews shall ensure that 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.

(8) Aircrews shall 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.

(9) The Navy shall ensure all payloads are accounted for. Explosive source sonobuoys (AN/SSQ-110A) that can not be scuttled shall be reported as unexploded ordnance via voice communications while airborne, then upon landing via naval message.

(10) Marine mammal monitoring shall continue until out of own-aircraft sensor range.

(p) The Navy shall abide by the letter of the "Stranding Response Plan for Major Navy Training Exercises in the MIRC" (available at: www.nmfs.noaa.gov/pr/permits/incidental.htm), which is incorporated herein by reference, to include the following measures:

(1) Shutdown Procedures – When an Uncommon Stranding Event (USE – defined in § 218.271) occurs during a Major Training Exercise (MTE) (as defined in the Stranding Plan, meaning including Multi-strike group exercises, Joint Expeditionary exercises, and Marine Air Ground Task Force exercises in the MIRC), the Navy shall implement the procedures described below.

(i) The Navy shall implement a Shutdown (as defined in the Stranding Response Plan for MIRC) when advised by a NMFS Office of Protected Resources Headquarters Senior Official designated in the MIRC Stranding Communication Protocol that a USE (as defined in the Stranding Response Plan for MIRC) involving live animals has been identified and that at least one live animal is located in the water. NMFS and Navy shall communicate, as needed, regarding the identification of the USE and the potential need to implement shutdown procedures.

(ii) Any shutdown in a given area shall remain in effect in that area until NMFS advises the Navy that the subject(s) of the USE at that area die or are euthanized, or that all live animals involved in the USE at that area have left the area (either of their own volition or herded).

(iii) If the Navy finds an injured or dead marine mammal floating at sea during an MTE, the Navy shall notify NMFS immediately or as soon as operational security considerations allow. The Navy shall provide NMFS with species or description of the animal (s), the condition of the animal(s) including carcass condition if the animal(s) is/are dead), location, time of first discovery, observed behaviors (if alive), and photo or video of the animals (if available). Based on the information provided, NMFS shall determine if, and advise the Navy whether a modified shutdown is appropriate on a case-by-case basis.

(iv) 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 shall coordinate (including an investigation of other potential anthropogenic stressors in the area) to determine if the proximity of MFAS/HFAS activities 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 shall further coordinate to determine what measures are necessary to further minimize that likelihood and implement those measures as appropriate.

(2) Within 72 hours of NMFS notifying the Navy of the presence of a USE, the Navy shall provide available information to NMFS (per the MIRC Communication Protocol) regarding the location, number and types of acoustic/explosive sources, direction and speed of units using MFAS/HFAS, and marine mammal sightings information associated with training activities occurring within 80 nm (148 km) and 72 hours prior to the USE event. Information not initially available regarding the 80 nm (148 km), 72 hours, period prior to the event shall be provided as soon as it becomes available. The Navy shall provide NMFS investigative teams with additional relevant unclassified information as requested, if available.

Monitoring and Reporting

All reports should be submitted to the Chief – Endangered Specific Division, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring MD 20910 and a copy provided to the Assistant Regional Administrator for Protected Resources, Pacific Islands Regional Office, National Marine Fisheries Service,1601 Kapiolani Boulevard, Suite 1110, Honolulu, HI 96814.

(a) General Notification of Injured or Dead Marine Mammals - Navy personnel shall ensure that NMFS is notified immediately (see Communication Plan) or as soon as clearance procedures allow) 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. The Navy will provide NMFS with the name of species or description of the animal (s), the condition of the animal(s) (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available). In the

event that an injured, stranded, or dead marine mammal is found by the Navy that is not in the vicinity of, or during or shortly after, MFAS, HFAS, or underwater explosive detonations, the Navy will report the same information as listed above as soon as operationally feasible and clearance procedures allow.

(b) General Notification of Ship Strike - In the event of a ship strike by any Navy vessel, at any time or place, the Navy shall do the following:

(1) 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 whether its status is unknown.

(2) Report to NMFS as soon as operationally feasible the size and length of animal, an estimate of the injury status (ex., dead, injured but alive, injured and moving, unknown, etc.), vessel class/type and operational status.

(3) Report to NMFS the vessel length, speed, and heading as soon as feasible.

(4) Provide NMFS a photo or video, if equipment is available.

(c) The Navy must conduct all monitoring and/or research required under this Incidental Take Statement, including abiding by the annual MIRC Monitoring Plan, which may be found at: www.nmfs.noaa.gov/pr/permits/incidental.htm#applications.

(d) Report on Monitoring required in paragraph (e) of this section – The Navy shall submit a report annually describing the implementation and results of the monitoring required in paragraph (d) of this section. Required submission date will be identified each year in the LOA. Navy will standardize data collection methods across ranges to allow for comparison in different geographic locations.

(e) Sonar Exercise Notification - The Navy shall submit to NMFS' Office of Protected Resources – Endangered Species Division either an electronic (preferably) or verbal report within fifteen calendar days after the completion of any Major Training Exercise for Reporting that indicates the following:

(1) Location of the exercise;

(2) Beginning and end dates of the exercise; and

(3) Type of exercise.

(f) Four months before applying for subsequent Letters of Authorization in 2011, the Navy shall submit an Annual Exercise MIRC Report that contains the following information:

(1) MFAS/HFAS Major Training Exercises, specifically Joint Multi-strike Group Exercises; Joint Expeditionary Exercises; and Marine Air Ground Task Force MIRC:

(i) Exercise Information (for each MTER):

(A) Exercise designator;

(B) Date that exercise began and ended;

(C) Location;

(D) Number and types of active sources used in the exercise;

(E) Number and types of passive acoustic sources used in exercise;

(F) Number and types of vessels, aircraft, etc., participating in exercise;

(G) Total hours of observation by watchstanders;

(H) Total hours of all active sonar source operation;

(I) Total hours of each active sonar source (along with explanation of how hours are calculated for sources typically quantified in alternate way (buoys, torpedoes, etc.)); and

(J) Wave height (high, low, and average during exercise).

(ii) Individual marine mammal sighting info (for each sighting in each MTER):

(A) Location of sighting;

(B) Species (if not possible – indication of whale/dolphin/pinniped);

(C) Number of individuals;

(D) Calves observed (y/n);

(E) Initial Detection Sensor;

(F) Indication of specific type of platform observation made from (including, for example, what type of surface vessel, i.e., FFG, DDG, or CG);

(G) Length of time observers maintained visual contact with marine mammal(s);

(H) Wave height (in feet);

(I) Visibility;

(J) Sonar source in use (y/n);

(K) Indication of whether animal is <200yd, 200-500yd, 500-1000yd, 1000-2000yd, or >2000yd from sonar source in (x) above;

(L) Mitigation Implementation – Whether operation of sonar sensor was delayed, or sonar was powered or shut down, and how long the delay was;

(M) If source in use (x) is hullmounted, true bearing of animal from ship, true direction of ship's travel, and estimation of animal's motion relative to ship (opening, closing, parallel); and

(N) Observed behavior – Watchstanders shall report, in plain language and without trying to categorize in any way, the observed behavior of the animals (such as animal closing to bow ride, paralleling course/speed, floating on surface and not swimming, etc.).

(iii) An evaluation (based on data gathered during all of the MTERs) of the effectiveness of mitigation measures designed to avoid exposing marine mammals to MFAS. This evaluation shall identify the specific observations that support any conclusions the Navy reaches about the effectiveness of the mitigation.

(2) ASW Summary - This section shall include the following information as summarized from non-major training exercises (unit-level exercises, such as TRACKEXs):

(i) Total Hours - Total annual hours of each type of sonar source (along with explanation of how hours are calculated for sources typically quantified in alternate way (buoys, torpedoes, etc.))

(3) Sinking Exercises (SINKEXs) - This section shall include the following information for each SINKEX completed that year:

(i) Exercise Info:

(A) Location;

(B) Date and time exercise began and ended;

(C) Total hours of observation by watchstanders before, during, and after exercise;

(D) Total number and types of rounds expended / explosives detonated;

(E) Number and types of passive acoustic sources used in exercise;

(F) Total hours of passive acoustic search time;

(G) Number and types of vessels, aircraft, etc., participating in exercise;

(H) Wave height in feet (high, low and average during exercise); and

(I) Narrative description of sensors and platforms utilized for marine mammal detection and timeline illustrating how marine mammal detection was conducted.

(ii) Individual marine mammal observation during SINKEX (by Navy lookouts) information:

(A) Location of sighting;

(B) Species (if not possible – indication of whale/dolphin/pinniped);

(C) Number of individuals;

(D) Calves observed (y/n);

(E) Initial detection sensor;

(F) Length of time observers maintained visual contact with marine mammal;

(G) Wave height;

(H) Visibility;

(I) Whether sighting was before, during, or after detonations/exercise, and how many minutes before or after;

(J) Distance of marine mammal from actual detonations (or target spot if not yet detonated) – use four categories to define distance:

(1) the modeled injury threshold radius for the largest explosive used in that exercise type in that OPAREA (TBD m for SINKEX in MIRC);

(2) the required exclusion zone (1 nm for SINKEX in MIRC);

(3) the required observation distance (if different than the exclusion zone (2 nm for SINKEX in MIRC); and

(4) greater than the required observed distance. For example, in this case, the observer shall indicate if < 426 m, from 426 m – 1 nm, from 1 nm – 2 nm, and > 2 nm.

(K) Observed behavior – Watchstanders will report, in plain language and without trying to categorize in any way, the observed behavior of the animals (such as animal closing to bow ride, paralleling course/speed, floating on surface and not swimming etc.), including speed and direction.

(L) Resulting mitigation implementation – Indicate whether explosive detonations were delayed, ceased, modified, or not modified due to marine mammal presence and for how long.

(M) If observation occurs while explosives are detonating in the water, indicate munitions type in use at time of marine mammal detection.

(4) Improved Extended Echo-Ranging System (IEER)/Advanced Extended Echo-Ranging (AEER) Summary:

(i) Total number of IEER and AEER events conducted in MIRC;

(ii) Total expended/detonated rounds (buoys); and

(iii) Total number of self-scuttled IEER rounds.

(5) Explosives Summary - The Navy is in the process of improving the methods used to track explosive use to provide increased granularity. To the extent practicable, the Navy shall provide the information described below for all of their explosive exercises. Until the Navy is able to report in full the information below, they will provide an annual update on the Navy's explosive tracking methods, including improvements from the previous year.

(i) Total annual number of each type of explosive exercise (of those identified as part of the "specified activity" in this final rule) conducted in MIRC; and

(ii) Total annual expended/detonated rounds (missiles, bombs, etc.) for each explosive type.

These reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. NMFS' Permits, Conservation, and Education Division and U.S. Navy must immediately provide an explanation, in wiritng, of the causes of any take and discuss possible modifications to the reasonable and prudent measures with NMFS' Endangered Species Division.

9 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The following conservation recommendations would provide information for future consultations involving the issuance of marine mammal permits that may affect endangered whales as well as reduce harassment related to research activities:

1. *Cumulative Impact Analysis*. The U.S. Navy should work with NMFS Endangered Species Division and other relevant stakeholders (the Marine Mammal Commission, International Whaling Commission, and the marine mammal research community) to develop a method for assessing the cumulative impacts of anthropogenic noise on cetaceans, pinnipeds, sea turtles, and other marine animals. This includes the cumulative impacts of U.S. Navy military readiness activities on the distribution, abundance, and the physiological, behavioral and social ecology of endangered and threatened species that are exposed to active sonar, underwater detonations, and vessel traffic at several locations in their distribution.

2. *Help expand our basic knowledge of the Mariana Islands Range Complex*. The U.S. Navy should continue the vessel surveys and field studies necessary to improve our understanding of the distribution and abundance of endangered and threatened marine mammals and sea turtles that occur on the Mariana Islands Range Complex. The small vessel surveys the U.S. Navy funded in 2010 and 2011 under the monitoring plan added to the basic knowledge of the area (Navy 2011). The surveys the U.S. Navy conducted in 2007 substantially increased our basic knowledge of the distribution and abundance of marine mammals and sea turtles that occur on the Mariana Islands Range Complex; nevertheless, those surveys only provide us insight on the distribution and relative abundance of marine species over a four-month window in a single year (Fulling et al. 2011). Additional surveys would allow us to identify patterns of distribution and abundance of these species and provide us insight into how those patterns change over time and space; we would need that information to reduce our uncertainty about the conclusions of our biological opinions.

3. Collect and dissemintate data on ambient noise levels in marine and coastal environments of the Mariana Island Range Complex.

In order to keep NMFS Endangered Species Division informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the U.S. Navy and the Permits, Conservation and Education Division of the Office of Protected Resources should notify the Endangered Species Division of any conservation recommendations they implement in their final action.

10 REINITIATION STATEMENT

This concludes formal consultation on the U. S. Navy's proposal to conduct military readiness activities on the Mariana Island Range Complex and NMFS' Permits, Conservation, and Education Division's proposed letters of authorization for the U.S. Navy's pursuant to the provisions of the Marine Mammal Protection Act of 1972. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, section 7 consultation must be reinitiated immediately.

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