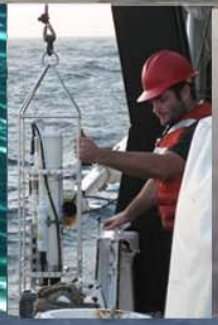
DRAFT
Programmatic Environmental Assessment

for

Fisheries Research Conducted and Funded by the
Southwest Fisheries Science Center



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ACCRONYMS AND ABBREVIATIONS

AERD	Antarctic Ecosystem Research Division
AMLR	Antarctic Marine Living Resources Program
CCAML	Convention for the Conservation of Antarctic Marine Living Resources
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
ERD	Environmental Research Division
FED	Fisheries Ecology Division
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
FRD	Fisheries Resources Division
IATTC	Inter-American Tropical Tuna Commission
IDCP	International Dolphin Conservation Program
IDCPA	International Dolphin Conservation Program Act
IHA	Incidental Harassment Authorization
ISC	International Scientific Committee for Tuna and Tuna-like Species
IWC	International Whaling Commission
LOA	Letters of Authorization
MBTA	Migratory Bird Treaty Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NADS	non-associated and dependent species
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NOAA	National Oceanic and Atmospheric Administration
NPFMC	North Pacific Fisheries Management Council
OPR	Office of Protected Resources
PFMC	Pacific Fisheries Management Council
PRD	Protected Resources Division
SWFSC	Southwest Fisheries Science Center
U.S.	United States
U.S.C.	United States Code
WCPFC	Western and Central Pacific Fisheries Commission
WPRFM	Western Pacific Regional Fishery Management Council

EXECUTIVE SUMMARY

CHAPTER 1 – INTRODUCTION AND PURPOSE AND NEED

The federal government has a responsibility to conserve and protect living marine resources in waters of the United States (U.S.), also referred to as federal waters. These waters generally lie 3 to 200 nautical miles (nm) from the shoreline, and comprise an area known as the Exclusive Economic Zone (EEZ)[1]. The National Oceanic and Atmospheric Administration (NOAA) has the primary responsibility for managing marine finfish and shellfish, certain marine mammal species, sea turtles in marine waters, and their habitats. Within NOAA, the National Marine Fisheries Service (NMFS) has been delegated primary responsibility for the science-based management, conservation, and protection of living marine resources within the U.S. EEZ.

NMFS is fundamentally a science-based agency, with its primary mission being the stewardship of living marine resources through science-based conservation and management. So central is science-based management to NMFS' fishery management efforts, it is listed among the ten National Standards set forth in the Magnuson-Stevens Fishery Conservation and Management Act: "(2) Conservation and management measures shall be based upon the best scientific information available." (16 U.S.C. §§ 1801-1884).

Fisheries Science Centers

In order to direct and coordinate the collection of scientific information needed to make informed fishery conservation and management decisions, NMFS established six Regional Fisheries Science Centers[2], each a distinct organizational entity and the scientific focal point within NMFS for region-based federal fisheries-related research in the United States. The Fisheries Science Centers conduct primarily *fisheries-independent* research studies[3] but may also participate in *fisheries-dependent* and *cooperative* research studies. This research is aimed at monitoring fish stock recruitment, survival and biological rates, abundance and geographic distribution of species and stocks, and providing other scientific information needed to improve our understanding of complex marine ecological processes.

Southwest Fisheries Science Center Research Activities

The Southwest Fisheries Science Center (SWFSC) is the research arm of NMFS in the Southwest Region. The SWFSC conducts research and provides scientific advice to manage fisheries and conserve protected species along the U.S. West Coast, throughout the Eastern Tropical Pacific Ocean, and in the Scotia Sea area off Antarctica (Figure 1.1-2). The SWFSC provides scientific information to support the Pacific Fishery Management Council and numerous other domestic and international fisheries management organizations.

In addition to fisheries management organizations, SWFSC generates and communicates scientific information to support the restoration of California rivers, the recovery of protected species, the establishment of marine protected areas, the emergence of marine spatial planning, and to advance scientific understanding of the structure and function of marine ecosystems and the impacts of climate change on these systems.

[1] An area over which a nation has special rights over the exploration and use of marine resources.

[2] Northeast FSC, Southeast FSC, Southwest FSC, Northwest FSC, Alaska FSC, and Pacific Islands FSC

[3] Fisheries-independent research is designed and conducted independent of commercial fishing activity to meet specific research goals, and includes research directed by SWFSC scientists and conducted on board NOAA- owned and operated vessels or NOAA-chartered vessels. Fisheries-dependent research is research that is carried out in partnership with commercial fishing vessels. The vessel activity is not directed by the SWFSC, but researchers collect data on the commercial catch. Cooperative research programs are those where SWFSC scientists play a significant role in some aspect of study design, administration, or assessment of results but which are carried out by cooperating scientists (other agencies, academic institutions, commercial fishing-associated groups, or independent researchers) on board non-NOAA vessels.

The specimen archives collected during SWFSC research cruises include some of the world's preeminent collections of ichthyoplankton, marine invertebrates, and tissue samples for molecular genetics. Sample coverage from temperate, tropical, and polar ecosystems is unique in the world because of the long time series and extensive area from which they have been sampled. These collection archives provide an important record of species diversity, community composition, genetic structure, and an extraordinary record of climate change and other human impacts for current and future studies.

NMFS has prepared this Draft Programmatic Environmental Assessment (EA) under the National Environmental Policy Act (NEPA) to evaluate several alternatives for conducting and funding these fisheries and ecosystem research activities as the primary federal action. NMFS is also evaluating in this EA a related action—also called a "connected action" under NEPA (Sec. 1508.25)—which is the proposed promulgation of regulations and authorization of "takes"[4] of marine mammals incidental to the research activities through issuance of Letters of Authorization (LOA) under the Marine Mammal Protection Act (MMPA) (see Section 6.3 for detailed discussion). Additionally, because the proposed fisheries and ecological research activities occur in areas inhabited by a number of marine mammals, birds, sea turtles, fishes, and invertebrates listed under the Endangered Species Act (ESA) as threatened or endangered, this EA evaluates activities that could result in unintentional impacts on ESA-listed marine species.

CHAPTER 2 - ALTERNATIVES

The National Environmental Policy Act requires federal agencies to consider alternatives to a proposed federal action. The evaluation of alternatives under NEPA assists the decision maker in ensuring that any unnecessary impacts are avoided through an assessment of alternative ways to achieve the underlying purpose of the proposed action that may result in less environmental harm.

To warrant detailed evaluation under NEPA, an alternative must be reasonable and meet the stated purpose and need for the proposed actions (see Section 1.3). For this EA, NMFS has applied the following screening criteria to a range of alternatives to identify which ones should be brought forward for detailed analysis:

Screening Criteria

To be considered "reasonable" for purposes of this EA, an alternative must meet the following criteria:

- The action must not violate any federal statute or regulation.
- The action must be consistent with reasonably foreseeable funding levels.
- The action must be consistent with long-term research commitments and goals to maintain scientific integrity of ongoing research efforts or consider no federal funding availability for fisheries research.

To maintain scientific integrity, fisheries and marine ecosystem scientific research must meet the following criteria:

- Methods and techniques must provide standardized, objective, and unbiased sampling consistent with past data sets (time series) in order to facilitate long-term trend analyses.
- Collected data must adequately characterize living marine resource and fishery populations and the health of their habitats.

[4] The term "take" under the MMPA means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." The MMPA defines "harassment" as "any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption or behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment)." (16 U.S.C. Sec 1361 *et seq*.)

- The surveys must enable tracking population dynamics and provide predictive capabilities required to respond to changing ecosystem conditions and manage future fisheries.
- Research on new methodologies to collect fisheries and ecosystem information (e.g. active and passive acoustic instruments and video surveys of benthic habitats in lieu of dredge gear or bottom trawls) and research oriented toward modifications of fishing gear to address bycatch or other inefficiencies should be conducted with sufficient scientific controls to allow statistically-valid comparisons with relevant alternatives.

NMFS evaluated each potential alternative against these criteria. Based on this evaluation, the No-Action/Status Quo Alternative and two other action alternatives have been identified as reasonable and are being carried forward for more detailed evaluation in this EA. NMFS will also evaluate a second type of no-action alternative that considers no federal funding for fisheries research activities. This will be called the No Research Alternative to distinguish it from the No-Action/Status Quo Alternative. The No-Action/Status Quo Alternative will be used as the baseline to compare all of the other alternatives.

Three of the alternatives include a program of fisheries and ecosystem research projects conducted or funded by the SWFSC as the primary federal action. Because this primary action is connected to a secondary federal action (also called a connected action under NEPA), to consider NMFS' issuance of five-year regulations and subsequent LOAs under Section 101(a)(5)(A) of the MMPA for the incidental, but not intentional, taking of marine mammals, NMFS must identify as part of this evaluation under the MMPA "(t)he means of effecting the least practicable adverse impact on the species or stock and its habitat." (MMPA Section 101 (a)(5)(A)). As a result, NMFS will identify and evaluate a reasonable range of mitigation measures to minimize impacts to protected species that occur in SWFSC research areas. These mitigation measures are considered as part of the identified alternatives in order to evaluate their effectiveness to minimize potential adverse environmental impacts. The three action alternatives also include mitigation measures intended to minimize potentially adverse interactions with other protected species that occur within the action area. Protected species include all marine mammals, which are covered under the MMPA, all species listed under the ESA, and bird species protected under the Migratory Bird Treaty Act.

Alternative 1 - No-Action/Status Quo Alternative - Conduct Federal Fisheries and Ecosystem Research with Scope and Protocols Similar to Past Effort

The Status Quo Alternative includes fisheries research using the same protocols as were implemented from 2008 through 2012. These federal research activities are necessary to fulfill NMFS' mission to provide science-based management, conservation, and protection of living marine resources in the three areas covered by the SWFSC: the California Current Research Area (CCRA), Eastern Tropical Pacific Research Area (ETPRA), and the Antarctic Research Area (ARA). Under Alternative 1, the SWFSC would use the same scope of research as in recent years and with current mitigation measures for protected species and would apply to NMFS' Office of Protected Resources (OPR)[5] to promulgate regulations governing the issuance of LOAs for incidental take of marine mammals under the MMPA. OPR would consider these activities and mitigation measures and determine whether it should promulgate regulations and issue LOAs as appropriate to the SWFSC. If regulations are promulgated and LOAs are issued, they would prescribe: the permissible methods of taking; a suite of mitigation measures intended to reduce the risk of potentially adverse interactions with marine mammals and their habitats during the specified research activities.

In addition, the SWFSC would engage in ESA Section 7 consultations with NMFS' Southwest Regional Office (and U.S. Fish and Wildlife Service, as appropriate) for species that are listed as threatened or endangered. These consultations may result in the development of one or more Biological Opinions

[5] Permits and Conservation Division, Incidental Take Program

(BiOps) that state the opinions of the agencies as to whether or not the primary and secondary federal actions are likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The BiOps may contain incidental take statements that would include reasonable and prudent measures along with implementing terms and conditions intended to minimize the number and impact of incidental takes of ESA-listed species during SWFSC research activities (i.e., effect the least practicable adverse impact); and monitoring and reporting requirements.

The Status Quo Alternative considers 14 scientific research surveys in the CCRA and one research survey each in the ETPRA and ARA (Table 2.2-1) that were conducted in the past five years (2008-2012). These surveys generally used fishing gear to capture fish and invertebrates for stock assessment purposes, and also included collection of plankton and larval life stages and oceanographic and acoustic data to characterize the marine environment. The main gear types of concern for potential interactions with protected species included mid-water trawls, surface trawls, and pelagic longline gear. The SWFSC did not use bottom-contact trawl gear except in the ARA, where bottom trawl surveys are conducted every few years to monitor the recovery of depleted finfish stocks. These past activities are considered as the basis for analysis of future activities under the Status Quo Alternative.

The Status Quo Alternative research activities include a suite of mitigation measures that were developed by the SWFSC in consultation with marine mammal scientists and other protected species experts. These mitigation measures have been implemented on SWFSC surveys since the 2008-2009 field seasons:

- Visual monitoring for protected species prior to deployment of gear;
- Use of the “move-on” rule if marine mammals are sighted from the vessel in the 30 minutes prior to setting trawl or pelagic longline gear and appear to be at risk of interaction with the gear as determined by the professional judgment of the Chief Scientist or officer on watch; and
- Use of a marine mammal excluder device in the NETS Nordic 264 trawl gear.

However, these mitigation measures may not be sufficient to reduce the effects of SWFSC fisheries research activities on marine mammals to the level of least practicable adverse impact, as required under the MMPA (see Alternative 2). Other mitigation measures may be required under the MMPA and ESA processes for the specified research activities conducted by the SWFSC.

Alternative 2 – Preferred Alternative - Conduct Federal Fisheries and Ecosystem Research (New Suite of Research) with Mitigation for MMPA and ESA Compliance

The Preferred Alternative includes the same set of research surveys as the Status Quo Alternative with the addition of a new pelagic longline survey in the ETPRA. Under this alternative, the SWFSC would also apply for authorizations under the MMPA and the ESA for incidental take of protected species during these research activities. The Preferred Alternative also includes new research efforts to test the efficacy, safety, and practicability of new equipment and procedures designed to reduce potentially adverse impacts on protected species, while maintaining the utility of survey results with regard to research objectives (conservation engineering and analysis). If these programs are successful, the SWFSC would incorporate new mitigation protocols into their research programs. These new efforts include:

- Development of a marine mammal excluder device for use in Modified Cobb trawl gear, and
- A retrospective analysis of potential factors influencing incidental take of protected species.

The SWFSC continually reviews its procedures and investigates options for incorporating new mitigation measures and equipment into its on-going survey programs. Evaluations of new mitigation measures include assessments of their effectiveness in reducing risk to protected species, but any such measures must also pass safety and practicability considerations, allow survey results to meet research objectives, and remain consistent with previous data sets.

The Preferred Alternative includes the same suite of mitigation measures as the Status Quo Alternative to reduce the risk of adverse interactions with protected species. It also includes at least two new mitigation measures:

- Modification of the "move-on" rule for trawl and pelagic longline sets to include a one nautical mile safety radius,
- The implementation of a new training program where all Chief Scientists and crew likely to be responsible for monitoring and addressing incidental capture of protected species participate in the elements of the existing commercial fisheries Observer Training Program that address appropriate responses to protected species interactions.

The modifications to the "move-on" rule are intended to restrict and clarify the conditions under which Chief Scientists and officers on watch may use professional judgment to reduce the risk of interactions with protected species, although such judgments are still an important element in reducing risks of potentially adverse interactions. The new training program would include a process for Chief Scientists and vessel captains to communicate with each other about their experiences with protected species interactions during research work with the goal of improving decision-making regarding avoidance of adverse interactions. It would also include Chief Scientists and crew receiving formal training through the commercial fisheries Observer Training Program currently conducted by NMFS Southwest Regional Office. Topics covered in this program include monitoring and sighting protocols, species identification, decision-making factors for avoiding take, procedures for handling and documenting protected species caught in research gear, and reporting requirements. This training program would formalize and standardize the information provided to all crew that might experience protected species interactions during research activities. Depending on the results of the conservation engineering and analysis described above, the Preferred Alternative may also include several other new mitigation measures that would be implemented in the time period covered by this EA, 2013-2018. The mitigation measures considered under the Preferred Alternative are intended to reduce the effects of SWFSC fisheries research activities on marine mammals to the level of least practicable adverse impact, as required under the MMPA.

Alternative 3 - Modified Research Alternative – Conduct Federal Fisheries and Ecosystem Research (New Suite of Research) with Additional Mitigation

Under Alternative 3, the SWFSC would conduct and fund the same scope of fisheries research as described in the Preferred Alternative and would include all of the same mitigation measures considered under the Preferred Alternative. Under this alternative, the SWFSC would also apply for authorizations under the MMPA and the ESA for incidental take of protected species during these research activities. The difference between Alternative 3 and the Preferred Alternative is that Alternative 3 includes a number of additional mitigation measures derived from a variety of sources including: (1) comments submitted from the public on similar fisheries actions, (2) discussions within NMFS' OPR as part of the proposed rulemaking process under the MMPA, and (3) a literature review of past and current research into potential mitigation measures.

Some of the mitigation measures considered under Alternative 3 (e.g., no night fishing or broad spatial/temporal restrictions on research activities) would not allow survey results to remain consistent with previous data sets and would essentially prevent the SWFSC from collecting data required to provide for fisheries management purposes under the Magnuson-Stevens Act. Some research surveys necessarily target fish species that are preyed upon by marine mammals with an inherent risk of interactions with marine mammals during these surveys. The SWFSC acknowledges the inherent risk of these surveys (e.g., the Coastal Pelagic Species Survey, Juvenile Salmon Survey, and Juvenile Rockfish Survey), and it has implemented a variety of measures to help mitigate that risk. As part of the analysis in this EA, NMFS has concluded that the SWFSC currently has no viable alternatives to collecting the data derived

from these surveys that meet the research objectives described under Purpose and Need. As a result, NMFS does not propose to implement potential mitigation measures that would preclude continuation of these surveys, such as the elimination of night surveys or pelagic trawl gear.

The connected federal action covered under this EA is the issuance of regulations and subsequent LOAs for incidental takes of marine mammals under the MMPA, which requires NMFS to consider a reasonable range of mitigation measures that may reduce the impact on marine mammals among other factors. As described above, some of these measures could prevent the SWFSC from maintaining the scientific integrity of its research programs. These measures would normally be excluded from consideration in the EA for not being consistent with the purpose and need (Chapter 1). However, these additional mitigation measures would likely be considered during the MMPA rulemaking process and/or ESA Section 7 consultation and are therefore covered in this EA.

Alternative 4 - No Research Alternative - No Fieldwork for Federal Fisheries and Ecosystem Research Conducted or Funded by SWFSC

Under the No Research Alternative, no direct impacts on the marine environment would occur from the primary or secondary federal actions. The SWFSC would no longer conduct or fund fieldwork for the fisheries and ecosystem research considered in the scope of this EA in marine waters of the California Current, Eastern Tropical Pacific, or Antarctic Research Areas. This moratorium on fieldwork would not extend to research that is not in scope of this EA, such as directed research on marine mammals and ESA-listed species covered under separate research permits and NEPA documents. NMFS would need to rely on other data sources, such as fishery-dependent data (i.e., harvest data) and state or privately supported fishery-independent data collection surveys or programs to fulfill its responsibility to manage, conserve and protect living marine resources in the U.S. Under this alternative, organizations that have participated in joint research programs may or may not continue their research efforts depending on whether they are able to secure alternative sources of funding. Any non-federal fisheries research would occur without NMFS funding, direct control of program design, or operational oversight. It is unlikely that these non-NMFS fisheries research surveys would be consistent with the time series data NMFS has collected over many years, which is the core information supporting NMFS' science and management missions and vital to fishery management decisions made by NMFS, the Fishery Management Councils and other marine resource management institutions, leading to greater uncertainty for fishery and other natural resource management decisions.

CHAPTER 3 – AFFECTED ENVIRONMENT

Chapter 3 presents baseline information on the marine environment affected by SWFSC research activities. This information is not intended to be encyclopedic but to provide a foundation for the analysis of environmental impacts of the alternatives and the cumulative effects analysis. Sources of additional information are incorporated by reference.

The marine environment affected by SWFSC research surveys includes sections of several coastal Large Marine Ecosystems (LMEs), including the California Current LME, the Gulf of California (Sea of Cortez) LME, the Pacific-Central American Coastal LME, the Humboldt Current LME, and the Antarctica LME (Sherman et al. 1996). However, a substantial amount of the SWFSC fisheries research activities are also conducted in offshore areas that lie outside of the coastal LME boundaries. There are many areas with special designations to protect various resources and are subject to various levels of conservation and management under a variety of authorities. Classifications of these special resource areas include Essential Fish Habitat, permanent or temporary fisheries closure areas, and designated Marine Protected Areas including National Marine Sanctuaries.

There are thousands of finfish and shellfish species that occur within the three SWFSC research areas. Descriptions or lists are provided for ESA-listed species, species targeted by commercial fisheries and

subject to SWFSC research assessments, sharks and highly migratory species, and other species caught frequently in SWFSC surveys.

Marine mammal species that occur in each of the three research areas are listed in Table 3.2-4, including at least 46 species of cetaceans (whales, dolphins, and porpoise), 16 species of pinnipeds (seals and sea lions), and one species of fissiped (sea otter). All of these species are federally protected under the MMPA regardless of where they occur. Seven large whale species, two pinnipeds, and one subspecies of sea otter are listed as threatened or endangered under the ESA. Information is presented on marine mammal acoustics and functional hearing ranges for several groups of marine mammals. Marine mammals rely on sound production and reception for social interactions (e.g., reproduction and communication), to find food, to navigate, and to respond to predators.

ESA-listed bird species that occur in the three SWFSC research areas include three species in the CCRA and five species in the ETPRA. There are no ESA-listed species in the ARA. Other common species in these areas that are susceptible to entanglement in fishing gear are listed. All species likely to occur in the U.S. EEZ are protected by the Migratory Bird Treaty Act.

Five species of sea turtles occur within the CCRA and ETPRA, all of which are listed as endangered under the ESA. Sea turtles are susceptible to damage of onshore nesting habitat, exploitation of eggs, and interactions with research, sport, and commercial fisheries. Two areas within the CCRA have been designated as critical habitat for leatherback turtles (77 FR 4170, January 26, 2012).

There are two species of ESA-listed invertebrates in the CCRA (white and black abalone) and one major target species (market squid). There are no ESA-listed invertebrate species in the ETPRA and the SWFSC does not conduct stock assessment research for any invertebrate fisheries in the area. There are no ESA-listed invertebrate species in the ARA, but the SWFSC conducts substantial research and provides stock abundance and distribution information for management of commercial fisheries on Antarctic krill.

Several components of the social and economic environment are summarized. A number of commercial fisheries harvest marine fish and invertebrates in the waters of the CCRA, ETPRA, and ARA. Complex associations exist between the fishing industry, fisheries management processes, and the social well-being of many communities. Commercial fisheries in the ETPRA and ARA are international in scope but information on fishing communities in the EA are limited to the U.S. West Coast. Recreational fisheries play an important role in the well-being of individuals and communities. These fisheries and communities receive scientific and economic benefits from the SWFSC research activities as they contribute to the scientific management of sustainable fisheries. Information is also presented on the basic operating costs of the SWFSC (approximately $50 million annually) and average costs for conducting research programs in the three research areas. These expenses include funds for ship time, fuel and supplies, crew, charter vessels, and other logistic support, some of which also benefits communities on the U.S. West Coast.

CHAPTER 4 – ENVIRONMENTAL EFFECTS

As indicated earlier, NMFS is fundamentally a science-based agency, with its primary mission being the stewardship of living marine resources through science-based conservation and management. Of the four alternatives evaluated in this EA, three alternatives maintain an active research program (Status Quo, Preferred, and Modified Research Alternatives) that clearly enables collection and development of additional scientific information and one alternative (No Research) does not. In NMFS' view, the inability to acquire scientific information essential to developing robust fisheries management measures that must prevent overfishing and rebuild overfished stocks would ultimately imperil the agency's ability to meet its mandate to promote healthy fish stocks and restore the nation's fishery resources. The scientific information provided by fisheries research programs also allows NMFS to address potential effects of climate change and ocean acidification. Long-term, consistent fisheries and ecosystem research programs contribute substantially to developing effective and timely fisheries management actions and assists in meeting international treaty obligations.

The following discussion summarizes the direct and indirect impacts by resource area associated with the alternatives evaluated in Chapter 4 of this EA. The analysis shows that the potential direct and indirect impacts on the physical and biological environments under the three research alternatives are similar and have minor adverse effects. The three research alternatives would have moderate beneficial economic effects on commercial and recreational fishermen and fishing communities by providing the scientific information needed for sustainable fisheries management and by providing funding, employment, and services. The similarity of impacts among the three research alternatives is due to the fact that the scope of research activities under these alternatives is similar; they differ primarily in the type of mitigation measures included for protected species. The No Research Alternative, in contrast, would eliminate the direct adverse effects of the research alternatives on the marine environment but would have minor to moderate adverse, indirect effects on several biological and socioeconomic resources due to increasing uncertainty in future resource management decisions caused by the loss of scientific information from the SWFSC on the marine environment. Table ES-1 provides a summary of impact determinations for each topic and Alternative considered.

Table ES-1 Summary of environmental effect conclusions by research area and by alternative. All conclusions refer to potentially adverse effects unless noted.

California Current Research Area				
Topic	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
Physical Environment	Minor	Minor	Minor	Minor to Moderate
Special Resource Areas	Minor	Minor	Minor	Minor to Moderate
Fish	Minor	Minor	Minor	Moderate
Marine Mammals	Minor	Minor	Minor	Minor to Moderate
Birds	Minor	Minor	Minor	Minor
Sea Turtles	Minor	Minor	Minor	Moderate
Invertebrates	Minor	Minor	Minor	Minor to Moderate
Social and Economic Environment	Moderate *beneficial*	Moderate *beneficial*	Moderate *beneficial*	Moderate
Eastern Tropical Pacific Research Area				
Topic	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
Physical Environment	Minor	Minor	Minor	Minor
Special Resource Areas	Minor	Minor	Minor	Minor
Fish	Minor	Minor	Minor	Minor
Marine Mammals	Minor	Minor	Minor	Minor to Moderate
Birds	Minor	Minor	Minor	Minor
Sea Turtles	Minor	Minor	Minor	Moderate
Invertebrates	Minor	Minor	Minor	Minor
Social and Economic Environment	Minor *beneficial*	Minor *beneficial*	Minor	Minor
Antarctica Research Area				

Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Physical Environment	Minor	Minor	Minor	Minor
Special Resource Areas	Minor	Minor	Minor	Minor
Fish	Minor	Minor	Minor	Minor
Marine Mammals	Minor	Minor	Minor	Minor to Moderate
Birds	Minor	Minor	Minor	Minor
Sea Turtles	N/A	N/A	N/A	N/A
Invertebrates	Minor	Minor	Minor	Minor
Social and Economic Environment	Minor *beneficial*	Minor *beneficial*	Minor	Minor

Physical Environment and Special Resource Areas

Under the three research alternatives, direct impacts to benthic habitats would be limited to the ARA, which is the only research area where bottom-contact trawl gear is used. This bottom trawl survey would only be conducted every few years and would have a very small footprint and minor localized adverse effects on the physical environment in the ARA. An analysis is presented on the proportion of research sampling and biomass removals made within National Marine Sanctuaries in the CCRA. While some surveys have substantial sampling effort within one or more sanctuaries, the removals of fish and invertebrates for scientific purposes is very small compared to estimated biomass metrics and is considered to have minor adverse effects on the sanctuaries.

Under the No Research Alternative, there would be no direct impacts on the physical environment or special resource areas from federal fisheries and ecological research. However, the loss of scientific information generated by SWFSC research would contribute to greater uncertainty about the effects of climate change and ocean acidification on three major marine ecosystems as well as the status of biological resources in marine protected areas. Indirect effects on resource management agencies and conservation plans for protected areas would likely vary from minor to moderate adverse under the No Research Alternative.

Fish

Under the three research alternatives, short term, minor, adverse impacts to fish populations are expected as a result of on-going research activities. Mortality from captures in surveys is a potential impact for some ESA-listed species but past levels of catch in SWFSC research surveys are small and considered minor to their respective populations. For species targeted by commercial fisheries, mortality due to research surveys is much less than one percent of commercial harvest and is considered to have minor adverse effects for all species. However, SWFSC research on several key species in the CCRA, such as sardines and Pacific hake (whiting), provides the scientific foundation for sustainable fisheries management and therefore has substantial long-term beneficial effects on target species populations. Under the No Research Alternative, there would be no direct adverse impacts on fish from federal fisheries research. However, the loss of scientific information for fisheries management could lead to long-term minor to moderate adverse impacts including overfishing on some stocks and uncertainty about the recovery of overfished stocks.

Marine Mammals

The primary direct effects of the three research alternatives on ESA-listed and non-listed marine mammals include behavioral responses to sound produced through the use of active acoustic sources (Level B harassment under the MMPA), capture or entanglement in fishing gear but released without serious injury (Level A harassment), and capture or entanglement resulting in serious injury or mortality. The potential for effects from ship strikes, contamination of the marine environment, and removal of marine mammal prey species was considered minor for all alternatives and research areas. The MMPA requires applicants for LOAs to estimate the number of each species of marine mammal that may be incidentally taken by harassment or serious injury/mortality during the proposed action. The SWFSC LOA application (attached to the EA as Appendix C) includes estimates of takes in all three research areas using the scope of research and mitigation measures described in the Preferred Alternative.

Level B harassment takes are estimated based on the acoustic properties of sonars and other acoustic equipment used during research, calculations of the volume of water ensonified to 160 decibels or more (NMFS' recommended threshold for Level B harassment from active acoustic equipment used in research), estimates of the densities of marine mammals in the three research areas, and a partitioning of species that typically do not dive deeper than 200 meters and those that do (which affects the size of the ensonified area they may be exposed to). The EA includes summary tables of the number of estimated Level B harassment takes by acoustic sources of each species affected in the three research areas. It also includes a summary of an assessment of biological effects from SWFSC acoustic equipment used during research (Appendix C, Section 7). Output frequencies of some active acoustic sources (short range echosounders, Acoustic Doppler Current Profilers) are higher than the functional hearing ranges of marine mammals so no adverse effects are anticipated. Other acoustic sources operate at frequencies within the hearing range of one or more groups of marine mammals and may cause temporary and minor behavioral reactions such as swimming away from an approaching ship. None of the SWFSC acoustic equipment is likely to present risks of hearing loss or injury to any marine mammal.

The LOA application combines estimated Level A harassment takes with serious injury or mortality takes because the degree of injury resulting from gear interaction cannot be predicted. The estimated take numbers are based on the historical capture of two species of cetaceans (Pacific white-sided dolphin and northern right whale dolphin) and two species of pinnipeds (California sea lion and northern fur seal) during SWFSC research surveys, primarily in pelagic trawls but also on pelagic longline gear. From 2008 through 2012, a total of 58 marine mammals were captured in trawl gear (three different surveys); 50 were killed, one was released alive but considered injured, and seven were released alive with no obvious signs of injury. Of the 50 animals that were killed, 27 were Pacific white-sided dolphins, six were northern right whale dolphins, 14 were California sea lions, and three were northern fur seals. During this period, five California sea lions were caught or entangled in pelagic longline gear; all were released alive but two had apparent injuries.

The number of marine mammals that have interacted with research gear has varied substantially over the past five field seasons. After many years with no or very rare takes of marine mammals, the 2008 field season ended with a large number of marine mammals being taken (43 total, with 38 killed), including several "disaster sets" where multiple animals were taken at once, primarily with the Nordic 264 trawl during the Coastal Pelagic Species survey (CPS, aka Sardine Survey). The CPS survey was suspended in 2008 due to the high number of takes and the SWFSC convened a panel of experts to examine the problem and develop more effective mitigation measures and formalized procedures. Most of the mitigation measures that are part of the Status Quo Alternative have been implemented since 2009 as a result of that expert review (Hewitt 2009), including development and deployment of a marine mammal excluder device for the Nordic 264 trawl.

For the four species that have been taken in research gear in the past, the LOA application uses a conservative approach for estimating future takes, using the average annual number of animals caught in

different gear types in the past five years, rounding up to the nearest whole number of animals, and assuming this number of animals could be caught every year for the next five years. The SWFSC considers this estimation method to be conservative in that it will likely overestimate the number of animals that will be caught in the future in order to ensure accounting for the maximum amount of potential take. This is especially true because additional mitigation measures and equipment have been implemented since the highest numbers of historical takes occurred in 2008. The EA uses the estimated takes in the LOA application to assess the impacts on marine mammals, given the likelihood that these are overestimates, the actual effects from injury, serious injury or mortality could be substantially less than described.

Other species that have not been captured in the past have been included in the LOA application's request for take authorization based on their similarity to species that have been taken by the SWFSC and incidental take in analogous commercial fisheries. Because the scope of research activities under the Status Quo Alternative is the same as the Preferred Alternative in the CCRA, the estimated take numbers from the LOA application are used as part of the analysis of effects on marine mammals in this research area under both alternatives. The Status Quo Alternative does not include any gear that is likely to cause Level A harassment or lethal takes in the ETPRA. The Preferred Alternative adds a new pelagic longline survey in the ETPRA; the LOA application estimates future takes in the ETPRA on pelagic longline gear based on incidental take of marine mammals in analogous commercial fisheries. SWFSC research in the ARA does not include any fishing gear likely to result in interactions with marine mammals and no takes by gear interaction are anticipated under any of the alternatives in this area.

The EA includes summary tables of the number of estimated Level A/serious injury or mortality takes for each species affected in the CCRA and ETPRA. One of the key elements of the effects analysis is to determine the adverse impact of takes on each species. The EA and LOA application compare estimated future takes for each species with its Potential Biological Removal (PBR) as part of this impact determination. The MMPA defines PBR as, "...the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population." PBR was intended to serve as an upper limit guideline for fishery-related mortality for each species. Given the similarity of fisheries research to many commercial fisheries and the role research plays in supporting commercial fisheries, it is appropriate to assess the impacts of incidental takes in a similar manner.

PBR is used as one of the criteria for determining the level of adverse impacts on marine mammals in the EA. For the purposes of this analysis under NEPA, research-related incidental serious injury or mortality less than or equal to 10% of PBR for the marine mammal stock is considered minor in magnitude for the population. Serious injury or mortality between 10% and 50% of PBR is considered moderate in magnitude. Serious injury or mortality greater than or equal to 50% of PBR is considered major in magnitude.

In the CCRA, estimated takes of all but two species of marine mammals would be less than 10% of their respective PBRs, would be considered unlikely to occur and rare or infrequent events, be distributed over large geographic areas, and would be considered to have overall minor adverse effects on the population. Risso's and Bottlenose dolphins are the exception, with estimated takes greater than 10% of PBR but less than 50% of PBR. The magnitude of such mortality effects, if they actually occurred, would be considered moderate and adverse on these stocks. However, given the implementation of new mitigation measures and the fact that the SWFSC has never taken either of these dolphin species in the past, the SWFSC considers the risk of taking either species to be very low (i.e., a rare event unlikely to occur in the next five years) and the overall assessment of potential adverse impact on the population of these species is minor.

In the ETPRA, the Status Quo Alternative does not include any fishing gear likely to cause interactions with marine mammals and no takes are anticipated. Under the Preferred Alternative, the new pelagic

longline survey has the potential to result in interactions with marine mammals. The LOA application estimates an average of one take per five-year period for each of nine cetacean species and an average of one take per year over the five-period for each of two pinniped species. Because the ETPRA is outside of U.S. waters, the MMPA does not require PBR to be calculated for these stocks. However, for the purpose of the analysis in this EA, the SWFSC has calculated PBR for these stocks using the best available information. For all of the marine mammal species with estimated takes in future SWFSC ecosystem research, the level of estimated takes, if they occurred, would be less than 10% of their respective PBRs, would be considered unlikely to occur and rare or infrequent events, be distributed over large geographic areas, and would be considered to have overall minor adverse effects on these populations.

The Modified Research Alternative includes the same scope of research in all three of the SWFSC research areas as the Preferred Alternative but considers a number of other mitigation measures that the SWFSC is not proposing to implement in its LOA application. The SWFSC considers the suite of mitigation measures to be implemented under the Preferred Alternative to represent the most effective and practicable means to reduce the risk of adverse interactions with marine mammals during the conduct of its research program without compromising the scientific integrity of the research program. The potential direct and indirect effects of this alternative on marine mammals would be the same as described for the Preferred Alternative except for the potential of the additional mitigation measures to reduce Level A/serious injury or mortality takes through gear interactions. Scientists at the SWFSC continually review their procedures to see if they can do their work more efficiently and with fewer incidental effects on the marine environment, including effects on marine mammals. Many of the additional mitigation measures included in this alternative have been discussed and considered in the past by SWFSC scientists. However, any changes to operational procedures or the equipment used during surveys must also be considered from the standpoint of how they affect the integrity of the scientific data collected, the cost of implementing equipment or operational changes, and the safety of the vessel and crew. It would be speculative to quantify how much any one of these measures (or some combination of them) may reduce the risk of future takes relative to the Status Quo or Preferred Alternatives. The analysis provides a qualitative discussion of the potential for each additional mitigation measure to reduce takes and other effects on marine mammals as well as how each measure may affect practicability, data integrity, and other aspects of the research survey work. Some elements of the Modified Research Alternative (e.g., use of Protected Species Observers and examining spatial/temporal risk factors) would offer mitigation advantages compared to the Status Quo Alternative but are addressed to some extent in the Preferred Alternative. Operational restrictions such as not allowing trawls to be set at night or in poor visibility conditions and spatial/temporal restrictions to avoid high densities of marine mammals would certainly reduce the risk of taking marine mammals. However, such restrictions would have a serious adverse impact on the ability of the SWFSC to collect certain kinds of research data and would have impacts to the cost and scope of research that could be conducted. Some concepts and technologies considered in the Modified Research Alternative are promising as a means to reduce risks to marine mammals and NMFS will continue to evaluate the potential for implementation if they become more practicable.

Under the No Research Alternative, no direct adverse impacts to marine mammals from fisheries and ecological research (i.e., takes by gear interaction and acoustic disturbance) would occur. However, some of the SWFSC research projects that would be eliminated under this alternative (e.g., marine mammal surveys and others that may include marine mammal observers) generate valuable ecological information on the abundance, distribution, and feeding behaviors of marine mammals in the three research areas. The loss of information on marine mammals would indirectly affect resource management decisions concerning the conservation of marine mammals. The discontinuation of research on marine mammals would greatly limit the ability of NMFS to update marine mammal stock assessments, which are key documents for recovery plans and other conservation efforts but also affect fishery management decisions in U.S. and international waters. Another possibility is that, should a marine mammal stock decline for various reasons (e.g. climate change effects on prey, anthropogenic noise in the environment, or fisheries-related interactions), the cause(s) of the negative population trend may not be detected. If the SWFSC

discontinued collecting scientific information on marine mammals through the research covered in this EA, the ability of state and federal agencies as well as international treaty organizations to make informed management decisions about the marine environment would be adversely compromised, especially as time went on and uncertainty about the status of marine mammals increased. Given NMFS' priority to develop ecosystem-based fisheries management models, where information on marine mammal stocks and other non-fish marine components is considered in setting fishery guidelines, the loss of information on marine mammals under the No Research Alternative would contribute to the adverse effects on marine resource management. There are too many unknown variables to estimate the specific effects this lack of information would mean to any particular stock of marine mammals but the No Research Alternative would likely have minor to moderate adverse effects for some species.

Seabirds

There have been no known adverse interactions with seabirds during SWFSC research activities; there are no records of gear interactions or ship strikes. The addition of a new pelagic longline survey in the ETPRA under the Preferred Alternative increases the risk of capturing seabirds in that area. However, incidental take of seabirds is unlikely and would not result in any measurable changes to seabird populations. Under the Modified Research Alternative, the SWFSC would deploy streamer lines before longline gear is set to mitigate the risk of catching seabirds. If seabird interactions with longline gear are documented in the future, the SWFSC will revisit whether use of streamer lines is warranted given the tradeoffs between the potential conservation benefit and operational and safety considerations. The adverse effects of the three research alternatives on seabirds are considered minor. Some of the SWFSC surveys have bird biologists on board to conduct transect surveys for bird distribution and abundance in each of the three research areas. This information is used by the U.S. Fish and Wildlife Service and other international resource management agencies to help with bird conservation issues and is considered to have indirect beneficial effects on the birds. Under the No Research Alternative, the risk of direct adverse effects on seabirds from SWFSC research would be eliminated, but there could be potential long-term minor to moderate adverse impacts to seabirds because resource management authorities would lose important ecological information needed to establish effective and timely management measures.

Sea Turtles

There has been only one sea turtle captured during SWFSC research in the past, a leatherback turtle that was caught in a trawl net but released alive with no signs of severe injuries. Most SWFSC pelagic longline surveys use large circle hooks and finfish bait to minimize the risk of catching sea turtles, and no takes have occurred on this gear. Under the three research alternatives, adverse impacts to sea turtles are expected to be rare and have minor effects on all species of sea turtles in the CCRA and ETPRA. As with seabirds and marine mammals, sea turtle studies included in the three research alternatives provide information for NMFS and other institutions interested in sea turtle recovery and conservation. The information collected during SWFSC research has indirect beneficial effects on sea turtles that would be lost under the No Research Alternative.

Invertebrates

Under the three research alternatives, short term, minor adverse impacts to invertebrates are expected from SWFSC research activities. The amount of invertebrates caught in research surveys is minimal compared to population levels. The SWFSC conducts research to monitor the recovery of two ESA-listed invertebrate species, white abalone and black abalone, but these studies are conducted with camera technologies and have no adverse impacts on these species. As is the case with fish, the SWFSC conducts research and provides stock assessment advice for several species of invertebrate species with valuable commercial fisheries, such as market squid in the CCRA and krill in the ARA. The SWFSC research is important for the scientific and sustainable management of these fisheries, helping to prevent overfishing

on the stocks. Under the No Research Alternative, direct adverse impacts to invertebrates would be eliminated. However, the loss of stock assessment information could result in minor to moderate adverse effects on commercially targeted species through increasing uncertainty in the fishery management environment.

Social and Economic Environment

Under the three research alternatives, long term, beneficial impacts to the social and economic environment are expected from ongoing SWFSC fisheries and ecosystem research activities. Research provides important scientific information which is the basis for sustainable fisheries management for some of the most valuable commercial and recreational fisheries along the U.S. West Coast, which benefits commercial and recreational fisheries and the communities that support them. These industries have large economic footprints, generating billions of dollars' worth of sales and thousands of commercial fishing-related jobs; millions of recreational fishers participate and support fishing gear and support service industries. Fisheries research activities also provide financial support for fishing communities through purchase of fuel, vessel charters, and supplies. Continued SWFSC fisheries research is important to build trust and cooperation between the fishing industry and NMFS scientists and fisheries managers. In the Eastern Tropical Pacific, SWFSC ecosystem research provides fundamental information on the status and distribution of marine mammals that informs international management of the yellowfin tuna fishery and conservation efforts related to military exercises and shipping traffic. In the Antarctic, SWFSC fisheries and ecosystem research fulfills U.S. international treaty obligations by providing scientific information for the sustainable management of valuable commercial fisheries on krill and Antarctic toothfish, of which the U.S. is the largest importer.

The No Research Alternative would likely have long term adverse impacts on the social and economic environment through greater uncertainty in fisheries management, which could lead to more conservative fishing quotas or an increased risk of overfishing, followed by reductions in commercial and recreational fisheries harvest quotas. The lack of scientific information would also compromise efforts to rebuild overfished stocks and monitor the effectiveness of no-fishing conservation areas. These impacts would cripple the ability of NMFS to comply with its obligations under the Magnuson-Stevens Fishery Conservation and Management Act. It would also eliminate research-associated federal spending on charter vessels, fuel, supplies, and support services in various communities. The No-Research Alternative would also have long-term adverse impacts on the scientific information the SWFSC contributes to meet U.S. obligations for living marine resource management under international treaties. The SWFSC provides scientific advice to support numerous international fisheries councils, commissions, and conventions. Research conducted by the SWFSC has also been critical in development and successful implementation of ecosystem-based management in Antarctica in order to fulfill the conservation objectives of the Antarctic Treaty. Under the No Research Alternative, the contribution of the SWFSC to supporting U.S. treaty obligations would be lost. NMFS' expertise in balancing fisheries with conservation measures would be compromised and other, potentially competing interests to those of NMFS and the U.S., would have a relatively greater voice.

CHAPTER 5 – CUMULATIVE EFFECTS

Cumulative effects are the net result of all past, present, and reasonably foreseeable future actions on the human environment over time. An individual action may have only minor or moderate impacts, but the cumulative effects of all actions may be major. NEPA requires an analysis of cumulative effects in order to alert decision makers to the full environmental consequences of a proposed action and its alternatives on resource areas of concern. This analysis looks at the overall cumulative impact and the contribution of fisheries research activities to the overall cumulative impact.

In terms of fisheries, understanding how the cumulative impacts from human activities and trends in the natural environment have influenced the marine environment over time is key to understanding the

importance of NMFS' role in fisheries management. The need for scientific information from SWFSC research activities is in large part the result of past actions that contributed to major adverse impacts on fish stocks from overfishing, pollution of coastal and ocean areas from accidental and intentional discharges, runoff of agricultural and industrial waste, and degradation of habitat from commercial fishing and dam construction, among other activities. Federal efforts within the last 40 years to reduce pollution, restore degraded habitats, and effectively manage commercial and recreational fishery harvests have reversed some of these trends. A number of important fishery stocks have been restored to healthy levels and others are in the rebuilding process.

Similarly, cumulative impacts from human activities and trends in the natural environment over time have contributed major adverse impacts to populations of marine mammals, marine turtles, and other marine species. As a result, the MMPA and ESA were enacted to help address specific conservation concerns and many human activities are subject to federal management measures to protect marine species and promote recovery of impacted populations.

Climate change and increase in ocean acidification have the potential to impact populations and distributions of many marine species. Fisheries research activities do not contribute to these long-term, global environmental processes. However, long-term, systematic marine research provides important scientific information on changes and trends in marine ecosystems.

In addition to SWFSC research efforts, there are many current and reasonably foreseeable activities that may contribute to cumulative impacts on the three marine environments the SWFSC operates in, including: conservation efforts, commercial shipping, commercial and recreational fisheries, oil and gas and alternative energy development, military activities, coastal development projects, marine research activities by other agencies and institutions, and other human activities that contribute to global climate change. These actions can produce both adverse and beneficial impacts that directly and indirectly affect ocean resources managed by NMFS and the social and economic environment of fishing communities that rely on them.

This EA generally considers the contribution of the three research alternatives to the cumulative effects on given resources to be very similar and they are often discussed together. The contribution of the No Research Alternative to the cumulative effects on resources is quite different and is discussed separately.

As described in the Chapter 4 summary above, SWFSC research activities would have minor adverse effects on the various resource components of the physical and biological environments. Because SWFSC research activities involve such a small number of vessels compared to other vessel traffic and collect relatively small amounts of biomass compared to commercial and recreational fisheries, the contribution of the three research alternatives to cumulative adverse effects on fish, marine mammal, and other species and resource areas is very small. The proposed SWFSC scientific research activities will also have beneficial contributions to the cumulative effects on both biological and socioeconomic resources. The research alternatives contribute substantially to the science that feeds into federal fishery management measures aimed at rebuilding and managing fish stocks in a sustainable manner. It also contributes to understanding the nature of changes in the marine environment and adjusting resource management plans accordingly, and it helps meet international treaty research obligations. The research activities under the three research alternatives help alleviate adverse cumulative impacts on the biological and socioeconomic environments, resulting in long-term beneficial contributions to cumulative effects.

The No Research Alternative would not contribute to direct adverse effects on the marine environment (e.g., research catch of fish and incidental take of marine mammals) but would contribute indirect adverse effects on both the biological and socioeconomic environments based on the lack of scientific information to inform future resource management decisions.

CONCLUSION

Based on the analysis in this EA, NMFS has not identified any potential environmental impacts that would rise to the level of "significant" under NEPA, thus triggering the requirement for an EIS. NMFS will not make a final determination about significance until the close of the 60-day public comment period on the draft EA and it has received all the public comments. A final determination on whether potential impacts of the proposed action are significant will be made and documented in the Finding of No Significant Impact (FONSI), which will be noticed in the *Federal Register* and made available to the public.

OTHER SECTIONS

In addition to the chapters summarized above, the EA includes a description of the laws applicable to SWFSC research activities in Chapter 6, cited references in Chapter 7, and a list of preparers and consulting agencies in Chapter 8. Appendix A provides a description of the fishing gear, other scientific instruments, and vessels used during SWFSC research activities. Appendix B includes figures showing the seasonal distribution of research effort in the three research areas. Appendix C is the SWFSC's application for promulgating regulations under the Marine Mammal Protection Act and Letters of Authorization from NMFS Office of Protected Resources for incidental take of marine mammals. Appendix D contains proposed handling and data collection procedures for marine mammals and sea turtles that are incidentally caught it SWFSC fisheries research activities; these procedures would be implemented after the SWFSC receives authorization for such incidental takes when the MMPA LOA and ESA consultation processes are completed.

1.1 NOAA'S RESOURCE RESPONSIBILITIES AND ROLE IN FISHERIES RESEARCH

The Federal Government has a responsibility to protect living marine resources in waters of the United States (U.S.), also referred to as federal waters. These waters generally lay 3 to 200 nautical miles (nm) from the shoreline, and comprise the Exclusive Economic Zone (EEZ). The U.S. government has also entered into a number of international agreements and treaties related to the management of living marine resources in international waters outside of the U.S. EEZ. To carry out its responsibilities over federal and international waters, Congress has enacted several statutes authorizing certain federal agencies to administer programs to manage and protect living marine resources. Among these federal agencies, the National Oceanic and Atmospheric Administration (NOAA) has the primary responsibility for protecting marine finfish and shellfish species and their habitats. Within NOAA, the National Marine Fisheries Service (NMFS) has been delegated primary responsibility for the science-based management, conservation, and protection of living marine resources.

Within the area covered by this Draft Programmatic Environmental Assessment (EA), NMFS manages finfish and shellfish harvest under the provisions of several major statutes, including the Magnuson-Stevens Fishery Conservation and Management Act (MSA)[6], the Tuna Conventions Act, the Marine Mammal Protection Act (MMPA), the Endangered Species Act (ESA), the International Dolphin Conservation Program Act (IDCPA), and the Antarctic Marine Living Resources Convention Act (AMLRCA). Accomplishing the requirements of these statutes requires the close interaction of numerous entities in a sometimes complex fishery management process. In the NMFS Southwest Region, the entities involved include the Southwest Fisheries Science Center, NMFS Southwest Regional Office, NMFS Headquarters, the Pacific Fisheries Management Council, and a number of international fisheries management organizations and commissions.

1.1.1 Fisheries Science Centers

Six Regional Fisheries Science Centers direct and coordinate the collection of scientific information needed to make fisheries management decisions[7]. Each Fisheries Science Center is a distinct entity and is the scientific focal point for a particular region (Figure 1.1-1). The Southwest Fisheries Science Center (SWFSC) conducts research and provides scientific advice to manage fisheries and conserve protected species along the U.S. west coast, throughout the Eastern Tropical Pacific (ETP) Ocean, and in the Southern Ocean off Antarctica (Figure 1.1-2). The SWFSC provides scientific information to support the NMFS Southwest Regional Office, the Pacific Fishery Management Council, and other domestic and international fisheries management organizations.

[6] 16 U.S.C. §§ 1801-1884, (MSA 2007).

[7] The six Regional Fisheries Science Centers are: 1) Northeast, 2) Southeast, 3) Southwest, 4) Northwest, 5) Alaska, and 6) Pacific Islands.

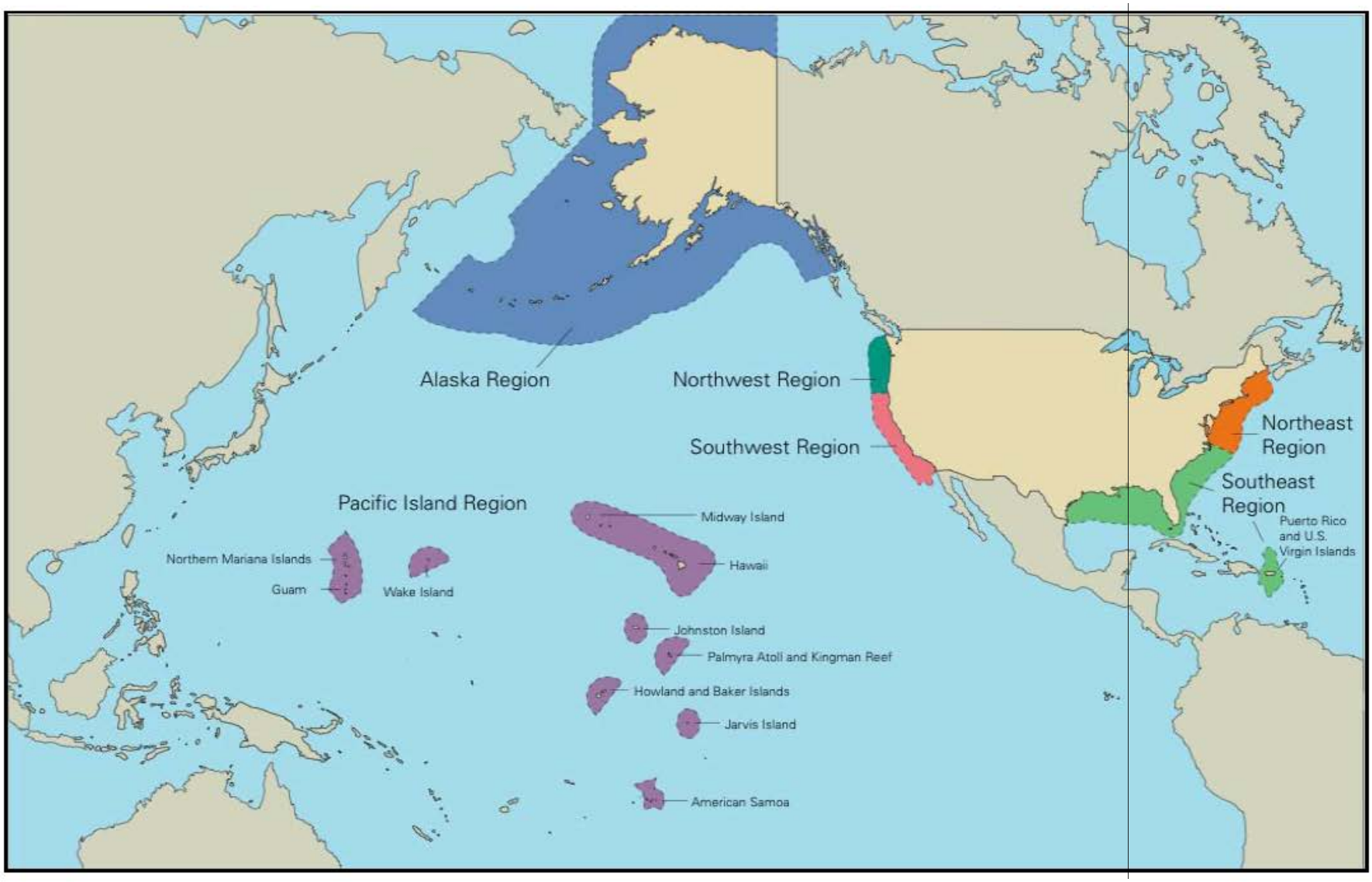


Figure 1.1-1 NMFS' Regions.

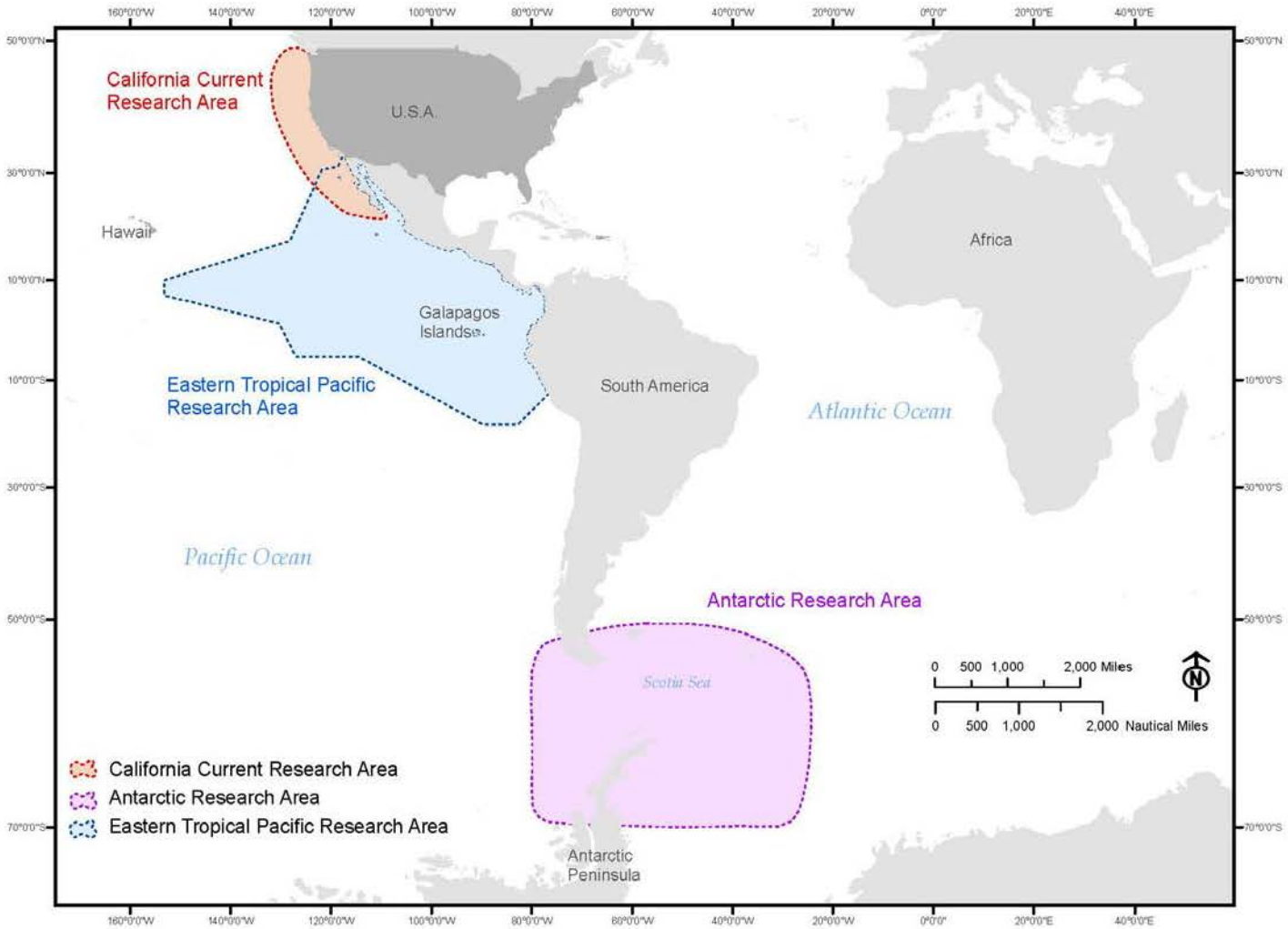


Figure 1.1-2 SWFSC Research Areas.

1.1.2 Fisheries Management Councils

In order to encourage a collaborative approach to fisheries management, the MSA established the nation's eight Regional Fishery Management Councils. Five councils are convened for the Atlantic Ocean (New England, Mid-Atlantic, South Atlantic, Gulf, and Caribbean), incorporating members of their respective states and territories. In the Pacific, the Pacific Fisheries Management Council (PFMC) includes Washington, Oregon, California, and Idaho. The North Pacific Fisheries Management Council (NPFMC) is concerned with the waters around Alaska. And in the far west, the Western Pacific Regional Fishery Management Council covers federal waters off the shores of the U.S. Pacific Islands including Hawaii, American Samoa, the Mariana Archipelago, and U.S. Pacific Remote Islands. The councils, which include fishing industry representatives, fishers, scientists, government agency representatives, federal appointees, and others, are designed to provide all resource users and managers a voice in the fisheries management process. Under the MSA, the councils are charged with developing Fishery Management Plans (FMPs) and management measures for the fisheries occurring within the EEZ adjacent to their constituent states. Data collected by fisheries science centers are often used to inform FMPs, as well as to inform other policies and decisions promulgated by the Fisheries Management Councils. Such policies and decisions sometimes affect areas that span the jurisdictions of several Fisheries Management Councils, and make use of data provided by multiple fisheries science centers.

1.1.3 International Fisheries Management Organizations

In addition to providing information to domestic fisheries management councils, the SWFSC provides scientific advice to support numerous international fisheries councils, commissions, and conventions including the Western and Central Pacific Fisheries Commission (WCPFC), International Scientific Committee for Tuna and Tuna-like Species (ISC), Inter-American Tropical Tuna Commission (IATTC), International Whaling Commission (IWC), the Parties to the Agreement on the International Dolphin Conservation Program (AIDCP), and the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR). Research conducted by the SWFSC has also been critical in development and successful implementation of ecosystem-based management in Antarctica in order to fulfill the conservation objectives of the Antarctic Treaty.

The WCPFC is an international organization that aims to ensure the long-term conservation and sustainable use of highly migratory fish stocks (i.e., tunas, billfish, and marlin) in the western and central Pacific Ocean. The WCPFC was established by the Convention for the Conservation and Management of Highly Migratory Fish Stocks in the western and central Pacific Ocean (WCPFC Convention) which was enacted in 2004. WCPFC is made up of 25 member nations (including the European Union), plus several participating territories and cooperating nations, who have an interest in the management of high seas fisheries in the western Pacific Ocean. The Convention applies to waters of the Pacific Ocean including areas around Hawaii, American Samoa, Guam, the Commonwealth of the Northern Marianas Islands, and U.S. Pacific Remote Island areas, and therefore encompasses the operational area of significant U.S. purse seine, longline, and distant-water troll fisheries, as well as local fisheries for highly migratory species (HMS). Through the WCPFC, the U.S. is directly engaged in the development of fisheries management measures to manage and conserve bigeye, yellowfin, and albacore tunas, and to minimize impacts on the non-associated and dependent species, such as sea turtles and seabirds. SWFSC scientists serve and/or provide scientific advice to U.S. representatives on WCPFC committees.

Current members of the ISC include Canada, China, Chinese-Taipei, Japan, Korea, Mexico, and the U.S. The purpose of the ISC is to enhance scientific research and cooperation for conservation and rational use of the species of tuna and tuna-like fisheries that inhabit the North Pacific Ocean, and to establish the scientific groundwork for the conservation and rational use of these species in the region. The results of the ISC are made available to participating members and HMS Regional Fishery Management Organizations of the Pacific Ocean. Through a Memorandum of Understanding, the ISC provides scientific support for the work of the Northern Committee of the WCPFC.

The IATTC is an international fisheries management organization concerned with the long-term conservation and sustainable use of tunas and billfish, as well as other components of the ecosystem (e.g., dolphins, turtles, non-target finfish, and sharks) that may be affected either directly or indirectly by fishing operations conducted in the Eastern Pacific Ocean (east of 150° W longitude to the coast of North, Central and South America between 50° N and 50° S latitudes). The IATTC was established under a 1949 convention between Costa Rica and the U.S. In 2010, the Antigua Convention entered into force, broadening the scope of the IATTC to include the conservation of non-target stocks and other components of the Eastern Pacific Ocean ecosystem. The IATTC is currently made up of 21 nations and fishing entities. The U.S. provides scientific input into stock assessments and conservation and management recommendations for target and non-target stocks in the convention area.

The agreement on the International Dolphin Conservation Program (IDCP) is closely aligned with the IATTC. The two organizations share a secretariat, an onboard observer program, some parts of their annual budgets, and a convention area. Whereas the IATTC has historically been primarily concerned with the management and sustainable use of tunas and tuna-like species in the Eastern Pacific Ocean, the agreement on the IDCP has been focused on monitoring and decreasing dolphin deaths in purse-seine fisheries for tunas in "dolphin sets." This technique involves intentionally chasing and encircling schools of dolphins to capture large yellowfin tuna that associate with certain dolphin stocks in the Eastern Pacific Ocean.

The IWC was established in 1946 under the International Convention for the Regulation of Whaling for the purpose of conserving whale populations and managing commercial and subsistence whaling efforts. In addition to its whaling management responsibilities, the IWC encourages, coordinates, funds, and publishes the results of scientific whale research. The IWC Scientific Committee includes many of the world's leading whale biologists, including scientists from the SWFSC, and provides advice on management issues based on scientific research. SWFSC research on whale distribution, abundance, and behavior in the Scotia Sea has provided valuable ecological information for the conservation of many species.

The CCAMLR was established in 1982 for the purpose of protecting and conserving the marine living resources in the waters surrounding Antarctica. CCAMLR is based upon an ecosystem approach to the conservation of marine living resources and incorporates standards designed to ensure the conservation of individual populations and species, and the Antarctic marine ecosystem as a whole. CCAMLR is comprised of the commission, executive secretary, and the scientific committee. The commission consists of one representative from each member nation and is responsible for facilitating research, compiling data on the status of and changes in Antarctic marine living resources (AMLR), ensuring the acquisition of catch and effort data, publishing information, identifying conservation needs, adopting conservation measures, and implementing a system of observation and inspection. The executive secretary handles the administrative matters for the commission. The scientific committee recommends research programs and conservation and other measures to the commission. The results of SWFSC research are presented to the scientific advisory bodies of the CCAMLR. SWFSC scientists have held leadership positions in all of CCAMLR's Working Groups and the Scientific Committee. In addition, SWFSC is the primary source of scientific advice to the U.S. Commissioner and delegation to CCAMLR.

1.1.4 Role of Fisheries Research in Federal Fisheries Management

Fisheries managers use a variety of techniques to manage marine resources, a principal one being the development of FMPs. FMPs articulate fishery goals as well as the methods used to achieve those goals, and their development is specifically mandated under the MSA. The SWFSC provides scientific information and advice to assist with the development of FMPs prepared by the NMFS, the PFMC, the WPFMC, and other agencies.

Through its Regional Fisheries Science Centers, NMFS conducts primarily fisheries-independent research on the status of living marine resources and associated habitats. Fisheries-independent research is

designed and conducted independent of commercial fishing activity to meet specific research goals, and includes research directed by SWFSC scientists and conducted on board NOAA-owned and operated vessels or NOAA-chartered vessels.

SWFSC resource surveys are designed to collect the data needed to inform fisheries stock assessment models so that harvest guidelines and management actions will foster sustainable commercial and recreational fisheries. Stock assessments rely on a suite of biological attributes: data on abundance, demographic composition (age composition and length) and life history (vital rates such as growth and maturity). SWFSC resource surveys take a multidisciplinary approach with a goal of characterizing the ecosystem by collecting data on oceanography, plankton, mid-trophic level species, and top predators; ecological data are used to interpret trends in abundance of the fish and mammal stocks of interest and to set harvest guidelines that take the state of the environment into account. To accomplish these goals, resource surveys provide data on spawning biomass (via various methods depending on the species of interest, including acoustics, capture, plankton sampling and continuous underwater egg counts).Trawls collect fish in order to determine demographic parameters (age composition, length), vital rates (growth, maturity), and tissue samples are taken for stock identification and other genetic analyses. Plankton samples are collected for species identification and to determine changes in community composition. For highly migratory species, SWFSC longline surveys provide samples and data for examining the relative abundance and size of key species and their growth and movement patterns through the use of conventional and chemical tags. The AMLR surveys are designed to map krill distribution and abundance, to measure environmental variables influencing krill abundance and distribution, and to conduct bottom trawl surveys to characterize Antarctic finfish populations and their relationships to other components of the Antarctic ecosystem. The long time series and the extensive sample collections enable the SWFSC to study the impacts of climate variability and change on marine populations and trends in community composition.

SWFSC resource surveys collect the information needed to inform stock assessment models (abundance, demographics and life history) which form the basis for natural resource decisions. SWFSC scientists collect the data in the field, analyze samples back at the lab and, combining these data with fishery dependent sources, generate stock assessment models, or work in collaboration to produce these models (many stocks are trans-boundary and require a team of international scientists to pool data). For U.S. harvested fish stocks, the MSA requires that stock assessment models be generated every year. For some international stocks, models are run less frequently. For marine mammals, the MMPA requires NMFS to publish stock assessment reports for strategic stocks every year and for non-strategic stocks every three years, and to update the stock assessment reports when new data become available. SWFSC stock assessment science is well-regarded nationally and internationally for the quality of the data, expertise in assessment, and long, trusted working relationships with colleagues around the globe. Stock assessment data are used to set harvest rates. For species that are endangered, stock assessment data provides protection, determines closed fishing areas, and is used to generate conservation measures to promote recovery.

The SWFSC also helps fund, staff, or analyze data from fishery-independent research directed by cooperating scientists (other agencies, academic institutions, and independent researchers) conducted on board non-NOAA vessels. SWFSC fisheries-dependent research is limited to collection of harvest data while fishing vessels are in port and does not involve research conducted in marine waters during commercial fishing operations.

The fishery-independent research activities carried out by the SWFSC are programmatically evaluated within this EA. (see Section 1.4).

1.2 SWFSC FISHERIES RESEARCH AREAS AND FACILITIES

The SWFSC is the research arm of NMFS in the Southwest Region. The SWFSC plans, develops, and manages a multidisciplinary program of basic and applied research to:

- Generate the scientific information necessary for the conservation and management of the region's living marine resources.
- Inform management of the region's marine and anadromous fish and invertebrate populations to ensure they remain at sustainable and healthy levels. Responsibilities include maintaining healthy fish stocks for commercial and recreational fishing; sustaining ecosystem services; and coordinating with domestic and international organizations to implement fishery agreements and treaties.

SWFSC research is conducted in three distinct marine environments: California Current Research Area (CCRA, Figure 1.2-1), Eastern Tropical Pacific Research Area (ETPRA, Figure 1.2-2), and Antarctic Research Area (ARA, Figure 1.2-3). The SWFSC headquarters, which includes the Torrey Pines Court Laboratory and the La Jolla Shores Drive Laboratory, is located in La Jolla, California. The Fisheries Ecology Division (FED) is based in Santa Cruz, California, adjacent to University of California Santa Cruz's Long Marine Laboratory, and the Environmental Research Division (ERD) is based in Pacific Grove, California. The SWFSC operates two field stations in California, located in Arcata and Granite Canyon. In Arcata, the Cooperative Fisheries Oceanography Research Team is a partnership between the SWFSC and Humboldt State University for fisheries oceanography. On the Antarctic Peninsula, the SWFSC's Antarctic Ecosystem Research Division (AERD) maintains two field stations located at Cape Shirreff on Livingston Island and at Copacabana in Admiralty Bay on King George Island.

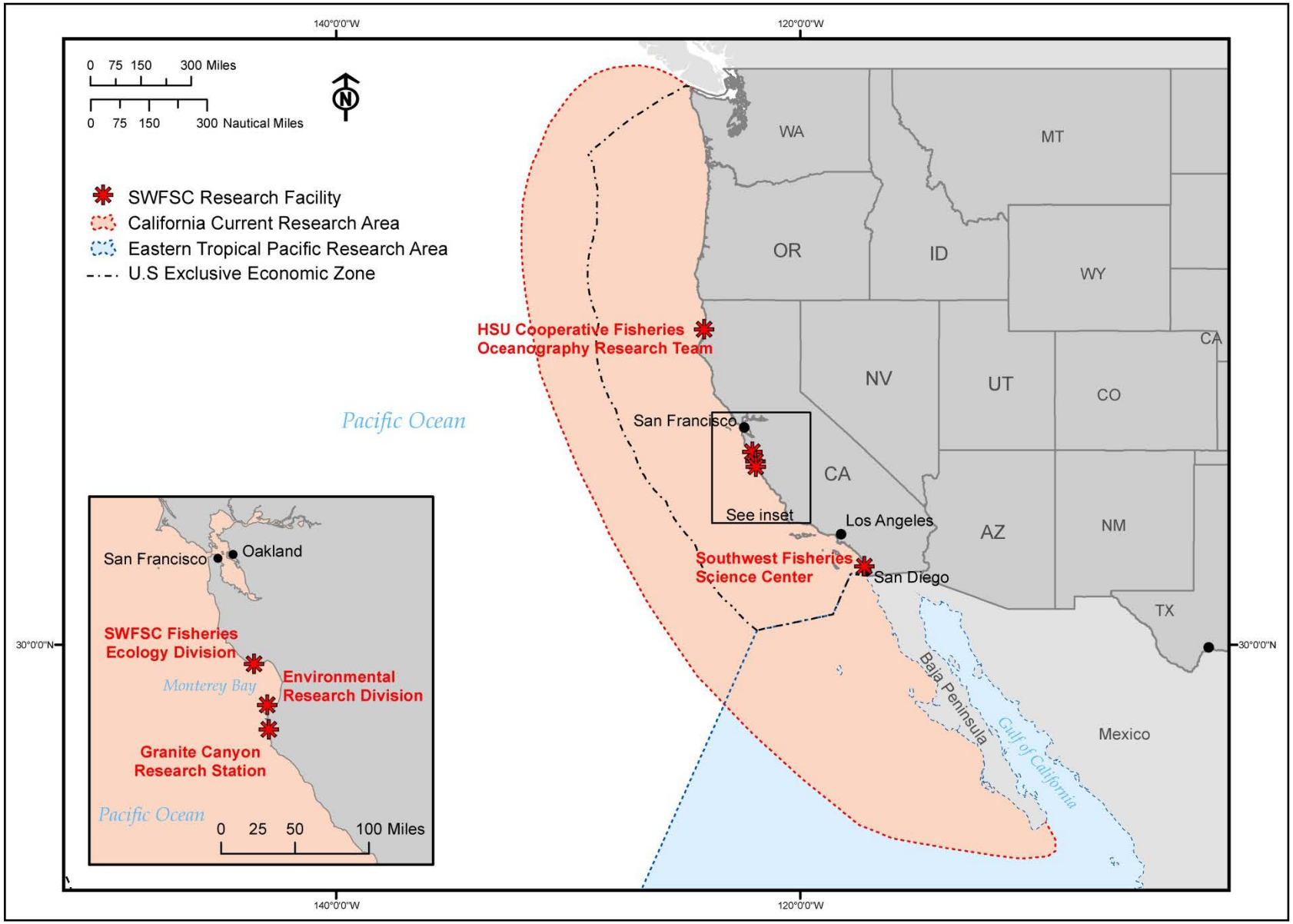


Figure 1.2-1 California Current Research Area and Research Facilities.

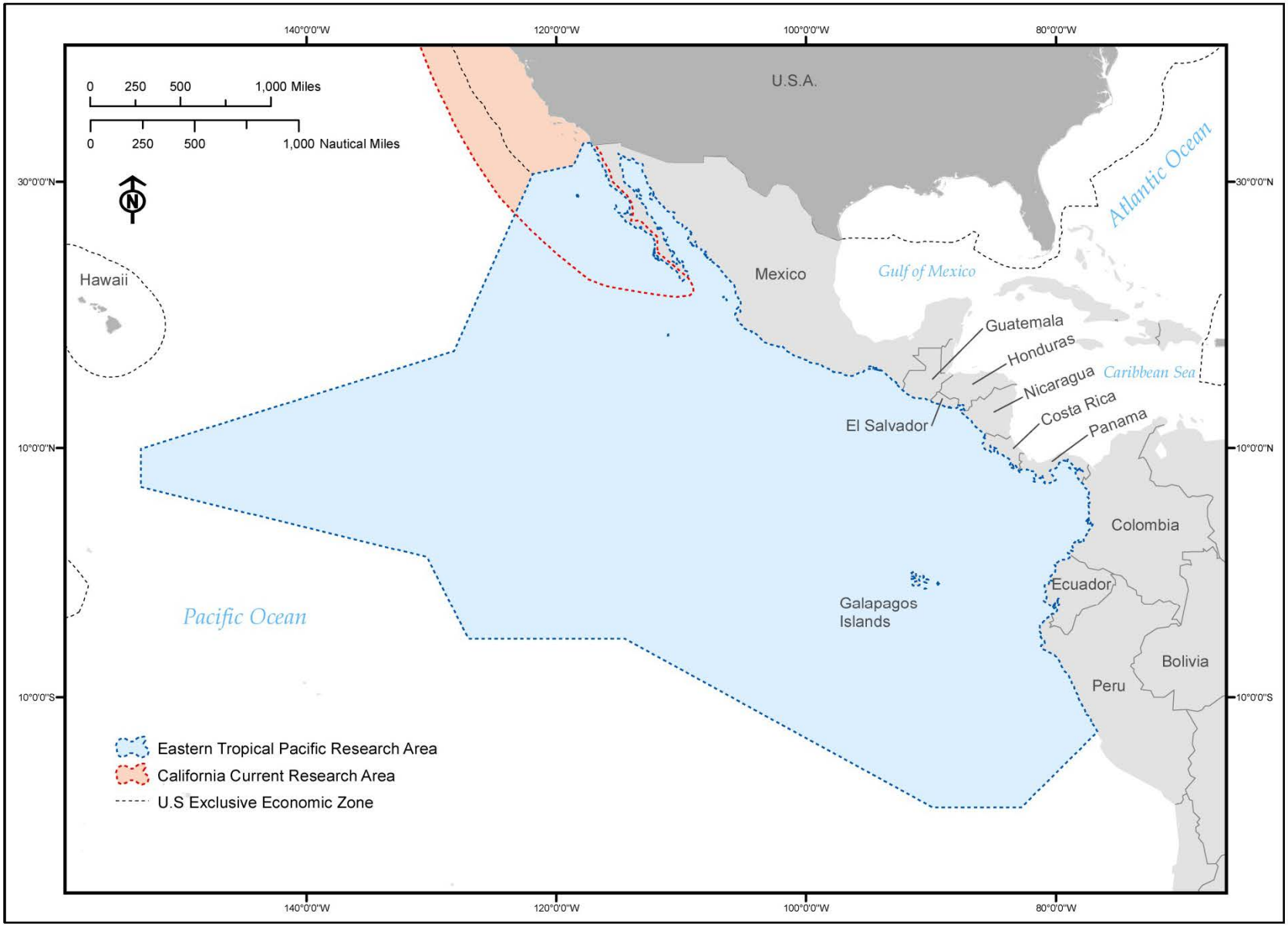


Figure 1.2-2 Eastern Tropical Pacific Research Area.

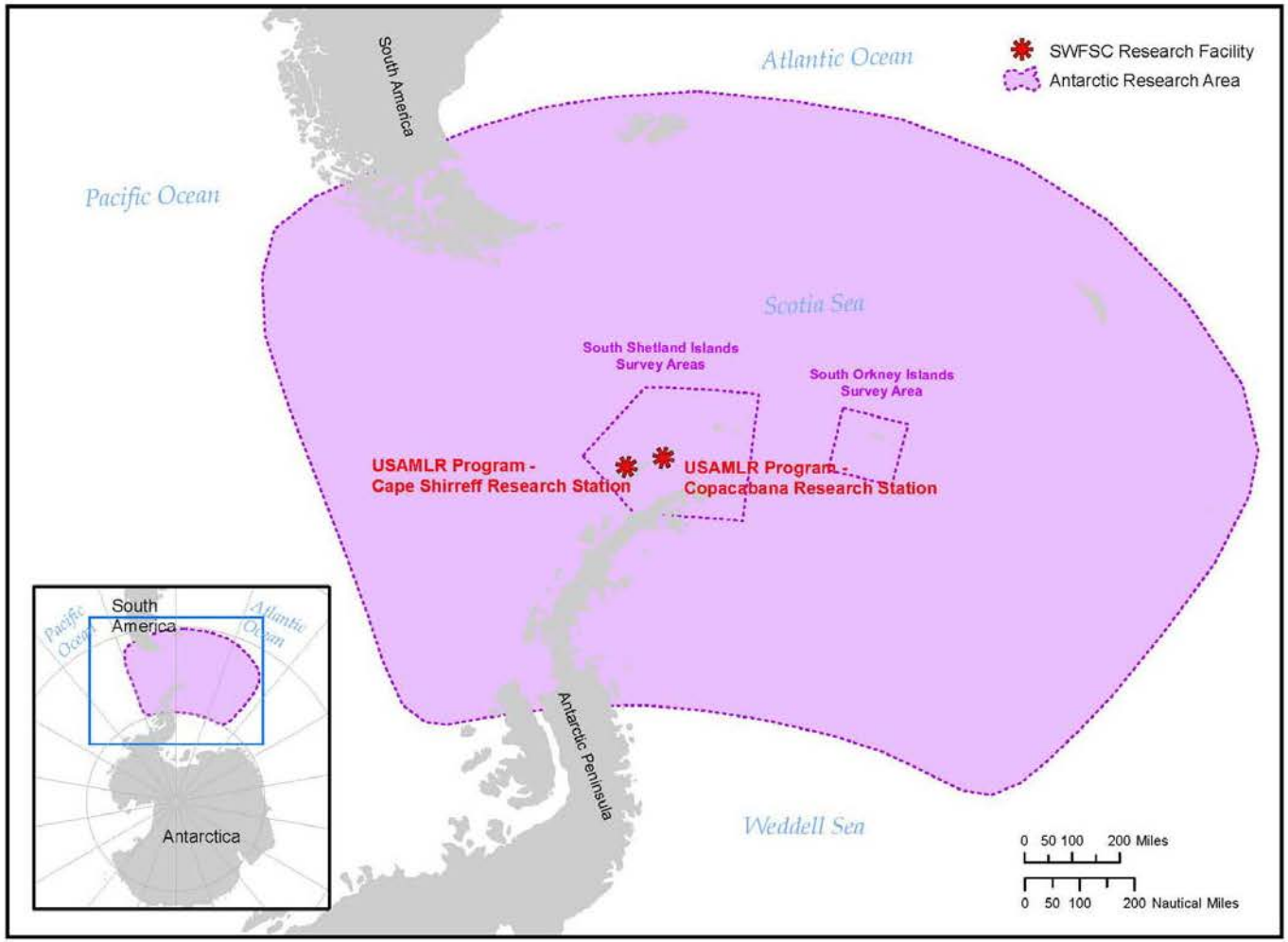


Figure 1.2-3 Antarctic Research Area and Research Facilities.

The South Shetland Islands survey area indicates the location of annual krill surveys and the South Orkney Islands survey area indicates the location of periodic benthic finfish surveys.

SWFSC research efforts are divided among five research divisions that are tasked with different roles in collecting scientific information on living marine resources and the ecosystems that sustain them.

1.2.1 Fisheries Resources Division

The SWFSC Fisheries Resources Division (FRD) develops the scientific foundation for the conservation and management of marine resources in the California Current and Pan-Pacific Pelagic Ecosystems. The division conducts seagoing surveys, genetic and morphometric research to define stock structure, life history studies to estimate production of eggs and larvae and adult vital rates, engineering work to develop advanced survey technologies, oceanographic studies to define critical habitat and population response to climate change, quantitative population assessments, and economic studies to define the value of fisheries and alternative management options. The division responds to the information needs of the Coastal Pelagic Species (CPS) FMP, Highly Migratory Species FMP, West Coast Salmon FMP and Groundfish FMP. FRD scientists also participate in international working groups and provide scientific advice to the ISC, IATTC and WCPFC.

1.2.2 Fisheries Ecology Division

The FED conducts research on the ecology of groundfish, economic analysis of fishery data, Pacific salmon studies (including 10 endangered salmon and steelhead runs), and coastal habitat issues affecting the San Francisco Bay and the Gulf of Farallones.

Results from FED research are used by the PFMC and NMFS to manage fisheries, and by NMFS to manage threatened and endangered species. FED scientists study causes of variability in abundance and health of fish populations, analyze ecological relationships in marine communities, and study the economics of exploiting and protecting natural resources. They also assess the stocks of species targeted by various fisheries, and assist in evaluating potential impacts of human activities on threatened or endangered species.

1.2.3 Antarctic Ecosystem Research Division

The AERD manages the U.S. AMLR, which provides information for U.S. policy on the management and conservation of Antarctic living resources and supports U.S. participation in international efforts to protect the Antarctic and its marine life. Research is directed toward gathering ecological and biological information to quantify the functional relationships between finfish and krill, their environment and their predators; to develop an ecosystem approach to ensure sustained harvesting of krill, fish and crabs; and to protect predator populations of seals, penguins, and pelagic seabirds resident in the Southern Ocean surrounding Antarctica.

1.2.4 Protected Resources Division

The Protected Resources Division promotes and conducts research that contributes to the conservation and management of U.S. and international populations of marine mammals and their designated critical habitats. Provisions of the MMPA and the ESA guide the division's activities, which include monitoring the abundance of pinniped and cetacean stocks and sea turtle populations, assessing and helping to minimize the effect of fishing operations and other human activities on these populations, determining stock structure and population dynamics, and conducting research on "dolphin-safe" tuna fishing methods. Research efforts span the entire migratory range of marine mammal and sea turtle populations. The Protected Resources Division monitors the life history, condition and health of populations, performs regular abundance estimates, advances studies of marine mammal acoustics, and strives to interpret these results in an ecosystem context. To do this, oceanographic data are collected to characterize habitat and its variation over time. Data describing the distributions and abundance of prey fishes and squids, seabirds,

and sea turtles are used to further characterize the ecosystems in which marine mammals and other protected species live.

1.2.5 Environmental Research Division

The ERD conducts a flexible research program to assess, understand, and predict climate and environmental variability and its impacts on marine fish populations and ecosystems. The ERD provides science-based, globally integrated, and fisheries-relevant environmental data, products, and information to meet the research and management needs of the SWFSC, NMFS, and NOAA.

1.3 PURPOSE AND NEED

Primary Action: This EA evaluates both a primary and a secondary action under the National Environmental Policy Act (NEPA). The primary action is the proposed performance of SWFSC fisheries research activities until 2018 (as described above and in Section 2.2) or later if no major changes to the primary action are appropriate. The purpose of this primary action is to produce scientific information necessary for the management and conservation of domestic and international living marine resources in a manner that promotes both the recovery of certain species and the long-term sustainability and recovery of these resources and generates social and economic opportunities and benefits from their use. The information developed from these research activities is essential to the development of a broad array of fisheries, marine mammal, and ecosystem management actions taken not only by NMFS, but also by other federal, state, and international authorities.

The ultimate purpose of SWFSC fisheries and ecosystem research activities is to inform management of the region's marine and anadromous fish and invertebrate populations to ensure they remain at sustainable and healthy levels. In order to achieve this, the SWFSC needs to continue its research activities through a suite of programs that generate the scientific information necessary for the conservation and management of the region’s living marine resources.

Secondary Action: A secondary, related action—also called a “connected action” under NEPA (Sec. 1508.25)—is the issuance of proposed regulations and subsequent Letters of Authorization (LOA) under Section 101(a)(5)(A) of the MMPA of 1972, as amended (MMPA; 16 United States Code [U.S.C.] 1361 *et seq*.) that would govern the unintentional taking of small numbers of marine mammals incidental to the SWFSC’s research activities.

Under the MMPA, any activities resulting in the take of marine mammals must be authorized by NMFS; this includes research programs conducted by the NMFS science centers. Because the SWFSC’s research activities have the potential to take marine mammals by Level A and B harassment, serious injury and/or mortality, the SWFSC is applying to NMFS for an incidental take authorization (ITA) for its research programs.

Section 101(a)(5)(A) and (D) of the MMPA direct the Secretary of Commerce (Secretary) to allow, upon request, the incidental, but not intentional taking of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and regulations are issued or, if the taking is limited to harassment, a notice of a proposed authorization is provided to the public for review. Authorization for incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant), and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth.

Take, under the MMPA is defined as, “To harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.” The MMPA defines harassment as, “Any act of pursuit, torment, or annoyance, which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the

wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment]."

The purpose of issuing incidental take authorizations is to provide an exemption to the take prohibition in the MMPA and to ensure that the action complies with the MMPA and NMFS' implementing regulations. ITAs may be issued as either: (1) regulations and associated LOAs under Section 101(a)(5)(A) of the MMPA; or (2) an Incidental Harassment Authorizations (IHAs) under Section 101(a)(5)(D) of the MMPA. An IHA can only be issued when there is no potential for serious injury and/or mortality or where any such potential can be negated through required mitigation measures. Because there is a potential for lethal takes and takes that may result in serious injury that could lead to mortality, the SWFSC is requesting rulemaking and the issuance of LOAs for this action.

Pursuant to Section 101(a)(5)(A) of the MMPA, NMFS, upon application from the SWFSC, may propose regulations to govern the unintentional taking of marine mammals incidental to the proposed fisheries research activities by the SWFSC in the Pacific and Southern Oceans from 2013 through 2018. Because the issuance of MMPA incidental take regulations and associated LOAs to the SWFSC are federal actions, NMFS is required to analyze the effects of their issuance on the human environment pursuant to NEPA and NMFS' NEPA procedures. As a result, one branch of NMFS (the Office of Protected Resources, Permits and Conservation Division [NMFS PR1]) will evaluate the effects of issuing regulations and an ITA to another branch of NMFS (the SWFSC).

This EA analyzes the environmental impacts associated with the requested authorization of the take of marine mammals, incidental to the SWFSC's conduct of fisheries research activities in the California Current and ETP areas in the Pacific Ocean and the Scotia Sea area of the Southern Ocean. It also analyzes a reasonable range of mitigation measures that may be required if NMFS issues an MMPA authorization. The analysis of mitigation measures includes a consideration of benefits to the affected species or stocks and their habitat, and an analysis of the practicability and efficacy of each measure. This analysis of mitigation measures could potentially be used to support requirements pertaining to mitigation, monitoring, and reporting specified in MMPA regulations and subsequent LOAs, if issued.

Further, because the proposed research activities occur in known habitat areas of species that are listed as threatened or endangered under the ESA[8], this EA evaluates potential impacts to ESA-listed species that may result from either the primary or secondary action. Likewise, because the proposed research activities occur partially within the boundaries of National Marine Sanctuaries, and within areas identified as Essential Fish Habitat (EFH), this EA evaluates potential impacts to sanctuary resources and EFH as required under section 304(d) of the National Marine Sanctuaries Act and section 305(b)(2) of the Magnuson-Stevens Act. The SWFSC intends to use this EA as the basis for consultations with the appropriate offices and agencies in compliance with these and other applicable laws (Table 1.6-1).

1.4 SCOPE AND ORGANIZATION OF THIS EA

In considering the proposed action, NMFS is responsible for complying with a number of federal statutes, regulations, and executive orders, including NEPA. As such, the purpose of this EA is to provide an environmental analysis to support the NMFS proposal to continue the research activities under the requirements of an LOA and to encourage and facilitate public involvement in the environmental review process.

Under NEPA, an EA is prepared to determine if any significant environmental impacts are likely to be caused by a proposed action. If the EA does not identify potentially significant impacts, a Finding of No Significant Impact (FONSI) is prepared to document the decision maker's determination and to approve the proposed action. If at any time during preparation of the EA it appears that significant impacts would result from the proposed action, the agency would halt development of the EA and begin preparation of an Environmental Impact Statement (EIS) to more thoroughly evaluate the potential impacts and potential

[8] 16 U.S.C. §1531 *et seq.*

ways to reduce or mitigate those impacts. Thus, while the EA objectively evaluates the full extent of potential impacts of a proposed action (from minor to major, adverse or beneficial, short-term to long-term – see discussion below), the FONSI provides the decision maker's rationale with regard to the significance of those impacts.

This EA provides a programmatic-level assessment of the potential impacts on the biological and human environments associated with the proposed SWFSC research programs. A programmatic approach is used when initiating or reevaluating a federal program for NEPA compliance. It takes a broad look at issues and alternatives (compared to documents for a specific project or action), and provides a baseline for future management actions. Subsequent NEPA evaluation during annual program review can tier off of an approved programmatic NEPA compliance document, as long as the activity/program being assessed is within the range of alternatives and nature of potential environmental consequences considered in the programmatic document. Programmatic documents are often intended to provide NEPA compliance for management and other activities over a fixed period before a formal review is again initiated.

The SWFSC EA assesses not only the potential direct and indirect impacts of the alternatives presented to the physical, biological and socioeconomic systems in the SWFSC area of responsibility, but also the potential impacts of the management processes that are used to monitor the health of the resources, develop plans to manage the resources to balance recovery goals and socioeconomic goals, and ensure the sustainability of the resources and affected fishing communities. This EA assesses the impacts of research activities conducted by SWFSC in three geographic areas: the CCRA, ETPRA, and ARA.

The chapters that follow describe the proposed research activities and potential alternatives considered (Chapter 2), the affected environment as it currently exists (Chapter 3), the probable direct and indirect consequences on the human environment that may result from the implementation of the proposed research activities and their alternatives (Chapter 4), and the potential contribution to cumulative impacts from the proposed activities and their alternatives (Chapter 5).

The scope of this EA covers research activities conducted by the SWFSC or its research partners that:

- Contribute to fishery management and ecosystem management responsibilities of NMFS under U.S. law and international agreements.
- Take place in marine waters in the California Current, the Eastern Tropical Pacific, and the Scotia Sea in the Southern Ocean off Antarctica.
- Involve the transiting of these waters in research vessels, observational surveys made from the deck of those vessels (e.g., marine mammal and seabird transects), the deployment of fishing gear and scientific instruments into the water in order to sample and monitor living marine resources and their environmental conditions, and/or use active acoustic devices for navigation and remote sensing purposes.
- Have the potential to interact adversely with marine mammals and protected species of fish, sea turtles, birds, and invertebrates. However, the research activities covered under this EA involve only *incidental* interactions with protected species, not *intentional* interactions with those species.

The primary focus of this EA is on fisheries-related research but several other types of surveys are also included because they deploy fishing gear and other instruments similar to those used in fisheries research in order to monitor the environment important to protected species and therefore involve the same potential risks of incidental interactions with protected species.

This EA does NOT cover:

- Directed research on protected species that involves intentional pursuit or capture of marine mammals or sea turtles for tagging, tissue sampling, or other intentional takes under the MMPA or ESA which require directed scientific research permits. Directed research on protected species

is covered by other environmental review processes and consultations under applicable regulations.

- In addition to the research covered under this EA, scientists from the SWFSC regularly collaborate with scientists in other NMFS regions. The potential effects of research conducted with the help of SWFSC scientists in these other NMFS Regions will be covered in separate NEPA analyses for those regions and are not included in this EA.
- Other activities of the SWFSC that do not involve the deployment of vessels or gear in marine waters, such as evaluations of socioeconomic impacts related to fisheries management decisions, taxonomic research in laboratories, fisheries enhancements such as hatchery programs, and educational outreach programs.

In the future, additional research activities may propose to use methods that were not considered in the evaluation of impacts in this EA. Some of these proposed projects may require further environmental impact assessment or satisfaction of other consultation, approval, or permitting requirements before being allowed to proceed (see also Section 2.3.3). In particular, proposed projects that may impact protected species and require permits under the ESA or the MMPA may require individual NEPA analyses and decisions tiered off this EA. Under NEPA, tiering refers to development of subsequent NEPA analyses that incorporate by reference and build on prior NEPA analyses. A programmatic NEPA approach is especially conducive to NEPA tiering. As the details of any such studies are presently unavailable, they cannot be assessed here. After new projects are sufficiently well defined and their potential environmental consequences are understood, specific impacts will be evaluated as necessary. If the proposed new research activities are not within or similar to the range of alternatives addressed in the programmatic document and may have adverse environmental impacts that are not within the scope of the analysis in this EA, additional NEPA review would be required.

In developing this EA, NMFS adhered to the procedural requirements of NEPA; the Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 Code of Federal Regulations [CFR] 1500-1508)[9], and NOAA's procedures for implementing NEPA[10].

The following definitions are used to characterize the nature of the various impacts evaluated with this EA:

- Short-term or long-term impacts. These characteristics are determined on a case-by-case basis and do not refer to any rigid time period. In general, short-term impacts are those that would occur only with respect to a particular activity or for a finite period. Long-term impacts are those that are more likely to be persistent and chronic.
- Direct or indirect impacts. A direct impact is caused by a proposed action and occurs contemporaneously at or near the location of the action. An indirect impact is caused by a proposed action and might occur later in time or be farther removed in distance but still be a reasonably foreseeable outcome of the action. For example, a direct impact of erosion on a stream might include sediment-laden waters in the vicinity of the action, whereas an indirect impact of the same erosion might lead to lack of spawning and result in lowered reproduction rates of indigenous fish downstream.
- Minor, moderate, or major impacts. These relative terms are used to characterize the magnitude of an impact. Minor impacts are generally those that might be perceptible but, in their context, are not amenable to measurement because of their relatively minor character. Moderate impacts are those that are more perceptible and, typically, more amenable to quantification or measurement. Major impacts are those that, in their context and due to their intensity (severity), have the potential to meet the thresholds for significance set forth in CEQ regulations (40 CFR 1508.27)

[9] See Reference (CEQ 1969).

[10] NOAA Administrative Order (NAO) 216-6, Environmental Review Procedures for Implementing the National Environmental Policy Act.

and, thus, warrant heightened attention and examination for potential means for mitigation to fulfill the requirements of NEPA.

- Adverse or beneficial impacts. An adverse impact is one having adverse, unfavorable, or undesirable outcomes on the manmade or natural environment. A beneficial impact is one having positive outcomes on the man-made or natural environment. A single act might result in adverse impacts on one environmental resource and beneficial impacts on another resource.
- Cumulative impacts. CEQ regulations implementing NEPA define cumulative impacts as, "Impacts on the environment which result 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) Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time within a geographic area.

The SWFSC has consulted the California State Historic Preservation Office (CSHPO) in order to identify fisheries research activities that may have a nexus with historic maritime sites or archaeological resources. Because SWFSC fisheries research activities do not use bottom contact gear within the U.S. EEZ (other than two longline sampling efforts that make minimal bottom contact), the proposed activities are not expected to result in any impacts to underwater historical or archaeological resources within the California Current Research Area. The SWFSC, therefore, finds that the proposed activity would have "No Adverse Effect" on historic properties in the identified areas. However, the SWFSC will contact the CSHPO if it intends to do future research that might impact submerged historic or archaeological properties within one of the "cautionary zones" identified by the CSHPO to protect known maritime heritage resources in U.S. Pacific waters.

The proposed SWFSC research activities are not expected to result in impacts to public health or safety. SWFSC has initiated consultation with potentially affected entities to determine the potential for impacts to cultural sites and tribal trust resources. These issues are not considered further in this assessment but may be considered further if consultation suggests that SWFSC research activities may impact such resources.

1.5 PUBLIC REVIEW

Public participation is a cornerstone of the NEPA process. In preparing EAs, federal agencies must involve environmental agencies, applicants, and the public to the extent practicable (40 CFR Sec. 1501.4 [b]). Following guidance for public review of EAs in NOAA Administrative Order 216-6 (Sections 5.02b.1 and 5.03e.2), this EA and the associated LOA application will be available for public review on the Internet, and notice of the availability of the EA will be published in the *Federal Register*. Public comments received on this draft EA will be addressed in the final EA.

1.6 REGULATORY REQUIREMENTS

NMFS is the lead federal agency for the proposed research activities evaluated in this EA. These activities trigger a broad range of regulatory compliance processes because they may both cause adverse impacts to public resources regulated by various statutes, and contribute to reducing impacts caused by other activities, such as fishing, that are also regulated by those same statutes. Chapters 4 and 5 assess the impacts of the research activities on protected species and habitat. Because the research activities are essential for NMFS to carry out its regulatory mandates, Chapters 4 and 5 also describe potential impacts to NMFS' ability to effectively monitor and manage fishery resources under the alternatives evaluated. Descriptions of the relevant statutory requirements are provided in Chapter 6, "*Applicable Laws*."

Table 1.6-1, below, presents a brief summary of some of the applicable laws and treaties. This information is provided to aid the reader in understanding the material presented later in the EA and is not

intended to be a complete listing of all statutes, orders, or regulations applicable to the proposed action and alternatives.

Table 1.6-1 Applicable Laws and Treaties

Law	Description
National Environmental Policy Act (NEPA)	Requires federal agencies to evaluate potential environmental effects of any major planned federal action and promotes public awareness of potential impacts by requiring federal agencies to prepare an environmental evaluation for any major federal action affecting the human environment.
Magnuson-Stevens Fishery Conservation and Management Act (MSA)	Authorizes the U.S. to manage fishery resources in an area from a state's territorial sea (extending 3nm from shore) to 200nm off its coast (termed as the EEZ). Includes 10 national standards to promote domestic commercial and recreational fishing under sound conservation and management principles, and provide for the preparation and implementation of fishery management plans (FMPs).
Marine Mammal Protection Act (MMPA)	Prohibits the take of marine mammals in U.S. waters and by U.S. citizens on the high seas and the importation of marine mammals and marine mammal products into the U.S. Allows, upon request, the "incidental," but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing).
International Dolphin Conservation Program Act (IDCPA)	The International Dolphin Conservation Program Act (IDCPA) was a 1997 amendment to the U.S.MMPA. It provides for the U.S. implementation of the international Agreement on the International Dolphin Conservation Program (IDCP), to which the U.S. is a signatory.
Endangered Species Act (ESA)	Provides for the conservation of endangered and threatened species of fish, wildlife, and plants throughout all or a significant portion of their range, and the conservation of the ecosystems upon which they depend. Administered jointly by NMFS and the USFWS.
Migratory Bird Treaty Act (MBTA)	Protects approximately 836 species of migratory birds from any attempt at hunting, pursuing, wounding, killing, possessing, or transporting any migratory bird, nest, egg, or part thereof, unless permitted by regulations.
Fish and Wildlife Coordination Act (FWCA)	Requires USFWS and NMFS to consult with other state and federal agencies in a broad range of situations to help conserve fish and wildlife populations and habitats in cases where federal actions affect natural water bodies.
National Marine Sanctuaries Act (NMSA)	Authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities as national marine sanctuaries. Section 304(d) of the NMSA requires interagency consultation between the NOAA Office of National Marine Sanctuaries (ONMS) and federal agencies taking actions that are "likely to destroy, cause the loss of, or injure a sanctuary resource."
Tuna Conventions Act Of 1950	Provides for U.S. representation on the Inter-American Tropical Tuna Convention (IATTC). The principal duties of the IATTC are (1) to study the biology of the tropical tunas, tuna baitfish, and other kinds of fish taken by tuna vessels in the eastern Pacific Ocean and the effects of fishing and natural factors upon them, and (2) to recommend appropriate conservation measures, when necessary, so that these stocks of fish can be maintained at levels which will afford the maximum sustained catches.
Antarctic Marine Living Resources Convention Act Of 1984	Provides the legislative authority necessary to implement, with respect to the U.S., the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR). The Act prohibits harvesting of Antarctic marine living resources in violation of the convention.
National Historic Preservation Act (NHPA)	Section 106 requires review of any project funded, licensed, permitted, or assisted by the federal government for impact on significant historic properties.
Executive Order 12989, Environmental Justice	Directs federal agencies to identify and address disproportionately high and adverse effects of federal projects on the health or environment of minority and low-income populations to the greatest extent practicable and permitted by law.

Law	Description
Executive Order 12114, Environmental Effects Abroad of Major Federal Actions	Directs federal agencies to extend their compliance with NEPA and other specified laws to major federal actions outside of the U.S., its territories, and possessions. The purpose of the order is to establish internal procedures for federal agencies to consider the significant effects of their actions on the environment outside the U.S. but it does not require redress of those effects.
Executive Order 13158, Marine Protected Areas	The purpose of this order is to strengthen and expand the Nation's system of marine protected areas (MPAs). It encourages Federal agencies to use science-based criteria and protocols to identify and prioritize natural and cultural resources in the marine environment that should be protected to secure valuable ecological services and to monitor and evaluate the effectiveness of MPAs. Each Federal agency whose actions affect the natural or cultural resources that are protected by an MPA shall identify such actions. To the extent permitted by law and to the maximum extent practicable, each Federal agency, in taking such actions, shall avoid harm to the natural and cultural resources that are protected by an MPA.
Coastal Zone Management Act (CZMA)	Encourages and assists states in developing coastal management programs. Requires any federal activity affecting the land or water use or natural resources of a state's coastal zone to be consistent with that state's approved coastal management program.
U.S.-Canada Albacore Treaty	Under a treaty between the U. S. and Canada, U.S. albacore vessels are authorized to fish for albacore in certain waters under the jurisdiction of Canada and to use certain port facilities in Canada. Similarly, Canadian vessels are authorized to fish in certain waters under U.S. jurisdiction, and to use certain U.S. ports to obtain supplies and other services.
Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean	The convention establishes an international commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean, now more commonly referred to as the Western and Central Pacific Fishery Commission (WCPFC). A noteworthy aspect of the convention is the fact that it will exercise management control into the high seas zones outside national EEZs in contrast to some other regional fishery management organizations.
High Seas Fishing Compliance Act	The United Nations Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas establishes the responsibility of each nation for the actions of vessels fishing under that nation’s flag on the high seas. The High Seas Fishing Compliance Act (HSFCA) is the domestic legislation enacted in 1995 to provide authority to the Secretary of Commerce to implement this agreement.
South Pacific Tuna Treaty	The 1987 Multilateral Fisheries Treaty with the U.S.in the Forum Fisheries Agency is a vital component of the political and economic relationship between the U.S. and the Pacific Island Parties. The treaty entered into force in 1987 for an initial period of five years. It has since been extended twice; the most recent extension is for 2003 through 2013. The treaty sets the operational terms and conditions for the U.S. tuna purse seine fleet to fish in a vast area of the central and western Pacific Ocean, including waters under the jurisdiction of the Pacific Island Parties.

2.1 INTRODUCTION

The Council on Environmental Quality (CEQ) is responsible for the development and oversight of regulations and procedures implementing the National Environmental Policy Act (NEPA). The CEQ regulations provide guidance for federal agencies regarding NEPA's requirements (40 Code of Federal Regulations [CFR] Part 1500). National Oceanic and Atmospheric Administration (NOAA) has also prepared environmental review procedures for implementing NEPA, NOAA Administrative Order 216-6 (NAO 216-6). Section 5.03b of NAO 216-6 states: "An Environmental Assessment [EA] must consider all reasonable alternatives, including the preferred action and the no action alternative."

To warrant detailed evaluation by the National Marine Fisheries Service (NMFS), an alternative must be reasonable[11] and meet the purpose and need (see Section 1.3). Screening criteria are used to determine whether an alternative is reasonable and should be considered further or whether it is not reasonable to consider in detail in the EA. Section 2.6 describes potential alternatives that were considered but rejected because they do not meet the purpose and need of the proposed action.

Screening Criteria – To be considered 'reasonable' for the purposes of this EA, an alternative must meet the following criteria:

1. The action must not violate any federal statute or regulation.
2. The action must be consistent with reasonably foreseeable funding levels.
3. The action must be consistent with long-term research commitments and goals to maintain the utility of scientific research efforts, or consider no federal funding availability for fisheries research.

To maintain the utility of scientific research efforts, fisheries and marine ecosystem scientific research should fulfill the following requirements:

1. Methods and techniques must provide standardized, objective, and unbiased data consistent with past data sets (time series) in order to facilitate long-term trend analyses.
2. Collected data must adequately characterize living marine resource and fishery populations and the health of their habitats.
3. The surveys must enable assessment of population dynamics and provide predictive capabilities required to respond to changing ecosystem conditions and manage future fisheries.
4. Research on new methodologies to collect fisheries and ecosystem information (e.g. active and passive acoustic instruments and video surveys of benthic habitats in lieu of dredge gear or bottom trawls), and research oriented toward modifications of fishing gear to address bycatch or other inefficiencies must be conducted with experimental controls sufficient to allow statistically valid comparisons with relevant alternatives.

NMFS evaluated each potential alternative against these criteria and requirements. Based on this evaluation, the No-Action/Status Quo alternative and two other action alternatives were identified as reasonable and are carried forward for more detailed evaluation in this EA. NMFS also evaluates a second type of no-action alternative that considers no federal funding for fisheries research activities. This

[11] "Section 1502.14 (NEPA) requires the EA/Environmental Impact Statement (EIS) to examine all reasonable alternatives to the proposal. In determining the scope of alternatives to be considered, the emphasis is on what is 'reasonable' rather than on whether the proponent or applicant likes or is itself capable of carrying out a particular alternative. Reasonable alternatives include those that are *practical or feasible from the technical and economic standpoint and using common sense*, rather than simply desirable from the standpoint of the applicant." (40 Questions) (emphasis added)

alternative is called the No Research Alternative to distinguish it from the No-Action/Status Quo alternative.

The No-Action/Status Quo Alternative is used as the baseline for comparison of the other alternatives. Three of the alternatives include fisheries and ecosystem research projects conducted or funded by the Southwest Fisheries Science Center (SWFSC) as the primary federal action. These three alternatives also include suites of mitigation measures intended to minimize potentially adverse interactions with protected species. Protected species include all marine mammals, which are covered under the Marine Mammal Protection Act (MMPA), all species listed under the Endangered Species Act (ESA), and bird species protected under the Migratory Bird Treaty Act (MBTA).

The three alternatives involving research activities in the marine environment trigger marine mammal protection requirements under the MMPA. For this reason, NMFS must evaluate the alternatives to ensure that they would fulfill the purpose and need of NMFS issuing regulations and subsequent Letters of Authorization (LOA) under Section 101(a)(5)(A) of the MMPA to the SWFSC, which is the secondary federal action considered in this EA. The LOA, if issued, would provide an exception to the SWFSC from the take prohibitions for marine mammals under the MMPA, incidental to the conduct of the SWFSC's research activities, namely: (1) the issuance of an LOA for the take of marine mammals by Level A and Level B harassment, and by serious injury or mortality incidental to the SWFSC's conduct of research activities from 2013 through 2018; and (2) compliance with the MMPA which sets forth specific findings (e.g. no unmitigable adverse impact on the availability of a species or stock for subsistence uses, negligible impact on a species or stock, reporting, monitoring, and mitigation requirements) that must be made in order for NMFS to issue an LOA. In order to authorize incidental take of marine mammals under the MMPA, NMFS must identify and evaluate a reasonable range of mitigation measures to minimize impacts to marine mammals to the level of least practicable adverse impact. This range of mitigation measures has been incorporated as part of the identified alternatives in order to evaluate their ability to minimize potential adverse environmental impacts. The efficacy and practicability of all potential mitigation measures are assessed in Chapter 4.

Further, because the proposed research activities occur in known habitat areas of species that are listed as threatened or endangered under the ESA, this EA evaluates potential impacts to ESA-listed species that may result from either the primary or secondary action. Likewise, because the proposed research activities occur partially within the boundaries of National Marine Sanctuaries, and within areas identified as Essential Fish Habitat (EFH), this EA evaluates potential impacts to sanctuary resources and EFH as required under section 304(d) of the National Marine Sanctuaries Act and section 305(b)(2) of the Magnuson-Stevens Act.

2.2 ALTERNATIVE 1 – NO-ACTION/STATUS QUO ALTERNATIVE - CONDUCT FEDERAL FISHERIES AND ECOSYSTEM RESEARCH WITH SCOPE AND PROTOCOLS SIMILAR TO PAST EFFORT

As discussed in Chapter 1, the SWFSC collects a wide array of information necessary to evaluate the status of fishery resources and the marine environment. SWFSC scientists conduct fishery-independent research onboard NOAA owned and operated vessels or on chartered vessels in three geographic research areas: the California Current Research Area (CCRA), the Eastern Tropical Pacific Research Area (ETPRA), and Antarctic Research Area (ARA) in waters of the Scotia Sea. The SWFSC also designs and executes a limited number of surveys conducted onboard commercial fishing vessels. In those instances, SWFSC scientists lead the surveys onboard the commercial vessels, and the vessel time is funded by the SWFSC. The SWFSC proposes to administer and conduct 16 survey programs over the 2013-2018 period, as described in Table 2.2-1. Under this alternative, the SWFSC would also apply for authorizations under the MMPA and the ESA for incidental take of protected species during these research activities.

Table 2.2-1 Summary description of SWFSC surveys conducted on NOAA vessels and NOAA-chartered vessels under the Status Quo Alternative.

See Appendix A for descriptions of the different gear types and vessels used. Appendix B includes figures showing the spatial coverage of each survey by season. Mitigation measures are described in Section 2.2.1.

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
California Current Research Area								
Survey Using Trawl Gear								
Coastal Pelagic Species (CPS) Survey (aka Sardine Survey)	One or two ship survey. Results of survey inform the annual assessment of sardines and the corresponding harvest guideline. Consists of southern and northern portions conducted on two survey vessels. When possible, preference has been for a two-ship survey. The southern portion is done in conjunction with the spring or summer CalCOFI Survey. Protocols similar to CalCOFI with the addition of mid-water trawls conducted near the surface at night to sample adult sardines.	United States (U.S.) West Coast Exclusive Economic Zone (EEZ)	Annually or biennially, April-May or July-August 70 DAS (~35DAS/vessel)	NOAA ship, Charter vessel One or two ship survey	NETS Nordic 264 two-warp rope trawl	Towed near-surface, primarily at night Tow speed: 2-4 knots (kts) Duration: 30 min at intended depth	50 tows	Acoustic pingers, marine mammal excluder devices (MMEDs), limited visual monitoring (night trawl), "move-on" rule.
					Various plankton nets (Bongo, Pairovet, Manta)	Tow speed: 1.5- 2.5 kts for Bongo and Manta; 0 for Pairovet Duration: 10-20 min	75 tows	
					Conductivity Temperature Depth (CTD) and rosette water sampler	Tow speed: 0 Duration: 20-120 min	75 casts	
					Continuous Underway Fish Egg Sampler (CUFES)		Continuous	
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200 kilohertz (kHz)	Continuous	
					Multi-beam echosounder (Simrad ME70) and sonar (Simrad MS70)		Continuous	
Juvenile Rockfish Survey	Targets pelagic phase of juvenile rockfish with nighttime tows. Results of survey inform assessments of several rockfish populations and may soon be used in assessments of Central California salmon productivity.	West Coast EEZ	Annually, May-mid-June 45 DAS	NOAA ship, Charter vessel	Modified Cobb Midwater Trawl	Tow speed: 2 kts Duration: 15 min at intended depth	150 tows	Acoustic pingers, development of MMEDs, limited visual monitoring (night trawl), "move-on" rule.
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 5-120 min	~250 casts	
					Various plankton nets (Bongo and Tucker)	Tow speed: 1.5- 2.5 kts Duration: 20-60 min	50 tows	
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200, 333 kHz	Continuous	

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Juvenile Salmon Survey	Measures ocean survival of juvenile salmon and produces early estimate of adult returns. Protocols include surface-water trawls, active acoustics, oceanographic and meteorological measurements. Tissue samples are collected for genetic analysis.	Central CA to southern OR	Annually, June and September 30 DAS total for two surveys	Charter vessel	NETS Nordic 264 two-warp rope trawl	Towed at 15-30 meters (m) deep during daytime Tow speed: 2-4 kts Duration: 30 min at intended depth	50 tows	Acoustic pingers, MMEDs, visual monitoring, "move-on" rule.
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 20-120 min	50 casts	
					Various plankton nets (Bongo and Tucker)	Tow speed: 1.5- 2.5 kts Duration: 20-60 min	50 tows	
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200, 333 kHz	Continuous	
Surveys Using Longline Gear								
Highly Migratory Species (HMS) Survey	This survey targets blue sharks, shortfin mako sharks, and other HMS as a basis for stock assessments and support for HMS Fishery Management Plans. Information is also obtained about their biology, distribution, movements, stock structure and status, and potential vulnerability to fishing pressure. Surveys involve catching sharks on longline gear, measuring, attaching various tags, and releasing them alive.	Southern to central CA	Annually, June-July 30 DAS	NOAA ship, Charter vessel	Pelagic longline	Mainline length: 2-4 mile set at 50 to 75 ft deep for mako and blue sharks; 300 to 600 ft for swordfish. Gangion length: 10-15 ft; 36 ft for swordfish Gangion spacing: 50-100 ft apart. Hook size and type: 9/0 J hooks for blue and mako sharks; 16/0 and 18/0 offset, stainless circle hooks for swordfish. Soak time: 2-4 hrs for most species, up to8 hrs for swordfish	60 sets	Visual monitoring, "move-on" rule, operational adjustments to avoid take. Use of circle hooks and finfish bait where possible to minimize sea turtle bycatch.
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 30 min	60 casts	
					Bongo plankton tows	Tow speed: 1.5 kts Duration: 20 min	60 tows	
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200, 333 kHz	Continuous	
Reproductive Life History	This survey is conducted to collect adult sablefish for reproduction studies. Surveys	Central California (near Bodega	Monthly (One day per month), 30 DAS	Charter vessel	Small commercial bottom longline	75 hooks per line, baited with squid, set at depths of 360-	2-3 sets per trip	"move on" rule if a marine mammal is encountered

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Analysis of Sablefish	involve catching sablefish on longline gear.	Bay)				450m		
Thresher Shark Survey	This survey is conducted to support stock assessment and management of thresher sharks, which are subject to commercial and recreational fisheries. Surveys involve catching sharks on longline gear, measuring and taking tissue samples, attaching various tags, and releasing them alive.	Southern CA Bight	Annually, September 20 DAS	Charter vessel	Anchored pelagic longline	Mainline length: 1-2 mile set at 12 ft deep Gangion length: 10-15 ft Gangion spacing: 50-100 ft apart. Hook size and type:13/0 offset circle hooks for thresher sharks Soak time: 2-4 hr	40 sets	Visual monitoring, "move-on" rule, operational adjustments to avoid take. Use of circle hooks and finfish bait to minimize sea turtle bycatch.
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 30 min	40 casts	
					Bongo plankton tows	Tow speed: 1.5 kts Duration: 20 min	60 tows	
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200, 333 kHz	Continuous	
Surveys Using Trawl and /or Longline Gear								
Habitat Surveys (swordfish and adult rockfish)	Surveys include adult rockfish EFH, co-use of habitat by swordfish and leatherback turtles.	California Current LME	Opportunistically as funds and ship time are available 50 DAS	NOAA ship and charter vessels	NETS Nordic 264 two-warp rope trawl	Towed near-surface at night Tow speed: 2-3 kts Duration: 30 min at intended depth	10 tows	Visual monitoring, "move-on" rule, acoustic pingers, and MMEDs
					Pelagic longline	Mainline length: 2-12 mile set at 600 feet deep depending on target species. Gangion length: 36 ft Gangion spacing: 50-100 ft apart Hook size and type:16/0 and 18/0 offset, stainless circle hooks for swordfish Soak time: up to 8 hr	20 sets	Visual monitoring, operational adjustments to avoid take. Use of circle hooks and finfish bait to minimize sea turtle bycatch.
					Bongo plankton tows	Tow speed: 1.5 kts Duration: 20 min	100 tows	
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 30 min	100 casts	

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
					Oozeki, IKMT, MOCNESS, Tucker nets	Tow speed: 2-3 kts Duration: 20-60 min	50 tows	
					Manned Submersible	1-3 hour dives	10 dives	
Surveys Using Other Gear								
California Cooperative Oceanic Fisheries Investigation (CalCOFI) **Winter, Spring, Summer and Fall Surveys**	CalCOFI is a partnership of NMFS, California Department of Fish and Game, and Scripps Institution of Oceanography. The survey series was started in 1949 to describe the pelagic ecology of the California Current and its influence on the population dynamics of west coast sardine stocks. Several hundred taxa of marine fishes and zooplankton are monitored along with aspects of their physical and biological environment. Sampling protocols include transects to assess the distribution and abundance of marine mammals and seabirds	San Diego to San Francisco	Four surveys annually in January-February, April, July and October 90 DAS total for four surveys	NOAA ships and University-National Oceanic Laboratory System fleet (Scripps Institution of Oceanography)	Various plankton nets (Bongo, Pairovet, Manta, PRPOOS)	Tow speed: 1.5- 2.5 knots (kts) for Bongo and Manta; 0 for Pairovet Duration: 10-20 minutes (min)	75-113 stations per survey; 340 samples total	Visual Monitoring
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 20-120 min	340 casts total	
					Various small, towed, fine-mesh nets designed to sample larval and juvenile fish and small pelagic invertebrates (Matsuda-Oozeki-Hu trawl net [MOHT], Isaacs-Kidd Mid-water Trawl[IKMT], MOCNESS, Tucker)	Tow speed: 2-3 kts Duration: 20-60 min	35-85 tows total	
					CUFES		Continuous	
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200 kHz	Continuous	
					Multi-beam echosounder (Simrad ME70) and sonar (Simrad MS70)		Continuous	
Collaborative Optical Acoustical Survey Technology (COAST) Survey	ROV and acoustic surveys of offshore banks designed to monitor recovery of rockfish. Conducted in collaboration with the charter boat fishing industry.	Southern and Central California	Opportunistically as funds and ship time are available 40 DAS	NOAA ship, Charter vessel	Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200, 333 kHz	Continuous	
					Still and video camera images taken from an ROV			

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Marine Mammal and Ecosystem Assessment Surveys	One or two ship surveys are conducted to assess all marine mammal species in west coast EEZ, or to focus on the distribution and ecology of a selected group of species. Sampling protocols include transects to assess the distribution and abundance of marine mammals, seabirds, and the status of the ecosystems that support them.	California Current Large Marine Ecosystem (LME)	Tri-annually (July - Dec) 60-120 DAS total for three surveys	NOAA ship One or two ship survey	Bongo plankton tows	Tow speed: 1.5 kts Duration: 20 min	60 tows	
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 30 min	40 casts	
					Oozeki, IKMT, MOCNESS, Tucker nets	Tow speed: 2-3 kts Duration: 20-60 min	60 tows	
					Expendable bathythermographs (XBTs)		80-240 units	
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200, 333 kHz	Continuous	
Pacific Coast Ocean Observing System (PacOOS) Central CA	Extension of CalCOFI observation protocols to CalCOFI lines off Monterey Bay and San Francisco during summer and fall surveys when the CalCOFI sampling grid is confined to the Southern California Bight. Surveys conducted in conjunction with Monterey Bay Aquarium Research Institute, UC Santa Cruz, and Navy Post-Graduate School	Central CA, fixed survey lines off Monterey and San Francisco Bays	Annually, July and October 6 DAS total for two surveys	Research Vessel (R/V) Point Sur	Various plankton nets (Bongo, California Vertical Egg Tow (CalVET), Pairovet, Manta)	Tow speed: 1.5- 2.5 kts for Bongo and Manta; 0 for CalVET and Pairovet Duration: 10-20 min	40 tows	
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 20-120 min	40 casts	
PacOOS North CA	Extension of CalCOFI observation protocols to a sampling line off Eureka CA. Surveys conducted in conjunction with Humboldt State University.	Northern CA, fixed survey lines off Eureka	Monthly 12 DAS total for 12 surveys	R/V Coral Sea	Various plankton nets (Bongo, CalVET, Pairovet, Manta)	Tow speed: 1.5- 2.5 kts for Bongo and Manta; 0 for CalVET and Pairovet Duration: 10-20 min	100 tows	
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 20-120 min	100 casts	
Swordfish Tagging using Deep-set Buoy Gear	Investigate the use of deep-set buoy gear to capture and tag swordfish without generating significant bycatch interactions	Southern California Bight	Annually for two years, June-November	PIER research vessel *R/V Malolo*, cooperative commercial fishing vessels	Modified swordfish buoy gear to target pelagic swordfish at depths of 250-400 meters during daylight hours	250-400 m mainline monofilament with a buoy flotation system and a 1-2 kilogram (kg) drop sinker. Two monofilament gangions would branch from the mainline at 250-400 m and would contain	300 - 600 sets per year	Minimize slack in the fishing line to maintain a vertical profile and use a high speed electric reel to reduce the time that baits are within the upper water column and minimize potential for marine mammal interactions. Use circle hooks to increase post-hooking survivorship of non-target species.

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
						a crimped 14/0 circle hook baited with either squid or mackerel. A single set of gear consists of two baited hooks soaked on average for a 4 hour period.		Visually monitor all of the indicator buoys from the vessel. When an indicator flag rises, the buoy set would immediately be tended and the animal caught would either be released or tagged and released in order to increase post-hooking survivorship of all animals.
White Abalone Survey	Remotely Operated Vessel (ROV) surveys of endangered white abalone to monitor population recovery. Surveys confined to offshore banks, island and continental margins, 30-150 m. depth.	Southern CA Bight	Opportunistically as funds and ship time are available 25 DAS	Charter vessel	Still and video camera images taken from an ROV	Tether connecting ROV to the ship is 0.75 inches diameter Avg. speed: 0.5 kts Max. speed: 2.4 kts	100 transects/yr	Slow operating speed minimizes risk of striking a marine mammal. The tether is securely attached to a steel cable and down-weight to minimize slack and prevent loops that might lead to entanglement risk.
Eastern Tropical Pacific Research Area								
Marine Mammal Surveys	Multi-year cetacean and ecosystem assessment study designed to monitor the recovery of several dolphin stocks that were depleted by the yellowfin tuna purse-seine fishery in the ETP Ocean. Sampling protocols include visual observations of marine mammals and seabirds.	Eastern Tropical Pacific Ocean	Tri-annually (Jul – Dec) 240 DAS total for three surveys	NOAA ships Two ship survey	Bongo plankton tows	Tow speed: 1.5 kts Duration: 20 min	500 tows	
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 30 min	500 casts	
					Oozeki, IKMT, MOCNESS, Tucker nets	Tow speed: 2-3 kts Duration: 20-60 min	50-125 tows	
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200, 333 kHz	Continuous	
					XBTs		720 units	
Antarctic Research Area								
Antarctic Survey	Shipboard surveys monitor the abundance and distribution of krill for stock assessments and studies of the foraging ecology of land-breeding penguin and fur seal populations. Protocols include marine mammal and seabird observations. Every 2-3 years these protocols are augmented with a bottom trawl	Scotia Sea sector of the Southern Ocean, including the continental shelf adjacent to the Antarctic Peninsula, and	Annually, January-March or Annually, July-October Bottom trawl conducted every 2-3 years 70 DAS	Charter (R/V Yuzhmorgeolgiya, R/V Moana Wave, R/V Ocean Stalwart)	Oozeki, IKMT, MOCNESS, Tucker nets	Tow speed: 2-3 kts Duration: 20-60 min	200 tows	
					Multi-frequency active acoustics	38, 70, 120 and 200 kHz	Continuous	
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 45 min	200 casts	
					Video camera tows	Tow speed: <3 kts Duration: <65 min	25 tows	

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
	used to sample benthic invertebrates and fish. Results of the survey inform fish stock assessments and benthic habitat descriptions.	the South Shetland, South Orkney, South Sandwich and South Georgia archipelagos			Two-warp NET Hard-Bottom Snapper Trawl	Tow speed: 2-3 kts Duration: 30 min	100 tows	

As Table 2.2-1 indicates, SWFSC fisheries research surveys are conducted in all seasons and within three primary geographic areas: the CCRA, the ETPRA, and ARA (see Figure 1.1-2).The gear types fall into several categories: pelagic trawl gear used at various levels in the water column, pelagic longlines with multiple hooks, bottom-contact trawls (ARA only), and other gear (various fine-meshed plankton nets, active and passive acoustic instruments, video recording equipment, Conductivity Temperature Depth [CTD] profiler, etc).

The Status Quo Alternative is to perform fisheries research as it was conducted from 2008 through 2012, which would require regulations and authorizations for incidental take of marine mammals under the MMPA and incidental take of protected species under the ESA. Under this alternative, the SWFSC would apply to NMFS' Headquarters Office of Protected Resources (OPR) requesting regulations governing the issuance of LOAs for incidental take of marine mammals under the MMPA. The OPR would make the necessary findings, and, if appropriate, promulgate regulations and issue LOAs to the SWFSC; the LOAs would likely prescribe mitigation measures intended to reduce the risk of potentially adverse interactions with marine mammals during the specified research activities.

In addition, both OPR and the SWFSC would engage in ESA Section 7 consultations with NMFS' Southwest Regional Office (and U.S. Fish and Wildlife Service [USFWS], as appropriate) for species that are listed as threatened or endangered. These consultations, when completed, may result in the development of one or more Biological Opinions (BiOps) that state the opinions of the services as to whether or not the federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The BiOps may contain incidental take statements (ITSs) for ESA-listed species that would include reasonable and prudent measures along with implementing terms and conditions intended to minimize the impact of incidental take of ESA-listed species during SWFSC research activities.

The Status Quo Alternative consists of the research activities described in Table 2.2-1 (see also Appendices A and B), including a suite of mitigation measures that were developed by the SWFSC in consultation with marine mammal scientists and other protected species experts. These mitigation measures have been implemented on SWFSC surveys since the 2008-2009 field seasons. These mitigation measures are anticipated to be required under the MMPA and ESA processes for the specified research activities conducted by the SWFSC. However, these mitigation measures may not be sufficient to reduce the effects of SWFSC activities on marine mammals and other protected species to the level of least practicable adverse impact (see Alternative 2).

The procedures described here are based on protocols used during previous SWFSC research surveys. These procedures are the same whether the survey is conducted on board a NOAA vessel or charter vessel. The SWFSC continually reviews its procedures and investigates options for incorporating new mitigation measures and equipment into its ongoing survey programs. Evaluations of new mitigation measures include assessments of their effectiveness in reducing risk to protected species. Implementation of any such measures must also be subject to safety and practicability considerations, allow survey results to meet research objectives, and maintain consistency with previous data sets.

2.2.1 Mitigation Measures for Protected Species

2.2.1.1 Trawl Surveys

1. Monitoring methods

- The officer on watch, Chief Scientist (or other designated member of the Scientific Party), and crew standing watch on the bridge visually scan for marine mammals, sea turtles, and other ESA-listed species (protected species) during all daytime operations. 7X bridge binoculars are used as necessary to survey the area as far as environmental conditions (lighting, sea state, precipitation, fog, etc.) will allow. A member of the crew designated to stand watch for protected species

(dedicated to that function) visually scans the waters surrounding the vessel at least 30 minutes before the trawl net is to be put into the water. This typically occurs during transit prior to arrival at the sampling station, but may also include time on station if other types of gear or equipment (e.g., bongo nets) are deployed before the trawl.

2. Operational procedures

- "Move-On" Rule. If any marine mammals or sea turtles are sighted anywhere around the vessel in the 30 minutes before setting the gear, the vessel may be moved away from the animals to a different section of the sampling area if the animals appear to be at risk of interaction with the gear at the discretion of the officer on watch. Small moves within the sampling area can be accomplished without leaving the sample station. After moving on, if marine mammals or sea turtles are still visible from the vessel and appear to be at risk, the officer on watch may decide to move again or to skip the station. The officer on watch will consult with the Chief Scientist or other designated scientist (identified prior to the voyage and noted on the cruise plan) and other experienced crew as necessary to determine the best strategy to avoid potential takes of these species. Strategies are based on the species encountered, their numbers and behavior, their position and vector relative to the vessel, and other factors. For instance, a whale transiting through the area and heading away from the vessel may not require any move, or may require only a short move from the initial sampling site, while a pod of dolphins gathered around the vessel may require a longer move from the initial sampling site or possibly cancellation of the station if the dolphins follow the vessel. In most cases, trawl gear is not deployed if marine mammals have been sighted from the ship in the previous 30 minutes unless those animals do not appear to be in danger of interactions with the trawl, as determined by the judgment of the Chief Scientist or officer on watch. The efficacy of the "move-on" rule is limited during night time or other periods of limited visibility; research gear is deployed as necessary when visibility is poor, although operational lighting from the vessel illuminates the water in the immediate vicinity of the vessel during gear setting and retrieval.
- Trawl operations are usually the first activity undertaken upon arrival at a new station in order to reduce the opportunity to attract marine mammals and other protected species to the vessel. However, in some cases, bongo or vertical nets may be deployed before the trawl in order to check for high densities of jellyfish and salps that may compromise the integrity of the trawl gear. Other exceptions include instances where trawls can only be conducted after night has fully fallen, but CTD's, bongo nets or other samples can be conducted during the crepuscular period (e.g., the juvenile rockfish survey). The order of gear deployment is determined on a case-by-case basis by the Chief Scientist based on environmental conditions and sonar information at the sampling site. Other activities, such as water sampling and most plankton tows, are conducted in conjunction with, or upon completion of, trawl activities.
- Once the trawl net is in the water, the officer on watch, Chief Scientist, or other designated scientist, and/or crew standing watch continue to monitor the waters around the vessel and maintain a lookout for marine mammal and sea turtle presence as far away as environmental conditions allow (as noted previously, visibility can be limited for various reasons). If these species are sighted before the gear is fully retrieved, the most appropriate response to avoid incidental take is determined by the professional judgment of the officer on watch, in consultation with the Chief Scientist or other designated scientist and other experienced crew as necessary. These judgments take into consideration the species, numbers, and behavior of the animals, the status of the trawl net operation (net opening, depth, and distance from the stern), the time it would take to retrieve the net, and safety considerations for changing speed or course. Consideration is also given to the increase in likelihood of marine mammal interactions during retrieval of the net, especially when the trawl doors have been retrieved and the net is near the surface and no longer under tension. Acoustic pingers and excluder devices are not operational

under these conditions. In some situations, risk of adverse interactions may be diminished by continuing to trawl with the net at depth until the marine mammals and/or sea turtles have left the area before beginning haul-back operations. In other situations, swift retrieval of the net may be the best course of action. The appropriate course of action to minimize the risk of incidental take of protected species is determined by the professional judgment of the officer on watch and appropriate crew based on all situation variables, even if the choices compromise the value of the data collected at the station.

- If trawling operations have been delayed because of the presence of marine mammals or sea turtles, the vessel resumes trawl operations (when practical) only when these species have not been sighted within 30 minutes or else otherwise determined to no longer be at risk. This decision is at the discretion of the officer on watch and is situationally dependent.
- Care is taken when emptying the trawl, including opening the cod end as close to the deck as possible in order to avoid damage to protected species that may be caught in the gear but are not visible upon retrieval. The gear is emptied as quickly as possible after retrieval in order to determine whether or not protected species are present.

3. Tow duration

- Standard tow durations have been reduced to 30 minutes or less at targeted depth, excluding deployment and retrieval time, to reduce the likelihood of attracting and incidentally taking protected species. These short tow durations decrease the opportunity for curious marine mammals to find the vessel and investigate. The resulting tow distances are typically 1 to 2 nautical miles, depending on the survey and trawl speed. Additionally, short tow times reduce the likelihood that captured sea turtles would drown.

4. Marine mammal excluder devices

- The SWFSC uses several different types of trawl nets for different surveys. The two types that have taken marine mammals in the past are the Nordic 264 and the Modified Cobb trawl. The Modified Cobb midwater trawl is smaller than the Nordic 264, is towed at slower speeds, at greater depths, and has historically had considerably lower rates of interactions with marine mammals compared to the Nordic 264 trawl which is generally operated closer to the surface. Currently, all Nordic 264 nets are outfitted with marine mammal excluder devices (MMEDs) developed for the SWFSC (Appendix A). Most marine mammals killed during SWFSC operations have been caught in surveys using this type of net before the excluder devices were installed. These excluder devices enable fish to pass through a grid and into the codend while preventing the passage of marine mammals, which contact the slanted grid and slide out through an escape opening or swim back out of the mouth of the net (See Appendix A).
- While this excluder device was designed to minimize small cetacean and pinniped mortalities in trawl gear, the design is an adaptation of turtle excluder devices used in trawl gears in the Atlantic and Gulf of Mexico. The SWFSC believes that due to its similar configuration to turtle excluder devices, the excluder device may also be effective at reducing sea turtle capture and mortality in mid-water trawls. To date, SWFSC has had no known interactions with sea turtles when using mid-water trawl gear with an excluder device in place, so further testing is needed to validate this hypothesis.
- The excluder device is an aluminum grate weighing 17 kilograms (38 pounds), 155 centimeters (cm) (61 inches) long and 112cm (44 inches) wide, with 12.7cm (5 inches) spacing on vertical bars. The excluder device is positioned at a 46-47 degree angle pointing upwards towards an escape panel in an intermediary section of netting sewn in just forward of the cod end. Additional details related to the design and construction of the MMED may be found in Appendix A and Dotson et al. 2010.

- Modified Cobb trawls have a different shape and functionality than the Nordic 264. The Modified Cobb trawl is smaller than the Nordic 264, is towed at slower speeds, at greater depths, and has historically had considerably lower rates of interactions with marine mammals compared to the Nordic 264 trawl which is generally operated closer to the surface. The Modified Cobb trawls do not yet have MMEDs, however, research and design work is currently being performed to develop effective excluders that will not appreciably affect the catch performance of the net and therefore maintain continuity of the fisheries research data set. Successful development and implementation of excluder devices for Modified Cobb trawls is expected to occur within the five-year timeframe of this EA. They are not currently part of standard surveys using this gear and are not considered to be part of the Status Quo Alternative. Use of MMEDs on Modified Cobb trawls is considered as part of the Preferred Alternative.
- The hard-bottom snapper trawl used in periodic Antarctic surveys has no history of interactions with marine mammals; marine mammal sightings during these surveys are rare. There are no MMEDs that have been developed for this type of snapper trawl and no work is being done to develop such devices.

5. Acoustic pinger devices

- Acoustic pingers are underwater sound emitting devices that decrease the probability of entanglement or unintended capture of marine mammals (see Appendix A). Acoustic pingers have been shown to effectively deter several species of small cetaceans from becoming entangled in gillnets. While their effectiveness has not been tested on trawls, pingers are believed to represent a mitigation measure worth pursuing given their effectiveness in other gears. They are deployed during all trawl operations using the Nordic 264 and Modified Cobb trawl nets. Two to four pingers are placed along the footrope and/or headrope to minimize marine mammal interactions.
- Pingers are manufactured by STM Products, model DDD-03H. Pingers remain operational at depths between 10 m and 200 m. Tones range from 100 microseconds to seconds in duration, with variable frequency of 5-500 kHz. The pingers generate a maximum sound pressure level of 176 decibels (dB) root mean square (RMS) referenced to 1 micropascal at 1m at 30-80 kHz.

6. Speed limits and course alterations

- Vessel speeds are restricted on research cruises in part to reduce the risk of ship strikes with marine mammals. Transit speeds vary from 6-14 knots, but average 10 knots. The vessel's speed during active sampling is typically 2-4 knots due to sampling design. Thus, these much slower speeds essentially eliminate the risk of ship strikes.
- As noted above, if marine mammals are sighted near the vessel within 30 minutes prior to deployment of the trawl net, the vessel will be moved away from the animals to a new station.
- At any time during a survey or in transit, any crew member that sights marine mammals that may intersect with the vessel course immediately communicates their presence to the bridge for appropriate course alteration or speed reduction as possible to avoid incidental collisions, particularly with large whales (e.g., blue whales).

2.2.1.2 Longline Gear

1. Visual surveillance by officer on watch, Chief Scientist, or other designated scientist, and crew

- Longline surveys are conducted aboard smaller vessels and with fewer crew members than trawl surveys but the monitoring procedures for longline gear are similar to those described for trawling gear. Some parameters, including the specific location on the vessel and the elevation above sea level from which the surveillance is conducted may be adapted to suit the size and design of the

particular vessel. However, surveillance would typically be performed from the wheelhouse or bridge of the vessel, using binoculars or another appropriate optical device.

2. Operational procedures

- The "move-on" rule is implemented if any protected species are present within sight of the vessel and appear to be at risk of interactions with the longline gear; longline sets are not made if marine mammals or sea turtles have been seen from the vessel within the past 30 minutes and appear to be in danger of interaction with the longline gear, as determined by the professional judgment of the Chief Scientist or officer on watch. The exception is for California sea lions, which are very common in the longline survey areas. Because they are so commonly seen but very infrequently interact with longline gear, small numbers of California sea lions may be visible from the vessel while the longline gear is set if the officer on watch decides that, because of their behavior or travel vector or other factors, they do not appear to be at risk of interaction with the longline gear. If groups of California sea lions are present, the "move-on" rule is applied and the vessel is moved until the sea lions are at a safe distance away from the setting operation, as determined by the professional judgment of the officer on watch.
- Longline gear is always the first equipment or fishing gear to be deployed when the vessel arrives on station. Longline gear is set immediately upon arrival at each station provided the conditions requiring the move-on rule have not been met.
- Hooks vary in size depending on the target species. For swordfish, 16/0 or 18/0 offset circle hooks (stainless steel) are used. Because the thresher shark survey targets pups, 13/0 offset circle hooks are used during that survey; use of larger circle hooks results in very low catch rates of shark pups. For mako and blue sharks, 9/0 J hooks continue to be used. This has been done because 1) sea turtles have not been taken during this survey and 2) during testing of circle hooks, target catch rates were substantially lower using circle hooks compared to J hooks.
- All SWFSC longline sets are conducted with pelagic gear (either anchored or drifting) marked at both ends with buoys (Appendix A). Typical sets are 2-4 hours. Circle hooks and finfish bait (mackerel or sardine) are used where possible to minimize sea turtle bycatch (the SWFSC has never caught sea turtles on longline gear).
- In shallow-set shark surveys, mainlines are set at a depth of 12 ft, which given the length of the gangions would allow a hooked turtle to reach the surface to breath. During swordfish sets, the mainline is set at a depth greater than 72 ft.
- If marine mammals or sea turtles are detected while longline gear is in the water, the officer on watch exercises similar judgments and discretion to avoid incidental take of these species with longline gear as described for trawl gear. The species, number, and behavior of the protected species are considered along with the status of the ship and gear, weather and sea conditions, and crew safety factors. The officer on watch uses professional judgment and discretion to minimize risk of potentially adverse interactions with protected species during all aspects of longline survey activities.
- If marine mammals or sea turtles are detected during setting operations and are considered to be at risk, immediate retrieval or halting the setting operations may be warranted. If setting operations have been halted due to the presence of these species, setting does not resume until no marine mammals or sea turtles have been observed for at least 30 minutes.
- If marine mammals or sea turtles are detected while longline gear is in the water and are considered to be at risk, haul-back is postponed until the officer on watch determines that it is safe to proceed. Adverse interactions with marine mammals, such as hooking and entanglement, are typically only observed during retrieval of the longline gear when hooks are close to the

surface. From limited observations it appears that marine mammals are attracted to fish caught on longline gear (rather than the bait) and on rare occasions are caught when they bite off too much of a hooked fish. Based on these observations, the SWFSC considers the haul back period to be the time when marine mammals are most likely to be caught in longline gear so extra caution is taken during this phase of sampling.

2.2.1.3 Plankton Nets, Small-mesh Towed Nets, Oceanographic Sampling Devices, Video Cameras, and Remotely Operated Vessel (ROV) Deployments

- The SWFSC deploys a wide variety of gear to sample the marine environment during all of their research cruises, such as plankton nets, oceanographic sampling devices, video cameras, and ROVs. These types of gear are not considered to pose any risk to protected species because of their small size, slow deployment speeds, and/or structural details of the gear and are therefore not subject to specific mitigation measures. However, the officer on watch and crew monitor for any unusual circumstances that may arise at a sampling site and use their professional judgment and discretion to avoid any potential risks to protected species during deployment of all research equipment.

2.2.1.4 Handling Procedures for Incidentally Captured Individuals

Marine Mammals

- Captured live or injured marine mammals are released from research gear and returned to the water as soon as possible with no gear or as little gear remaining on the animal as possible. Animals are released without removing them from the water if possible. Data collection is conducted in such a manner as not to delay release of the animal(s) and should include species identification, sex identification if genital region is visible, estimated length, disposition at release (e.g., live, dead, hooked, entangled, amount of gear remaining on the animal, etc.) and photographs. The Chief Scientist or crew should collect as much data as possible from hooked or entangled animals, considering the disposition of the animal; if it is in imminent danger of drowning, it should be released as quickly as possible. Under the Status Quo Alternative, NMFS could collect biological samples in accordance with section 109(h)(1) of the MMPA for live/dead marine mammals (non-listed)[12], or under a directed scientific research and enhancement permit.
- If a large whale is alive and entangled in fishing gear, the vessel should immediately call the U.S. Coast Guard (USCG) at VHF Ch. 16 and/or the appropriate Marine Mammal Health and Stranding Response Network. Entangled whales may be reported to the NOAA Fisheries entanglement reporting hotline (1-877-767-9425).

Sea Turtles

- SWFSC policy currently is to not retain killed sea turtles. Pending the outcome of consultation undertaken pursuant to section 7 of the ESA, sea turtle carcasses would be salvaged or biological data would be obtained from live turtles in accordance with established regulations (50 CFR 223.206 and 222.310). Only one sea turtle has been captured during SWFSC research activities and it was released alive. Captured live and injured sea turtles are handled in accordance with established handling procedures (Appendix D). Data collection includes species identification, length, weight, sex, visible injuries, disposition at release (e.g., live, dead, hooked, entangled, amount of gear remaining on the animal, etc.), photographs, and examination for presence of

[12] Section 109(h)(1) specifies that the MMPA does not prohibit Federal, State, or local government officials or an employee or person designated under section 112(c) of the MMPA from taking, in the course of his or her duties as an official, employee, or designee, a marine mammal in a humane manner (including euthanasia) if such taking is for (A) the protection or welfare of the mammal, (B) the protection of the public health and welfare, or (C) the nonlethal removal of nuisance animals.

Passive Integrated Transponder (PIT) tags. Crew may elect to install PIT tags or flipper tags in animals that have not already been tagged. Captured turtles are quickly processed and released in accordance with established handling procedures (50 CFR 223.206 (d)(1)).

2.3 ALTERNATIVE 2 - PREFERRED ALTERNATIVE - CONDUCT FEDERAL FISHERIES AND ECOSYSTEM RESEARCH (NEW SUITE OF RESEARCH) WITH MITIGATION FOR MMPA AND ESA COMPLIANCE

The Preferred Alternative is comprised of a combination of past research and additional, new research, and includes the same set of research surveys described in the Status Quo Alternative with the addition of a new survey in the ETPRA. Details of the additional survey are summarized in Table 2.3-1. Under this alternative, the SWFSC would also apply for authorizations under the MMPA and the ESA for incidental take of protected species during these research activities. The Preferred Alternative includes several additional research programs to test the efficacy, safety, and practicability of new techniques and equipment for fisheries research designed to reduce adverse impacts to protected species (conservation engineering and analysis). Under the Preferred Alternative, new mitigation protocols would be developed based on the results of this research. These new protocols would become mitigation measures during the period covered by this EA (2013-2018), pending the outcome of the following conservation engineering and analysis research programs for fisheries research:

- MMEDs for Modified Cobb trawl gear: The SWFSC will continue to design and develop excluder devices for use on Modified Cobb trawl gear. When one or more prototypes are built, sea trials will take place to test the new gear under actual operating conditions, including side by side or paired trawls with standard gear to test for differences in catchability. If all safety and development concerns can be addressed, the new excluder devices will be installed on Modified Cobb trawl gear as soon as practicable.
- Retrospective analysis of factors influencing incidental take of protected species: SWFSC staff have been using predictive machine-learning methods (classification trees) for various applications, including a recently published paper (Carretta and Barlow 2011) examining bycatch rates of cetaceans and pinnipeds in a commercial swordfish and thresher shark drift gillnet fishery in relation to the use of acoustic pingers. Using similar methods, the SWFSC plans to examine research trawl data for any link between trawl variables and observed marine mammal bycatch. SWFSC staff are currently reviewing historical fisheries research data to determine whether sufficient data exist for such an analysis. Some of the variables SWFSC is currently considering for this analysis are: moon phase, sky cover, pinger presence, trawl speed, vessel sonar use during trawl, use of deck lights, etc. SWFSC is exploring patterns in past marine mammal bycatch in its fisheries research surveys to better understand what factors might increase the likelihood of take. If take patterns emerge, the SWFSC will focus future research on reducing or eliminating high-risk factors in ways that enable scientifically important surveys to continue with minimized environmental impact.

Table 2.3-1 Summary description of a new survey in the ETPRA proposed under the Preferred Alternative

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Eastern Tropical Pacific Research Area								
HMS Survey	New survey planned for the future to monitor HMS abundance and distribution	Eastern Tropical Pacific Ocean	Annually, June-July 30 DAS	NOAA ship, Charter vessel	Pelagic longline	Mainline length: 2-4 mile set 50 to 75 feet deep for mako and blue sharks; 300 to 600 feet deep for swordfish Gangion length: 10-15 ft Gangionspacing: 50-100 ft apart Hook size and type: 9/0 J hooks for blue and mako sharks; 16/0 and 18/0 offset, stainless circle hooks for swordfish. Soak time: 2-4 hr	60 sets	Visual monitoring, "move-on" rule, operational adjustments to avoid take. Use of circle hooks where possible and finfish bait to minimize sea turtle bycatch.
					Bongo plankton tows	Tow speed: 1.5 kts Duration: 20 min	60 tows	
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 20-120 min	60 casts	
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200, 333kHz	Continuous	

2.3.1 Mitigation Measures for Protected Species

The Preferred Alternative also includes the same suite of mitigation measures described in the Status Quo Alternative to reduce the risk of adverse interactions with protected species but includes at least two and (as described previously) possibly several new mitigation measures that would be implemented in the time period covered by this EA, 2013-2018. The mitigation measures to be implemented in this Preferred Alternative are anticipated to be sufficient for and required by NMFS under MMPA and ESA authorizations for the specified research activities conducted by the SWFSC. In addition to the mitigation measures included in the Status Quo Alternative, the Preferred Alternative would include the following:

- The "move-on" rule will be modified for both trawl and longline gear to clarify and restrict when some of the decisions currently left to the professional judgment of the Chief Scientist or officer on watch may be made and situations when they may not be made. The Status Quo includes a monitoring zone limited only by environmental conditions (visibility factors) but the Chief Scientist or officer on watch may decide to set gear even if animals are seen if they consider the risk of interaction to be low (either because of the animals' distance, behavior, or trajectory).The Preferred Alternative will implement a one nautical mile (1.85 km) monitoring zone within which sets may not be made at the discretion of the Chief Scientist or officer on watch. The crew assigned to monitor for marine mammals or sea turtles will use one or more methods (e.g., reticulated binoculars) to determine the distance of protected species seen from the vessel during daytime and the best available means during nighttime observations. If any protected species are seen within 1 nautical mile of the vessel within the 30 minutes prior to the trawl or longline gear being set, the vessel will be moved to at least 1 nautical mile away from the animals before gear is set. If the vessel is moved to avoid animals monitoring will continue, but the 30 minute monitoring period requirement will be waived; gear may be deployed immediately upon arrival at the new position, provided that no marine mammals or sea turtles are detected within 1 nautical mile. Professional judgment will still be considered but only for decisions involving animals more than 1 nautical mile from the vessel; in such cases the Chief Scientist or officer on watch may decide to move the vessel or delay setting gear if they consider the animals to be at risk of interacting with the gear even if they are farther away than 1 nautical mile (e.g., they are on a trajectory to intercept the vessel and are species known to interact with gear).
- One exception applies to this modified "move-on" rule for longline surveys only. Due to the prevalence of California sea lions in the areas where longline surveys are conducted in the California Current Research Area, it would be impractical to apply the move-on rule whenever a California sea lion is seen within 1 nautical mile of a research vessel during the 30 minute period preceding deployment of longline gear. This exception has been defined considering the rarity of past interactions between this gear and California sea lions and in order to make this mitigation measure practicable to implement. Without it, given the density of California sea lions in the areas where longline surveys are conducted, the SWFSC believes implementing the move-on rule for a single animal would preclude sampling in some areas and introduce significant bias into survey results. For California sea lions only, the vessel would not be required to move if a group of five or fewer animals is sighted during the watch period within 1 nautical mile of the set location. The SWFSC believes this exception to the move-on rule would allow sampling for target species without increasing the number of interactions between marine mammals and research longline gear. If more than five California sea lions are seen within 1 nautical mile, the vessel will be moved at least 1 nautical mile away from the animals before the gear is set. As described above, the officer on watch may also choose to move the vessel before setting gear if they consider the risk of interaction to be too high even if the conditions of the "move-on" rule are not met.

- If seabird interactions with longline gear are documented in the future, the SWFSC will revisit whether use of streamer lines is warranted given the tradeoffs between the potential conservation benefit and operational and safety considerations.
- The SWFSC will initiate a process for its Chief Scientists and vessel captains to communicate with each other about their experiences with protected species interactions during research work with the goal of improving decision-making regarding avoidance of adverse interactions. As noted above, there are many situations where professional judgment is used to decide the best course of action for avoiding marine mammal interactions when research gear is in the water. The intent of this mitigation measure would be to draw on the collective experience of people who have been making those decisions, provide a forum for the exchange of information about what went right and what went wrong, and try to determine if there are any rules-of-thumb or key factors to consider that would help in future decisions regarding avoidance practices. The SWFSC would coordinate not only among its staff and vessel captains but also with those from other fisheries science centers with similar experience. The initial process would focus on discussing past experiences but the goal would be to develop a training program for both new and experienced crew members. Training programs would be conducted on a regular basis and would include topics such as monitoring and sighting protocols, species identification, decision-making factors for avoiding take, procedures for handling and documenting protected species caught in research gear, and reporting requirements. These topics are currently covered under existing NMFS training programs for the commercial fisheries Observer Program. The SWFSC will examine the Observer Program training material and incorporate elements of that training appropriate for their research crews. This proposed new training program would be developed with guidance from NMFS' Southwest Regional Office Protected Resources Division, and would formalize and standardize the information provided to all crew that might experience protected species interactions during research activities.

2.3.2 Handling Procedures for Protected Species

Another difference between the Status Quo and the Preferred Alternative involves handling and data collection procedures for incidentally captured marine mammals. Under Alternative 2, the Chief Scientist or other designated scientists will participate in the commercial fisheries Observer Training Program currently conducted by NMFS Southwest Regional Office. This formalized training will provide the Chief Scientist or other designated scientists the instructions necessary for determining the severity of injuries to marine mammals. The SWFSC will work with the Southwest Regional Office to customize these trainings to meet their particular needs.

Certain types of data are needed to evaluate the severity of a particular injury. The Chief Scientist or other designated scientists will collect biological information from captured, live marine mammals before they are released, including species identification, sex identification (if genital region is visible), estimated length, and photographs. This information will be recorded on standardized regional commercial fishery observer forms. If the safety of the crew or the captured animal would be compromised by this data collection effort, however, the animal will be immediately released. The Chief Scientist will submit data on all captured animals to marine mammal experts at the appropriate NMFS Science Center who will use specific criteria to determine whether the injury is considered serious (i.e., more likely than not to result in mortality). If insufficient data has been collected for any reason, the marine mammal experts may not be able to determine the severity of the injury. However, the marine mammal experts may use other types of information to assign the injury to either the serious or non-serious categories for reporting and stock assessment purposes. These injury assessments would also affect the classification of takes for MMPA and ESA compliance purposes. The Chief Scientist or other designated scientist would be required to remove as much gear as possible from an animal before release. Gear remaining on an animal that has the potential to cause future entanglements generally increases the chances that an injury will be serious.

Human safety is paramount when considering whether and how to disentangle or dehook a marine mammal.

2.3.3 Unknown Future SWFSC Research Activities

In addition to the activities identified above, the SWFSC may propose additional surveys or research activities within the timeframe covered by this programmatic analysis. Because of the annual cycle under which decisions to fund and/or conduct research are made, the SWFSC cannot identify in advance all the potential future activities that may take place over the next five years. For purposes of this programmatic analysis, NMFS has examined the research activities that have occurred from 2008-12 and used this information as a proxy for future proposed research activities that may occur through 2018.Taken together, these activities comprise the actions evaluated within this programmatic EA under the Preferred Alternative.

Over the next five years, as future congressional appropriations and NMFS fisheries research budgets are established, the SWFSC will examine the proposed future research to determine if the activities are consistent with the scope of actions considered under the Preferred Alternative. To be considered 'within scope' under this programmatic EA, future proposals for specific research projects must be consistent with the gear types, spatial/temporal distribution of research activities, and types of effects analyzed within this document. If future research projects are not consistent with the type or scope of fisheries research activities analyzed in this EA, they will be subject to additional NEPA, ESA, and MMPA evaluations.

More specifically, the basic methodology used to evaluate any proposed future research activity will be as follows:

1. **Evaluate the activity to determine if it would be conducted within the geographic scope of the region evaluated in the EA.** The evaluation described in Chapter 4 of this EA is based on the historic spatial distribution of research surveys. Any future research activities proposed within the geographic areas described in Chapter 4 would pass this step of the evaluation. The geographic scope of this EA is extensive, but some areas (e.g., areas with permanent exclusions) were not subject to research surveys and are not included in this evaluation. Any proposed research in those areas would require additional evaluation.
2. **Evaluate the seasonal distribution of the activity**. The activities evaluated in this EA are conducted throughout the year but certain surveys are only conducted in specific time frames/seasons. If a program was proposed that was similar in methodology to past surveys but significantly shifted the timing of research activities from what was analyzed in this EA, additional evaluation may be required.
3. **Evaluate the gear types proposed**. The gear types that were included in the analysis are described in Appendix A. If the proposed future research activity used the same or similar gear in the same manner analyzed in this EA, then the research activity would fall within the analysis conducted. The research activity would not have to exactly match the descriptions in this EA, because the same impacts would be expected from similar gear types and activities. For example, if a new side-scan sonar were to be deployed, but the signal strength and frequency were within the ranges evaluated for bottom sounding sonar evaluated in this EA, then the impacts would be similar because only the area swept by the sonar would be changing. If a new type of gear was to be deployed, or if a gear type was to be used in substantially different ways than described, environmental impacts not considered in this EA could result and additional NEPA analysis would be required.

To reiterate, any proposed action 1) conducted in regional areas described in this EA, 2) during times of the year considered, and 3) using gear types and methods generally equivalent to the methods evaluated,

would be considered covered by the conclusions drawn in this EA. If future proposed research activities, projects, or programs are not consistent with the type or scope of fisheries research activities analyzed in this EA, they would be subject to additional NEPA evaluations.

2.4 ALTERNATIVE 3 - MODIFIED RESEARCH ALTERNATIVE – CONDUCT FEDERAL FISHERIES AND ECOSYSTEM RESEARCH (NEW SUITE OF RESEARCH) WITH ADDITIONAL MITIGATION

Under Alternative 3, the SWFSC would continue fisheries research as described in Section 2.2 and Appendix A and would apply for authorizations of incidental take of protected species under the MMPA and the ESA. Alternative 3 would include all of the same mitigation measures required by the MMPA and ESA authorization procedures as described for the Preferred Alternative. The difference between Alternative 3 and the Preferred Alternative is that Alternative 3 includes a number of additional mitigation measures derived from a variety of sources including: (1) comments submitted from the public on similar fisheries actions, (2) discussions within NMFS as a part of the proposed rulemaking process, and (3) a literature review of past and current research into potential mitigation measures. The new suite of research activities is a combination of past research and additional, new research, as described for the preferred alternative.

As described in the Preferred Alternative, the SWFSC continually reviews its procedures and investigates options for incorporating new mitigation measures and equipment into its ongoing survey programs. Evaluating new mitigation measures includes assessing their effectiveness in reducing risk to protected species, but measures must also: pass safety and practicability considerations, meet survey objectives, allow survey results to remain consistent with previous data sets, and be consistent with the purpose and need for SWFSC research activities (Section 1.3). Some of the mitigation measures considered in this alternative (e.g., no night fishing or broad spatial/temporal restrictions) would essentially prevent the SWFSC from collecting data required to provide for fisheries management purposes under the Magnuson-Stevens Fishery Conservation and Management Act. Some research surveys necessarily target fish species that are preyed upon by marine mammals with an inherent risk of interactions with marine mammals during these surveys. The SWFSC acknowledges the inherent risk of these surveys (e.g., the CPS survey, juvenile salmon survey, and juvenile rockfish survey), and it has implemented a variety of measures to mitigate that risk. The SWFSC currently has no viable alternatives to collecting the data derived from these surveys and does not propose to implement potential mitigation measures that would preclude continuation of these surveys, such as the elimination of night surveys or use of pelagic trawl gear. An analysis of the potential efficacy and practicability of the additional mitigation measures considered in this alternative is presented in Section 4.4.

The secondary federal action covered under this EA is the issuance of requested regulations and subsequent Letters of Authorization under Section 101(a)(5)(A) of the MMPA that would govern the unintentional taking of small numbers of marine mammals incidental to the SWFSC's research activities. In order to authorize incidental take of marine mammals under the MMPA, NMFS must identify and evaluate a reasonable range of mitigation measures to minimize impacts to marine mammals to the level of "least practicable adverse impact." As described above, some mitigation measures could prevent the SWFSC from maintaining the utility of ongoing scientific research efforts, and those mitigation measures would normally be excluded from consideration in the EA under screening criteria 3 (Section 2.1). However, such mitigation measures would likely be considered during the MMPA incidental take authorization process and/or ESA Section 7 consultation and are therefore considered under Alternative 3 in this EA.

2.4.1 Additional Mitigation Measures for Protected Species

2.4.1.1 Trawl Surveys

1. Monitoring methods

Visual observations (using bridge binoculars as needed) by the officer on watch, Chief Scientist or other designated scientist, and crew standing watch are currently the primary means of detecting protected species in order to avoid potentially adverse interactions. However, there are other detection methods that have been used in commercial fisheries, naval exercises, and geotechnical exploration that could be considered. These additional types of detection methods would be intended to be used in specific circumstances, such as operating at night or in low visibility conditions.

- Visual surveillance by dedicated protected species observers. This measure would require the SWFSC to use trained protected species observers whose dedicated job is to detect the presence of marine mammals and other protected species within the survey area and communicate their presence to ship operations personnel. This dedicated observer position would be different than having marine mammal and/or bird biologists on board whose job is to conduct abundance and distribution surveys (as is currently the practice on CalCOFI and other surveys). Considerations include the use of dedicated observers for all surveys or during trawl surveys of particular concern.
- Use of a camera or underwater video system to monitor any interactions of protected species with the trawl gear. Underwater video technology may allow the SWFSC to determine the frequency of interactions with the trawl gear and to evaluate the effectiveness of a measure's ability to mitigate injurious or lethal interactions.
- Use of passive acoustic monitoring for marine mammal vocalizations to aid in the detection of marine mammals present in the survey area and to implement appropriate modifications of trawl operations.
- Use of aircraft, unmanned aerial vehicles, or autonomous underwater gliders to provide additional detection capabilities.
- Use of infrared (IR) technologies to detect marine mammals.
- Use of night-vision devices to detect marine mammals.

2. Operational restrictions

- This measure would require the SWFSC to suspend trawl operations at night or during periods of low visibility (including fog and high sea state) to minimize interactions with marine mammals that would be difficult to detect by visual monitoring.
- Video sampling with an open cod end: The SWFSC would investigate the use of video cameras to identify fish and their encounter rates in lieu of a closed cod end on pelagic trawls, which may take protected species as well as target fish. This approach would be appropriate for swept area surveys designed to determine the density of fish or verification of acoustic target identification (e.g., all surveys). However, it would not be appropriate for surveys designed to determine the reproductive condition of adult fish (e.g., Coastal Pelagic Species [CPS] surveys) or the growth rates of fish (e.g., juvenile salmon surveys) as these measurements require the dissection of specimens. Considerable insight and experience may be gained by experimenting with open cod end trawls and associated high-resolution, high-speed video cameras, particularly with real-time video feeds to the ship. In some cases this experience could lead to routine use of cameras instead of capture. In other situations the number of closed cod end trawls required for estimating vital rates could be reduced. While it would not be the primary objective, video camera data may also

provide documentation of protected species interactions with trawl gear and may thus provide insight into the efficacy of other measures intended to reduce the interactions with protected species (e.g., excluder devices or acoustic pingers).

3. Acoustic and visual deterrents

- This measure would require the SWFSC to use deterrents, such as recordings of predator vocalizations (e.g., killer whale) to deter interactions with trawl gear, or use visual deterrence techniques (e.g., lights, light sticks, reflective twine/rope) to reduce marine mammal interactions with the gear.

4. Temporal or geographic restrictions

- Spatial/temporal restrictions are one of the most direct means of reducing adverse impacts to protected species. By reducing the overlap in time and space of the survey's footprint with known concentrations of protected species, the SWFSC may reduce the amount of incidental take of such species. This measure would require the SWFSC to identify areas and times that are most likely to result in adverse interactions with protected species (e.g., areas of peak abundance) and to avoid, postpone, or limit their research activity to minimize the risk of such interactions with protected species as long as such spatial/temporal restrictions do not conflict with the ability of the SWFSC to conduct scientifically valid surveys and to provide the best scientific information available for purposes of managing commercial fisheries. This may include limits on specific locations, physical or oceanographic features, biologically important times, and/or gear types.
- Avoidance of federal and state marine protected areas. This measure would disallow or restrict SWFSC trawl surveys in federal and/or state marine protected areas (Section 3.1.2.4).

2.4.1.2 Longline Gear

1. Monitoring methods

- Visual surveillance by independent protected species observers. This measure would require the SWFSC to use trained, independent, protected species observers on each longline survey to detect the presence of marine mammals and other protected species within the survey area. Considerations include the use of independent observers for all surveys or during longline surveys of particular concern.

2. Operational procedures

- Decoy vessels. This measure would require use of a decoy research vessel playing prerecorded longline fishing sounds to distract marine mammals away from the fishing grounds.
- Streamer lines. Under this measure, the SWFSC would deploy streamer lines before longline gear is set to mitigate the risk of catching seabirds. Deploying streamer lines on each side of the baited longline to discourage seabirds from diving on baited hooks has been proven effective in reducing seabird bycatch in other Pacific fisheries (Melvin et al. 2001).

3. Acoustic deterrents

- This measure would require the SWFSC to use deterrents such as acoustic pingers or recordings of predator vocalizations (e.g., killer whale) to deter interactions with longline gear.

4. Visual deterrents

- This measure would require the crew to use visual deterrence techniques (e.g., lights, light sticks, reflective twine/rope, or marked lines) to make the longline gear more detectable thereby reducing the likelihood of hooking or entangling a marine mammal. Note that lights and light

sticks are prohibited for use on longline gear in some Pacific fisheries as they may contribute to increased turtle bycatch.

2.5 ALTERNATIVE 4 – NO RESEARCH ALTERNATIVE - NO FIELDWORK FOR FEDERAL FISHERIES AND ECOSYSTEM RESEARCH CONDUCTED OR FUNDED BY SWFSC

Under the No Research Alternative the SWFSC would no longer conduct or fund fieldwork for the fisheries and ecosystem research considered in the scope of this EA in marine waters of the California Current, Eastern Tropical Pacific, or Antarctic Research Areas. This moratorium on fieldwork would not extend to research that is not in scope of this EA, such as directed research on marine mammals and ESA-listed species covered under separate research permits and NEPA documents. NMFS would need to rely on other data sources, such as fishery-dependent data (e.g., harvest data) and state or privately supported fishery-independent data collection surveys or programs to fulfill its responsibility to manage, conserve and protect living marine resources in the U.S. Under this alternative, organizations that have participated in joint research programs may or may not continue their research efforts depending on whether they are able to secure alternative sources of funding. Any non-federal fisheries research would occur without NMFS funding, direct control of program design, or operational oversight. It is unlikely that these non-NMFS fisheries research surveys would be consistent with the time series data NMFS has collected over many years, which is the core information supporting NMFS' science and management missions and vital to fishery management decisions made by the Fishery Management Councils, NMFS, and other marine resource management institutions, leading to greater uncertainty for fishery and other natural resource management decisions.

Currently, fisheries and marine ecological research is also being conducted by state agencies, other international agencies, and research institutes in the three SWFSC research areas, sometimes with funding support from the SWFSC. However, this research is generally confined to state waters and near-shore ocean areas and does not cover many fisheries topics currently investigated by the SWFSC. Under the No Research Alternative, it is unlikely that any of the state or other institutional research programs would be able to undergo the fundamental realignment of budgets and scientific programs necessary to maintain the level and continuity of information currently provided by the SWFSC. No agencies or other entities would likely conduct marine research to replace the research abandoned by the SWFSC in the three research areas under the No Research Alternative.

2.6 ALTERNATIVES CONSIDERED BUT REJECTED FROM FURTHER ANALYSIS

As stated previously, the alternatives evaluated in an EA must achieve the purpose and need of the proposed action without violating any of the applicable laws and regulations described in Chapter 6 and summarized in section 1.6. Other potential alternatives that do not satisfy the agency's purpose and need, or would not meet minimum environmental standards, are not considered reasonable and need not be carried forward for evaluation in an EA. The following alternatives were considered but rejected because they do not meet the purpose and need as stated in Section 1.3 or the screening criteria described in Section 2.1.

2.6.1 Sole Reliance on Commercial Fishery Data

One alternative that NMFS considered was to rely solely on commercial fisheries data such as Catch Per Unit Effort, seasonal and geographic distribution of harvests, and other harvest data to assess the status of commercially important stocks. This alternative was rejected from further analysis because it would not provide sufficient information on the age/size class structure of exploited fish stocks and would be insufficient to track fish population dynamics or provide other types of predictive capabilities required to manage the fisheries. This approach would also not meet the need to maintain a standardized, objective, and unbiased sampling approach provided by independent surveys.

Conclusion: This alternative does not meet screening criteria 1 or 3. It would not meet statutory obligations because directed research activities would not be conducted. It would not maintain scientific integrity of research programs because the results would not maintain the consistency of data with prior research efforts. For these reasons this alternative is not carried forward for detailed evaluation.

2.6.2 New Methodologies

Another alternative considered was to adopt other types of survey methodologies or develop new methodologies based primarily on their potential to eliminate or greatly reduce interactions with protected species or effects on habitat, as opposed to adopting new methods and gear for fisheries research purposes. Although NMFS continues to place a high priority on avoiding adverse interactions with protected species and is continually reviewing potential mitigation measures for research activities, the purpose and need for conducting fisheries research requires future sampling methodologies be consistent with past data sets to maintain long-term trend analyses for commercially fished and ecologically important species. NMFS is currently evaluating alternative sampling methods for fisheries and marine ecosystem research, some of which may reduce the potential for incidental takes of protected species or effects on benthic habitats. However, these new methodologies will be evaluated primarily for consistency with the purpose and need for fisheries and marine ecosystem research and whether they provide information that can build on and supplement past data sets.

Conclusion: This alternative did not meet screening criterion 3. It would not maintain scientific integrity of research programs because the results would not maintain the consistency of data with prior research efforts. Therefore, this alternative is not carried forward for detailed evaluation.

2.6.3 Alternative Research Program Design

In this alternative the types of research conducted would be revised to determine if alternative levels of a particular research would result in different levels of impacts. This alternative would emphasize minimizing potential adverse environmental impacts when designing research activities. Other factors, such as maximizing efficient use of scientific research funding and maintaining the integrity of long-term data sets, would not be considered in this approach.

Conclusion: This alternative was rejected because it would not meet screening criterion 3 and would intrude on inherently technical and scientific decisions. Therefore, this alternative is not carried forward for detailed evaluation.

AFFECTED ENVIRONMENT CHAPTER 3

3.1 PHYSICAL ENVIRONMENT

The geographic areas and physical environments potentially affected by the Southwest Fisheries Science Center's (SWFSC's) research surveys are located throughout the Pacific Ocean and in the Southern Ocean off Antarctica. These areas include the California Current, Eastern Tropical Pacific Ocean, and Antarctic ecosystems. SWFSC research surveys occur both inside and outside the United States Exclusive Economic Zone, and sometimes span across multiple ecological, physical, and political boundaries.

3.1.1 Large Marine Ecosystems

Large Marine Ecosystems (LMEs) are large areas of coastal ocean space. LMEs generally include greater than 200,000 square kilometers (km^2) of ocean surface area, and are located in coastal waters where primary productivity is generally higher than in open ocean areas. LME physical boundaries are based on four ecological criteria: bathymetry, hydrography, productivity, and trophic relationships. Based on these four criteria, 10 LMEs have been delineated for the coastal marine waters of the U.S., and a total of 64 distinct LMEs have been delineated around the coastal margins of the Atlantic, Pacific and Indian Oceans (Sherman et al. 2004). Figure 3.1-1 shows the world's LMEs as defined at www.lme.noaa.gov. Each color represents a distinct LME.

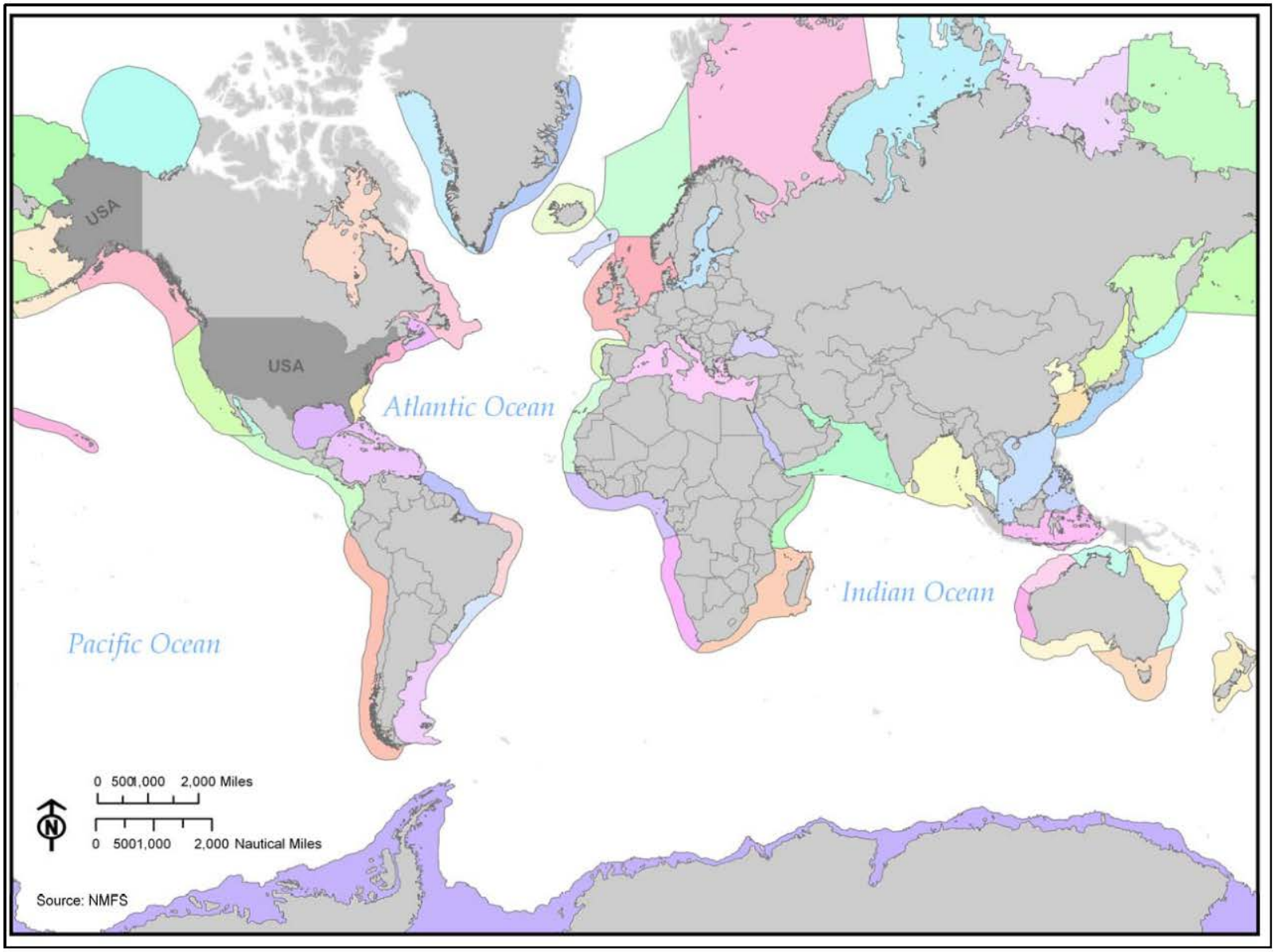


Figure 3.1-1 Large Marine Ecosystems of the World.

Globally, LMEs are the source of 80 to 95 percent of the world's marine fish harvest, and are centers of economic activity for oil and gas, shipping, and tourism industries. The LME concept provides a practical framework for the application of ecosystem-based approaches to fisheries assessment and management, habitat restoration, and research on pollution and ecosystem health. NMFS has implemented a management approach designed to improve the long-term sustainability of LMEs and their resources by using practices that focus on ensuring the sustainability of the productive potential for ecosystem goods and services. For more detailed information on the LME management concept and trends in ecosystem health, see *The UNEP* [United Nations Environmental Program] *Large Marine Ecosystem Report: A perspective on changing conditions in LMEs of the world's Regional Seas* (Sherman and Hempel 2008).

SWFSC's fisheries research activities take place in three primary research areas: the California Current Research Area (CCRA), the Eastern Tropical Pacific Research Area (ETPRA), and the Antarctic Research Area (ARA), which are described in detail in the following sections. These areas include sections of several coastal LMEs, including the California Current LME, the Gulf of California (Sea of Cortez) LME, the Pacific-Central American Coastal LME, the Humboldt Current LME, and the Antarctica LME. However, a substantial amount of the SWFSC fisheries research activities are also conducted in offshore areas that lie outside of the coastal LME boundaries.

3.1.1.1 California Current

The SWFSC conducts research surveys in the CCRA, both inside and outside of the LME boundaries. The California Current LME has a surface area of about 2.2 million km² and is bordered by the U.S. and Mexico. The California Current moves south along the western coast of North America, beginning off southern British Columbia, flowing southward past Washington, Oregon and California, and ending off southern Baja California (Bograd *et al*. 2010). The California Current is part of the North Pacific Gyre and brings cool waters southward. Additionally, extensive upwelling of colder sub-surface waters supports large populations of whales, seabirds and important fisheries along the west coast of the U.S. (Sherman and Hempel 2008). The California Current LME includes coastal areas where SWFSC conducts research surveys for rockfish, coastal pelagics and numerous other species. However the SWFSC also conducts research that extends into deeper waters beyond the California Current LME boundary.

On the shoreward side of the California Current, the California Current Front separates cold low-salinity upwelled waters from the warmer saltier waters close to shore. Offshore frontal filaments transport the frontal water across the entire LME. In winter, the Davidson Current Front forms along the boundary between inshore subtropical waters and colder offshore temperate and subarctic waters (see Figure 3.1-2) (Sherman and Hempel 2008).

The California Current determines the general hydrography off the coast of California. The current is related to the anticyclonic circulation of the central North Pacific. In general, an area of divergence parallels the coast of California, with a zone of convergence 200-300 kilometers (124-186 miles) from the coastline. Surface flow of the California Current appears to be diverted offshore at Point Conception and again at Punta Eugenia, while semi-permanent eddies exist south of these headlands. These eddies contribute to the recruitment of pelagic larvae to the adult species populations in these areas (Hewitt 1981).

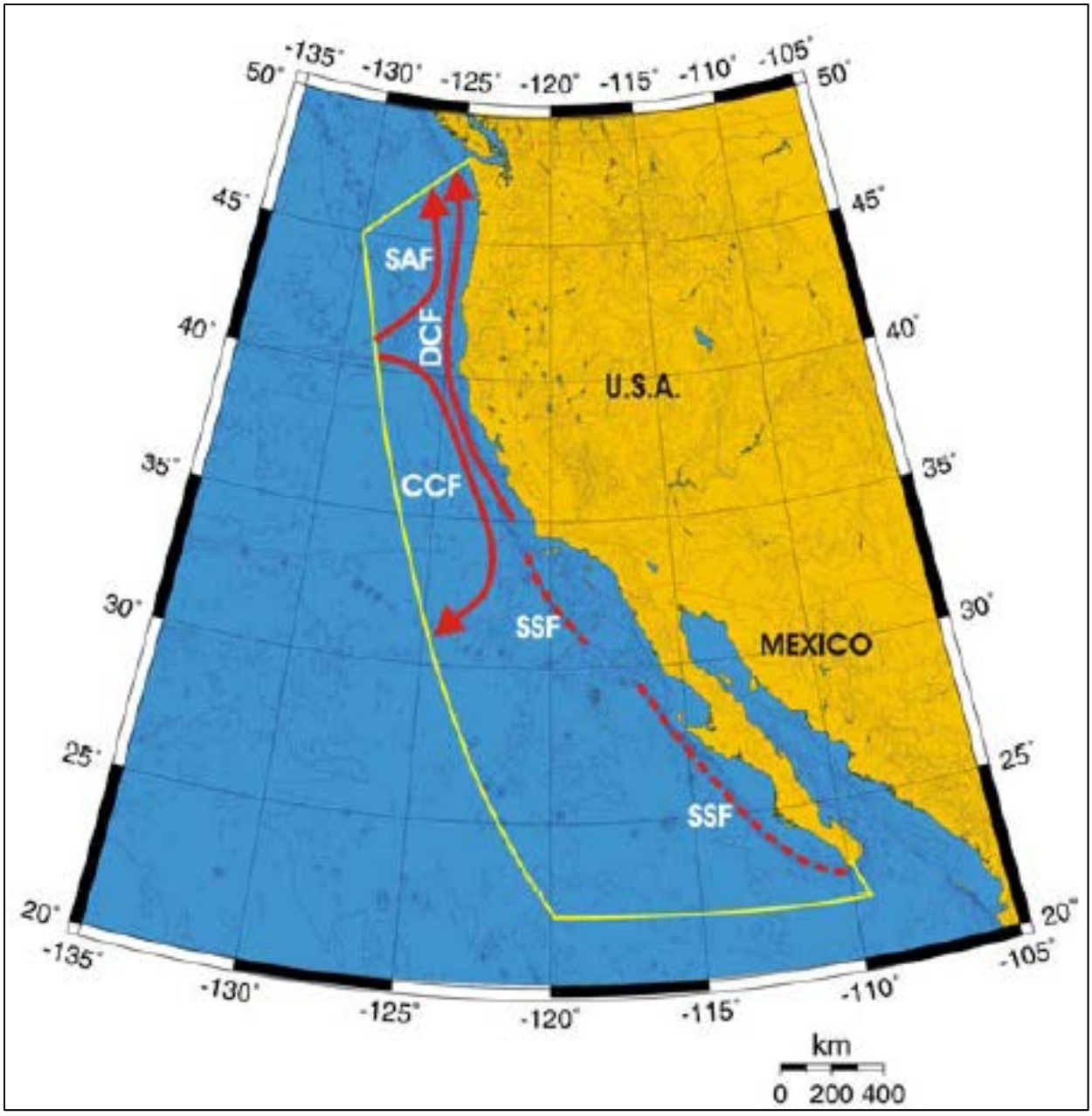


Figure 3.1-2 Oceanographic Fronts of the California Current.

Figure 3.1-2 shows the California Current Front (CCF), Davidson Current Front (DCF), Subarctic Front (SAF), Shelf Slope Front (SSF), and the California Current LME boundary (yellow line) (from Sherman and Hempel 2008; Belkin et al. 2009).

3.1.1.2 Eastern Tropical Pacific Ocean

The eastern tropical portion of the Pacific Ocean extends from San Diego west to Hawaii and south to Peru. Located between the subtropical gyres of the North and South Pacific, this area is one of the most productive tropical oceans in the world. Cool, low-salinity eastern boundary current waters flow into the ETP from the north and south, while warm, high-salinity subtropical surface waters flow into the ETP after being subducted into the thermocline primarily in the southern Subtropical Convergence. As a result of upwelling, the surface layer has relatively cool temperatures, high salinity, and high nutrient concentrations along the equator, coastal Peru and Baja California, and at the Costa Rica Dome. Nutrient-rich thermocline waters lie close to the surface along the countercurrent thermocline ridge between the North Equatorial Countercurrent and the North Equatorial Current. Deep and bottom waters formed in the Antarctic and North Atlantic are relatively homogeneous in the ETP (Fiedler and Lavın 2006).

The SWFSC's ETP Research Area spans the boundaries of several LMEs, including the California Current LME, the Gulf of California (Sea of Cortez) LME, the Pacific-Central American Coastal LME, and the Humboldt Current LME. The Research Area also includes a large portion of the offshore ETP Ocean outside of coastal LME boundaries (Sherman and Hempel 2008).

3.1.1.3 Antarctic

The Antarctic region includes the waters encircling Antarctica south of 60°S latitude. Cold waters flowing north from Antarctica mix with warm sub-Antarctic waters in the Antarctic Ocean. The Antarctic Circumpolar Current moves eastward and comprises the world's longest ocean current. There are only limited areas of shallow waters in the Southern Ocean, where the average depth is between 4,000 and 5,000 meters (13,000 to 16,000 feet) over most of its extent. The continental shelf is unusually deep, averaging 450 meters (1,462 feet) and in places measuring over 1,000 meters (3,250 feet) deep.

The Southern Ocean seafloor is primarily composed of siliceous ooze formed over thousands of years from dead phytoplankton deposits (Griffiths 2010). The Southern Ocean continental shelf sediments are predominantly a combination of glacial deposits and diatomaceous muds (Griffiths 2010). Shelf faunas are characterized by a high degree of endemism, approaching 90 percent in taxa such as sponges, peracarid crustaceans, and some gastropod families (Brandt et al. 2004). Benthic sampling has largely been restricted to the shelf and less is known about the fauna of the deeper waters of the Southern Ocean, including the Scotia and Weddell seas. Deep sea meiofaunal studies in the Southern Ocean indicate nematodes, harpacticoid copepods and foraminiferans are abundant and widely distributed (Brandt et al. 2004). The keystone species of the Antarctic ecosystem is the Antarctic krill, which provides an important food source for many species of marine mammals, sea birds, and fishes (SWFSC 2010). The SWFSC's ARA survey activities are usually conducted within the Antarctic LME, which is defined by the Antarctic Convergence. The location of the Antarctic Convergence oscillates between 48 and 60 degrees south and represents the boundary between cold Antarctic surface water and warmer sub-Antarctic waters (Sherman and Hempel 2008).

3.1.2 Special Resource Areas

3.1.2.1 Essential Fish Habitat

Essential Fish Habitat (EFH) is comprised of the waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (16 United States Code [U.S.C.] §1802 sec. 3(10)). Regulatory guidelines explain that EFH should be sufficient to "support a population adequate to maintain a sustainable fishery and the managed species' contributions to a healthy ecosystem" (50 Code of Federal Regulations [CFR] § 600, subpart J). EFH applies to federally managed species in both state and federal jurisdictional waters throughout the range of the species within U.S. waters. Where a species' range

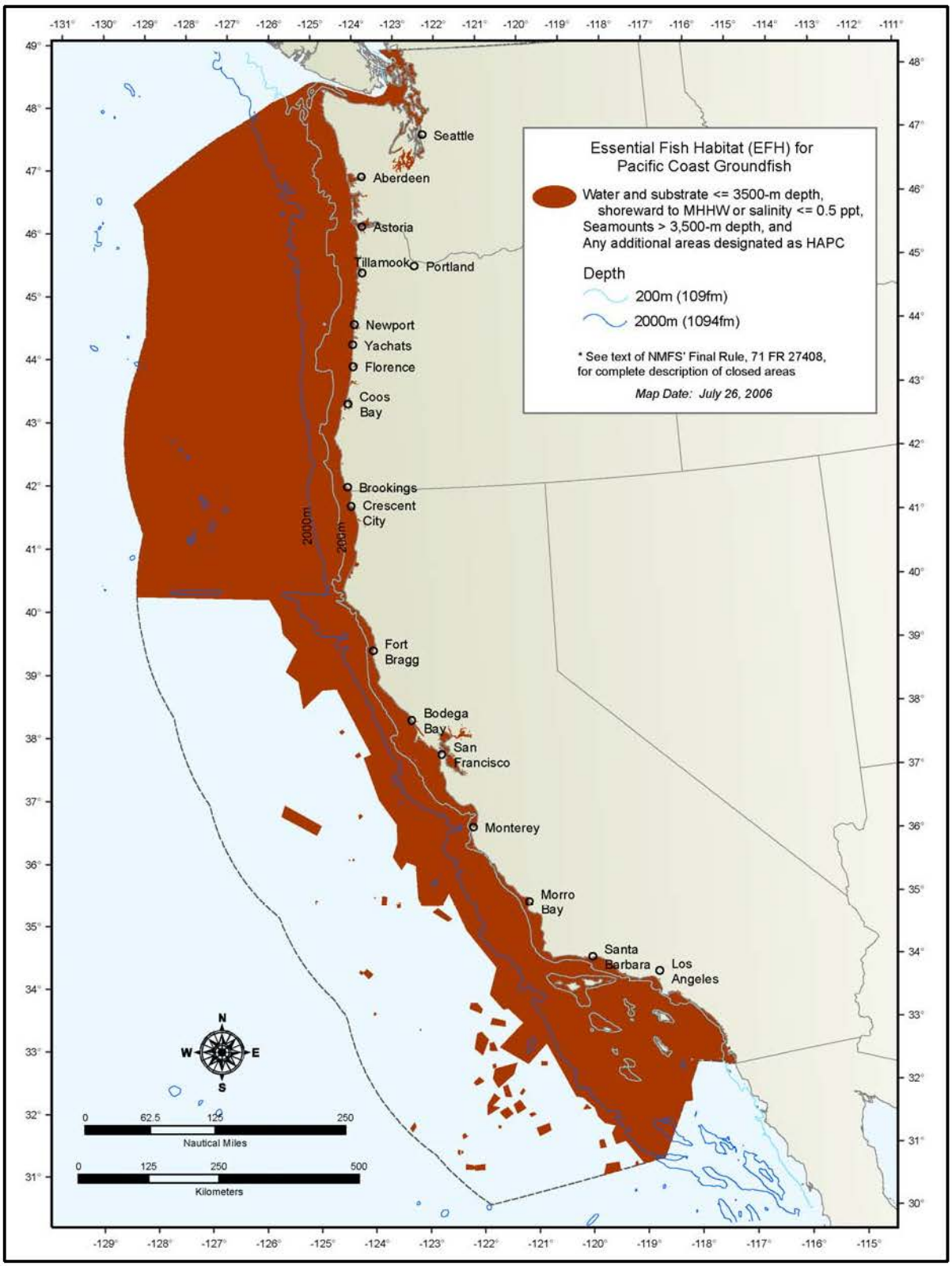
extends beyond U.S. waters, EFH stops at the boundary. For this reason, no EFH exists within the ARA or the portion of the ETPRA that lies outside of the U.S. EEZ.

The designation of EFH by itself does not confer any protection of the areas from non-fishing or fishing impacts. Instead, it is a tool used by managers to reduce impacts and improve fisheries management. It is described and identified in Fishery Management Plans (FMPs) that are developed by regional fisheries management councils. NMFS regional offices implement FMPs to facilitate long-term protection of EFH through conservation and management measures.

The EFH for a managed species is designated separately for each life stage: eggs, larvae (normally pelagic), juveniles, and adults (pelagic and/or demersal). In certain species EFH is also designated for spawning adults. Many species require different habitats for different life stages, sometimes resulting in vast areas of EFH for a single species. Overlapping EFH areas for numerous federally managed species, including over 82 species covered by the Pacific Coast Groundfish FMP, have been identified in areas where SWFSC research surveys occur (Pacific Fisheries Management Council [PFMC] 2008). Descriptions of groundfish EFH for the various life stages of each of the species result in the definition of over 400 distinct EFH areas. As shown in Figure 3.1-3, when these EFHs areas are combined, groundfish EFH includes all waters less than 3,500 meters in depth from the mean higher high water line, and the upriver extent of saltwater intrusion in river mouths, to the seaward boundary of the U.S. EEZ along the coasts of California, Oregon, and Washington (PFMC 2008).

The Coastal Pelagic Species (CPS) FMP describes EFH for five pelagic species: northern anchovy, Pacific sardine, Pacific (chub) mackerel, jack mackerel and market squid (PFMC 1998). These four finfish and one squid are treated as a single species complex because of similarities in their life histories and habitat requirements. Krill was added to the FMP as an essential component of the California Current Ecosystem under amendment 12 of the CPS FMP in February 2008. EFH for these CPS includes all marine and estuarine waters above the thermocline where sea surface temperatures range between 10 and 26 C° along the coasts of California, Oregon, and Washington from the shoreline to the seaward boundary of the U.S. EEZ. The southern boundary of the EFH area for CPS is effectively the maritime boundary between U.S. and Mexican waters while the northern boundary for the EFH area is defined by the 10 C° isotherm, the location of which changes seasonally and annually (PFMC 1998).

Three species of salmon (Chinook, coho, and pink) are covered by the Pacific Salmon FMP (PFMC 2003). In estuarine and marine areas, salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters to the seaward boundary of the U.S. EEZ along the coasts of Washington, Oregon, and California north of Point Conception. The Pacific Salmon FMP also includes the salmon EFH in marine areas off the coast of Alaska designated by the North Pacific Fisheries Management Council. Freshwater EFH for Pacific salmon includes all streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in Washington, Oregon, Idaho, and California, with the exception of areas upstream of certain impassable manmade barriers (as identified by the PFMC), and upstream of longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for several hundred years) (PFMC 2003).



Source: http://www.pcouncil.org/wp-content/uploads/A18-19Final.pdf

Figure 3.1-3 Essential Fish Habitat for Pacific Coast Groundfish.

From Amendment 19 to the Pacific Coast Groundfish FMP (PFMC 2008).

The FMP for U.S. West Coast Fisheries for Highly Migratory Species defines EFH for thirteen species (common thresher shark, pelagic thresher shark, bigeye thresher shark, shortfin mako shark, blue shark, albacore tuna, bigeye tuna, northern bluefin tuna, skipjack tuna, yellowfin tuna, striped marlin, swordfish, and dorado or dolphinfish) (PFMC 2007). The combined EFH for these species includes a large fraction of the pelagic marine waters within the U.S. EEZ along the coasts of California, Oregon, and Washington.

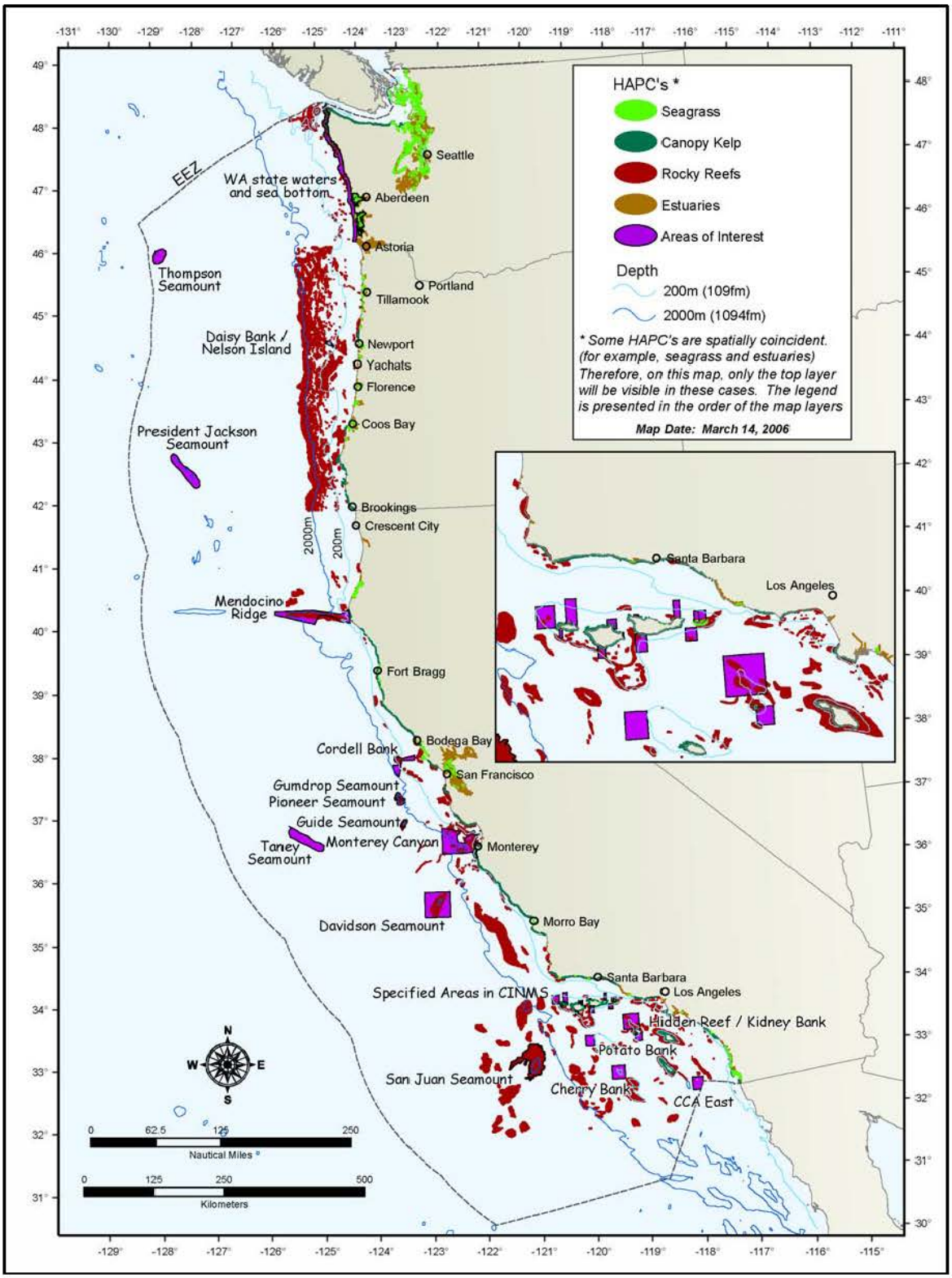
3.1.2.2 Habitat Areas of Particular Concern

The EFH provisions of the regulations implementing the Magnuson-Stevens Fishery Conservation and Management Act (50 CFR part 600) recommend that specific areas of habitat within EFH are identified as "habitat areas of particular concern." Habitat Areas of Particular Concern (HAPC) are discrete subsets of EFH that provide important ecological functions or are especially vulnerable to degradation. Fishery management councils may designate a specific habitat area as a HAPC for one or more of the following reasons: the importance of the ecological function provided by the habitat, the extent to which the habitat is sensitive to human-induced environmental degradation, whether and to what extent development activities are or will be stressing the habitat type, and the rarity of habitat type.

The intended goal of identifying HAPC is to focus conservation efforts on the most important areas. While the HAPC designation does not trigger any specific regulatory process or confer any specific protection, it highlights certain habitat types that are of high ecological value. This designation is manifested in EFH consultations, during which NMFS can recommend protective measures for specific HAPCs.

Several fishery management councils have designated discrete habitat areas as HAPCs, while others have broadly designated all areas of a specific habitat type as HAPCs. The PFMC designated the following HAPCs in Amendment 19 to the Pacific Coast Groundfish FMP: seagrasses, canopy kelp, estuaries, rocky reefs, and a number of clearly defined areas of interest but none in its three other FMPs. The "areas of interest" and estuaries designated by the Council in the Pacific Coast Groundfish FMP are examples of discrete HAPC, while the seagrass, canopy kelp, and rocky reef HAPC are examples of broadly defined HAPC that are based on a description of the habitat (PFMC 2008). Figure 3.1-4 shows the location of these HAPCs. For HAPC defined by habitat type, as opposed to discrete areas, this map offers an approximation of their location and extent (from Amendment 19 to the Pacific Coast Groundfish FMP; PFMC 2008**)**. HAPCs, like EFH, are subject to periodic reviews and may be modified over time.

During the review process for Pacific Coast Salmon EFH, PFMC recommended but has not yet formally designated the following five habitat types as potential HAPCs: complex channels and floodplains, thermal refugia, spawning habitat, estuaries, and marine and estuarine submerged aquatic vegetation. The Pacific Fishery Management Council concluded that more research is needed before HAPCs can be established under the FMPs for highly migratory species and coastal pelagic species. Shark pupping grounds have been suggested as potential HAPCs to be included under the FMP for highly migratory species.



Source: http://www.pcouncil.org/wp-content/uploads/A18-19Final.pdf

Figure 3.1-4 HAPCs for Pacific Coast Groundfish

For HAPCs defined by habitat type (sea grasses, canopy kelp, and rocky reef areas) this map offers an approximation of their location and extent (from Amendment 19 to the Pacific Coast Groundfish FMP).

3.1.2.3 Closed Areas

The Pacific Fishery Management Council has established seasonal and year-round areas closed to all fishing gear and specific to trawl gear within the CCRA. These specially managed areas protect key habitats and species and have contributed to the precautionary approach the council has undertaken to manage its fisheries. Detailed information on the restrictions within of the Habitat Closure Areas and Closed Areas can be found in the Multi-species Fishery Regulations (NOAA 2010). The types of marine areas closed to fishing by federal regulation are categorized by fishing type, and are listed below.

Commercial Trawl Closed Areas

Commercial vessels fishing with trawl gear are prohibited from fishing in any of the following areas:

- Trawl (Groundfish and Non-Groundfish) Rockfish Conservation Areas
- Cowcod Conservation Areas
- Cordell Banks Closed Area
- Farallon Islands Closed Areas
- EFH Conservation Areas

Commercial Non-Trawl Closed Areas

Commercial vessels fishing with gear other than trawl gear are prohibited from fishing in any of the following areas:

- Non-trawl Rockfish Conservation Areas
- Cowcod Conservation Areas
- Cordell Banks Closed Area
- Farallon Islands Closed Areas
- EFH Conservation Areas
- Yelloweye Rockfish Conservation Areas
- North Coast Commercial Yelloweye Rockfish Conservation Area
- Salmon Troll Yelloweye Rockfish Conservation Area
- North Coast Recreational Yelloweye Rockfish Conservation Area (voluntary closure)
- South Coast Recreational Yelloweye Rockfish Conservation Area (voluntary closure)
- Westport Offshore Recreational Yelloweye Rockfish Conservation Area (voluntary closure)

Recreational Closed Areas

Recreational fishing vessels are prohibited from fishing in any of the following areas:

- Recreational Rockfish Conservation Areas
- Yelloweye Rockfish Conservation Areas
- North Coast Recreational Yelloweye Rockfish Conservation Area
- South Coast Recreational Yelloweye Rockfish Conservation Area
- Westport Offshore Recreational Yelloweye Rockfish Conservation

- Stonewall Bank Yelloweye Rockfish Conservation Area
- Cowcod Conservation Areas
- Cordell Banks Closed Area
- Farallon Islands Closed Areas
- EFH Conservation Areas

The states of California, Oregon, and Washington have established additional closed areas within state waters.

In addition to closed areas within the U.S. EEZ, a series of closed areas in the Antarctic region have been established by the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) conservation measures, as discussed in *Schedule of Conservation Measures in Force 2010/11 Season* (CCAMLR 2010). Taking of all finfish, other than for scientific research purposes, is prohibited in CCAMLR statistical subareas 48.1 and 48.2, which overlap with the SWFSC ARA (Figure 3.1-5). In addition, directed fishing for certain species in certain areas (except for scientific research purposes) is prohibited as described in a series of CCAMLR conservation measures. Directed fishing for sharks (except for scientific research purposes) is prohibited throughout the CCAMLR convention area, and any sharks caught accidentally are required to be released alive, if possible.

An additional series of closed areas have been proposed as a management tool to determine the efficacy of small scale management units in the Antarctic krill fishery (Constable *et al*. 2000; Hill et al. 2009).

Closed areas within the ETP region are described in Section 3.1.2.4 Marine Protected Areas.

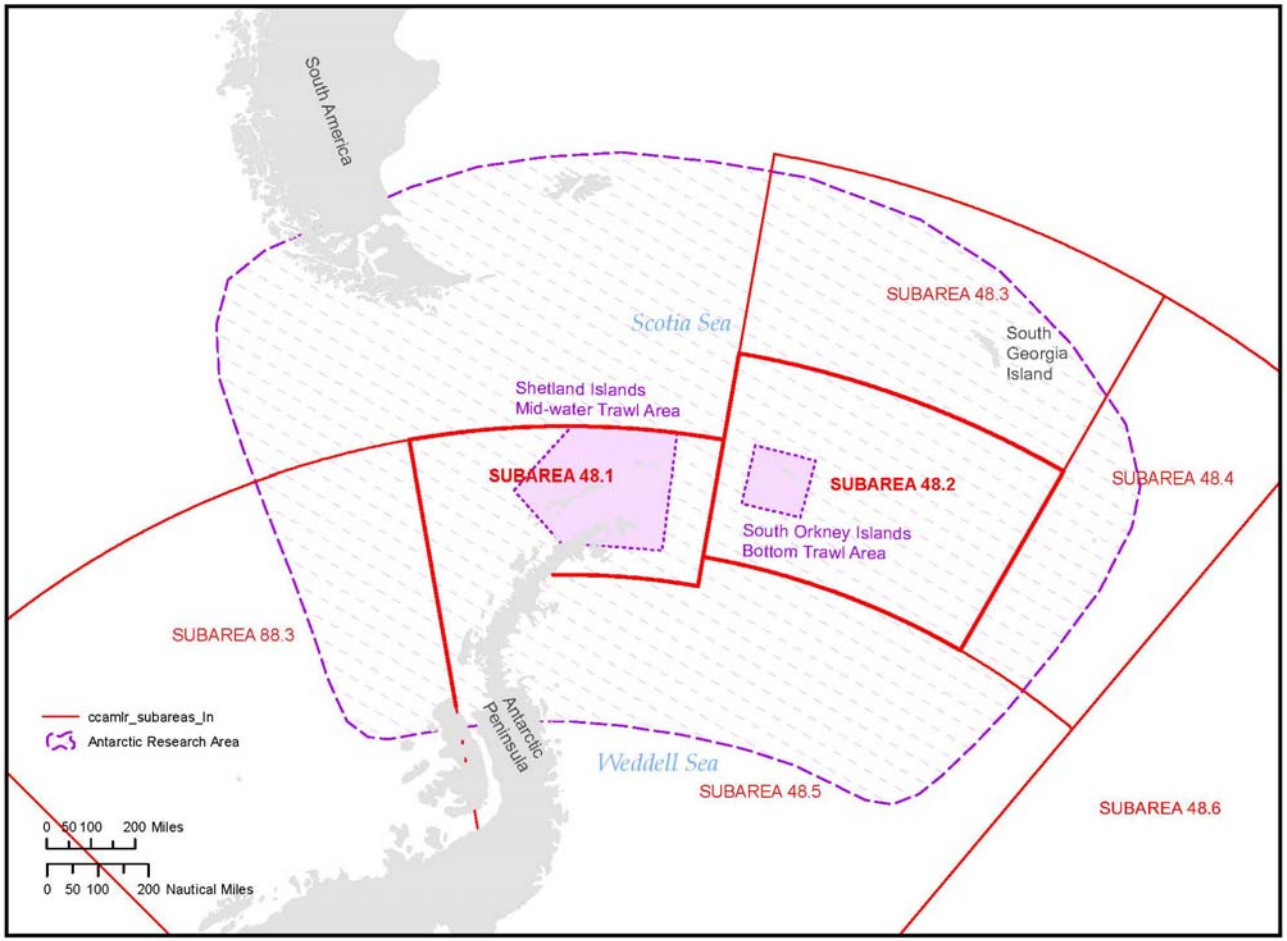


Figure 3.1-5 Areas closed to finfish fisheries in the ARA.

Taking of all finfish, other than for scientific research purposes, is prohibited in CCAMLR statistical subareas 48.1 and 48.2.

3.1.2.4 Marine Protected Areas

A Marine Protected Area (MPA) is defined by Executive Order 13158 as "any area of the marine environment that has been reserved by federal, state, tribal, territorial, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein." They are a group of sites, networks, and systems established and managed by federal, state, tribal, and local governments. Most MPAs have legally established goals, conservation objectives, and intended purposes. MPAs generally address one or more of three areas of conservation focus:

Natural Heritage: established and managed wholly or in part to sustain, conserve, restore, and understand the protected area's natural biodiversity, populations, communities, habitats, and ecosystems; the ecological and physical processes upon which they depend; and, the ecological services, human uses and values they provide to this and future generations.

Cultural Heritage: established and managed wholly or in part to protect and understand submerged cultural resources that reflect the nation's maritime history and traditional cultural connections to the sea.

Sustainable Production: established and managed wholly or in part with the explicit purpose of supporting the continued extraction of renewable living resources (such as fish, shellfish, plants, birds, or mammals) that live within the MPA, or that are exploited elsewhere but depend upon the protected area's habitat for essential aspects of their ecology or life history.

MPAs encompass almost the entire area where research surveys are conducted. They contain: California's State Marine Reserves, State Marine Parks, State Marine Conservation Areas, and State Marine Recreational Management Areas; Oregon's MPAs; Washington's MPAs; Wildlife Refuges; National Parks; Federal Marine Reserves; and National Marine Sanctuaries. MPAs vary widely in the level and type of legal protection afforded to the site's natural and cultural resources and ecological processes. Many of the MPAs within the action area have various levels of fishing restrictions. Marine reserves, a type of MPA, are areas where some or all fishing is prohibited for a lengthy period of time. Marine reserves provide an alternative means of controlling fishing mortality and serve as a valuable management tool when the status of a fish stock is uncertain. Details of MPAs located within the U.S. EEZ, can be found on the List of National System MPAs (NOAA 2009). This list also includes Habitat Closed Areas and Closed Areas (see Section 3.1.2). Although these areas are not formally classified as marine reserves, they provide similar levels of protection for many species.

The National Marine Sanctuaries Act authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities as national marine sanctuaries. The National Marine Sanctuary System is intended to (A) improve the conservation, understanding, management, and wise and sustainable use of marine resources; (B) enhance public awareness, understanding, and appreciation of the marine environment; and (C) maintain for future generations the habitat, and ecological services, of the natural assemblage of living resources that inhabit these areas. Day-to-day management of national marine sanctuaries has been delegated by the Secretary of Commerce to NOAA's Office of National Marine Sanctuaries. The primary objective of the National Marine Sanctuaries Act is to set aside marine areas of special national significance for their permanent protection and to manage them as ecosystems to maintain their natural biodiversity and historical and cultural heritage, consistent with compatible uses. The National Marine Sanctuary System consists of 14 MPAs that encompass more than 150,000 square miles of marine and Great Lakes waters. The square mileage noted here may increase per revisions to Fagatele Bay National Marine Sanctuary. The SWFSC CCRA includes five National Marine Sanctuaries: Olympic Coast, Cordell Banks, Gulf of the Farallones, Monterey Bay, and Channel Islands (Figure 3.1-6). Site-specific regulations applicable to each of these marine sanctuaries may be found in the National Marine Sanctuary Program Regulations (15 CFR § 922). Descriptions of each of the five west coast sanctuaries are provided below.

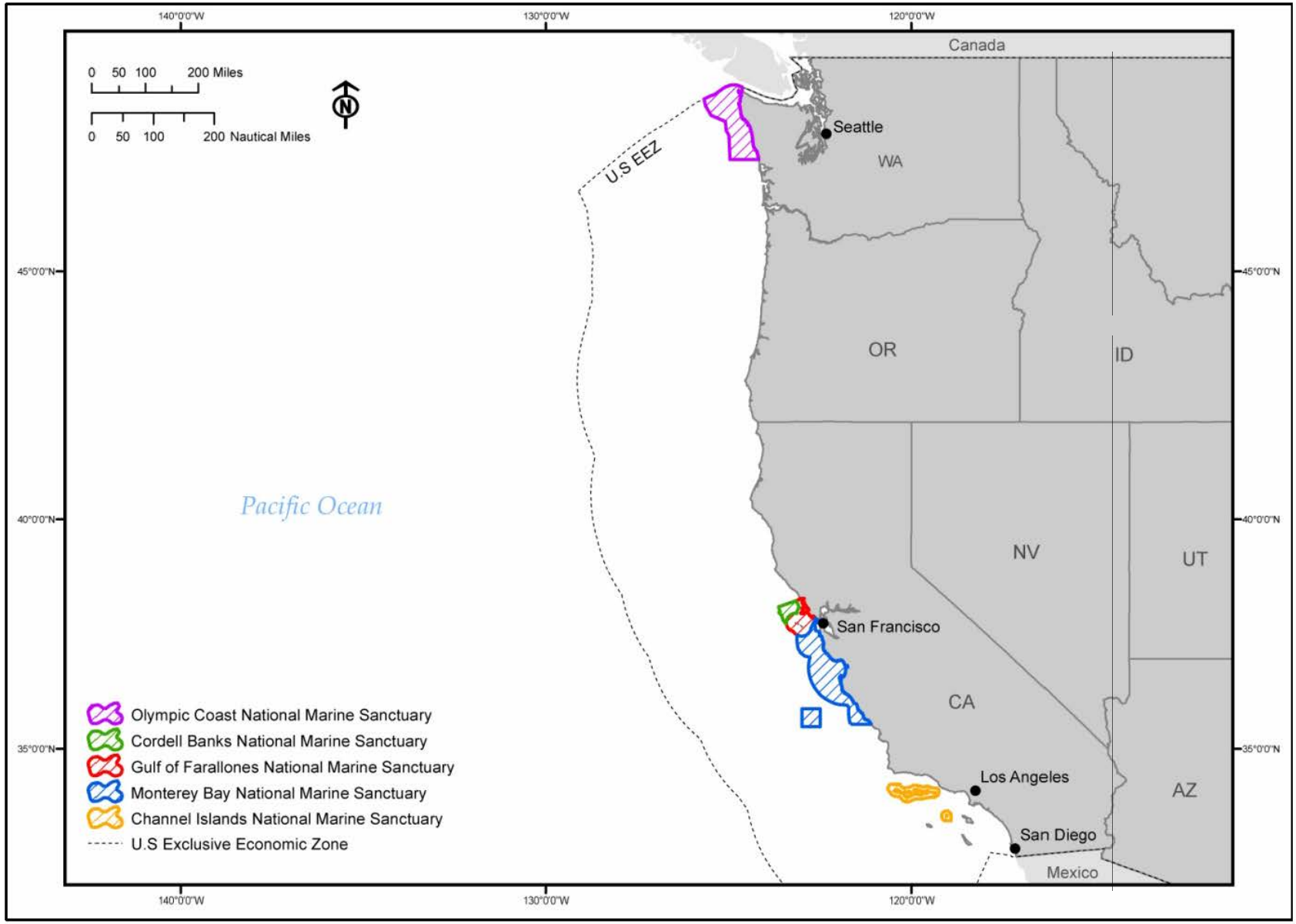


Figure 3.1-6 National Marine Sanctuaries in the CCRA.

Olympic Coast National Marine Sanctuary includes 3,310 square miles of marine waters off the Olympic Peninsula coastline. The sanctuary extends 25 to 50 miles seaward, covering much of the continental shelf and several major submarine canyons. The sanctuary protects a productive upwelling zone, including habitat for marine mammals and seabirds. Along its shores are thriving kelp and intertidal communities. On the seafloor, scattered communities of deep sea coral and sponges form habitats for fish and other important marine wildlife.

Cordell Bank National Marine Sanctuary was established in 1989 to protect and preserve the extraordinary marine ecosystem surrounding the Cordell Bank. Surrounded by soft sediments of the continental shelf seafloor, Cordell Bank consists of a rocky habitat, which supports a diverse population of invertebrates, algae, and fishes. The productive waters attract migratory seabirds and marine mammals from throughout the Pacific Ocean to feed in this dynamic food web. With its southernmost boundary located 42 miles north of San Francisco the sanctuary is entirely offshore, with the eastern boundary six miles from shore and the western boundary 30 miles offshore. In total, the sanctuary protects an area of 529 square miles.

Gulf of the Farallones National Marine Sanctuary spans 1,279 square miles just north and west of San Francisco Bay, and protects open ocean, nearshore tidal flats, rocky intertidal areas, estuarine wetlands, subtidal reefs, and coastal beaches within its boundaries. In addition, the sanctuary has administrative jurisdiction over the northern portion of the Monterey Bay National Marine Sanctuary, from the San Mateo/Santa Cruz County line northward to the existing boundary between the two sanctuaries and maintains an office in San Francisco. It provides breeding and feeding grounds for at least 25 endangered or threatened species; 36 marine mammal species, including blue, gray, and humpback whales, harbor seals, elephant seals, Pacific white-sided dolphins, Steller sea lions; over a quarter-million breeding seabirds; and a significant population of white sharks.

Monterey Bay National Marine Sanctuary is a federally protected marine area off California's central coast designated in 1992. The sanctuary encompasses a shoreline length of 276 miles and 6,094 square miles of ocean, extending an average distance of 30 miles from shore. It was established for the purposes of resource protection, research, education and public use. Its natural resources include our nation's largest kelp forest, one of North America's largest underwater canyons, and the closest-to-shore deep ocean environment in the continental U.S. The sanctuary provides habitat for 33 species of marine mammals, 94 species of seabirds, 345 species of fishes, and numerous invertebrates and plants.

Channel Islands National Marine Sanctuary consists of an area of approximately 1,470 square miles off the coast of southern California. It is adjacent to the following islands and offshore rocks: San Miguel Island, Santa Cruz Island, Santa Rosa Island, Anacapa Island, Santa Barbara Island, Richardson Rock, and Castle Rock extending seaward to a distance of approximately six nautical miles. The islands and rocks vary in distance from 12 to 40 nautical miles offshore from Santa Barbara and Ventura counties. A fertile combination of warm and cool currents in this area results in a diversity of plants and animals including kelp forests, fish and invertebrates, pinnipeds, cetaceans and sea birds. The sanctuary also has a wealth of maritime heritage resources including Chumash Native American artifacts and more than 100 historic shipwrecks. Human uses in the area include commercial and recreational fishing, marine wildlife viewing, boating, diving, kayaking, maritime shipping, nearby offshore oil and gas development, research and monitoring, military and numerous educational activities.

Within the ETP region, but outside of the U.S. EEZ, the United Nations Educational, Scientific and Cultural Organization has established five World Heritage Sites: Galapagos Islands and Marine Reserve (Ecuador), Islands and Protected Areas of the Gulf of California (Mexico), Cocos Island (Costa Rica), Coiba National Park (Panama), and Malpelo Island (Columbia). The Cocos Island World Heritage Site is managed by the Costa Rican government as the “Seamounts Marine Management Area” (Area Marina de Manejo Montes Submarinos), which includes a roughly 200,000 hectare no-fishing-zone, Cocos Island National Park, and surrounding areas with restrictions on fish harvest. The Malpelo Fauna and Flora

Sanctuary, located 506 kilometers off the coast of Colombia, includes Malpelo island (350 hectares) and the surrounding marine environment (857,150 hectares), which is managed as a marine park. The Malpelo Island marine park includes the largest no-fishing zone in the ETP. While each World Heritage Site remains part of the legal territory of the state wherein the site is located, the United Nations Educational, Scientific and Cultural Organization considers it in the interest of the international community to preserve each site.

Other marine areas protected as national parks or under other designations established by the nations that border the ETPRA and CCRA are listed in Table 3.1-1.

Table 3.1-1 Marine Reserves in the Eastern Tropical Pacific

Mexico
Rocas Alijos
Isla San Benedicto
Reserva de la Biosfera Isla Guadelupe
Reserva de la Biopsfera Islas de Golfo California
Reserva de la Biopsfera Alto Golfo de California y Delta Río de Colorado
Reserva de la Biosfera Bahía de los Ángeles, canales de Ballenas y de Salsipuedes, Baja California
Reserva de la Biosfera El Vizcaíno, Baja California Sur
Parque Nacional Bahía de Loreto, Baja California Sur
Reserva de la Biosfera Complejo Lagunar Ojo de Liebre, Baja California Sur
Colombia
Isla Malpelo
Costa Rica
Cocos Island
Ecuador
Galapagos Islands
France
Clipperton Island

In addition, a transnational Marine Conservation Corridor has been established between Costa Rica, Panama, Columbia, and Ecuador in cooperation with a team involving the UNEP, the World Conservation Union, and the International Union for the Conservation of Nature (Guzman *et al*. 2008). Commercial fishing activities are not permitted within the Clipperton Island EEZ (France) (Pauly 2009).

In the ARA, specific mechanisms exist under the Antarctic Treaty System and CCAMLR for protection of sensitive marine areas. The entire Antarctic region is protected to some degree by the Antarctic Treaty System and CCAMLR, and therefore all marine areas south of the 60°S parallel fulfill the operational definition of MPAs. However, specific areas may be further protected as either Antarctic Specially Protected Areas or Antarctic Specially Managed Areas, which are established under the Antarctic Treaty System. Antarctic Specially Protected Areas are closed except to permit holders, while Antarctic Specially Managed Areas are intended to assist in the planning and coordination of activities within specified areas where certain activities pose risks of mutual interference or cumulative environmental impacts. In addition, several specific MPAs are established by CCAMLR conservation measures

(CCAMLR 2010). This process is ongoing, with continued efforts to designate further MPAs throughout the Antarctic LME. For example, the South Orkney Islands Southern Shelf MPA has recently been established in relatively close proximity to SWFSC research facilities near the Antarctic Peninsula. All types of fishing are prohibited within the South Orkney Islands MPA, with the exception of approved scientific fishing research activities (CCAMLR 2010).

The CCAMLR conservation measures also stipulate specific requirements related to exploratory fisheries for Antarctic krill (*Euphausia superba*) (CCAMLR 2010).

3.2 BIOLOGICAL ENVIRONMENT

3.2.1 Fish

Thousands of finfish species occur within the three SWFSC research areas. This section of the EA provides baseline information for species important to the analysis of effects in Chapter 4; ESA-listed species, important target species caught in SWFSC survey efforts, and prohibited and highly migratory species.

3.2.1.1 Threatened and Endangered Fish Species

The information presented in the following species accounts is primarily from the NOAA Fisheries Office of Protected Resources website (NOAA 2011a), available online at: http://www.nmfs.noaa.gov/pr/species/fish/.

Bocaccio

The bocaccio *(Sebastes paucispinis)* is a large piscivorous rockfish ranging from Punta Blanca, Baja California, to the Gulf of Alaska off Krozoff and Kodiak Islands, but most commonly observed between Oregon and northern Baja California. Bocaccio are most common between 160 and 820 feet. (50-250 meter) depth, but may be found as deep as 1,560 feet (475 meters). Adults generally move into deeper water as they increase in size and age, and typically exhibit strong site fidelity to rocky bottoms and outcrops. Juveniles and subadults may be more common than adults in shallower water, and are associated with rocky reefs, kelp canopies, and artificial structures, such as piers and oil platforms. Like all species of the genus *Sebastes*, fertilization and embryo development is internal and female rockfish give birth to live larval young. Larvae are found in surface waters and may be distributed over a wide area extending several hundred miles offshore. It is thought that larvae and small juveniles may remain in open waters for several months, being passively dispersed by ocean currents. Bocaccio are difficult to age, but it is thought that approximately 50 percent of adult bocaccio mature in 4 to 6 years and scientists suspect they can live as long as 50 years. Bocaccio are fished for directly and are often caught as bycatch in fisheries such as the salmon fishery.

Bocaccio is comprised of three distinct population segments (DPS): a southern coastal population off California, currently listed as a species of concern, a northern coastal population extending from the California/Oregon border north to British Columbia, and a Puget Sound/Georgia Basin population. The bocaccio Puget Sound/Georgia DPS was listed as endangered by NOAA on April, 28, 2010 and is the only bocaccio DPS protected under the ESA. The final rule became effective on July 27, 2010. Under this ruling it was determined the Puget Sound/Georgia Basin DPS was discrete from other bocaccio populations and significant in relation to the entire species. The main reason for listing is the magnitude of decline in abundance. Critical habitat has yet to be established for this DPS (75 FR 22276). Fishing restrictions have been placed on this species since they are slow-growing, late to mature, and long lived; which means even if threats are no longer affecting the species, recovery will take many years (NOAA 2011a).

Canary rockfish

The canary rockfish *(Sebastes pinniger)* is a Pacific coast rockfish that ranges between Punta Colnett, Baja California, and the Western Gulf of Alaska, but are most commonly found off the coast of central Oregon. Canary rockfish primarily inhabit waters from 160 to 820 feet (50 to 250 meters.) deep but may be found up to 1,400 feet (425 meters). Approximately 50 percent of adult canary rockfish are mature around 5 to 6 years of age and 14 inches (36 centimeters) total length. Canary rockfish are directly fished for and are often caught as bycatch in other fisheries, including salmon fisheries. Canary rockfish are long lived (up to 75 years), and slow to recover from population declines.

The canary rockfish is comprised of two DPSs, coastal and Puget Sound/Georgia Basin. The Puget Sound/Georgia Basin DPS was listed as threatened by NOAA on April 28, 2010 and is the only canary rockfish DPS protected under the ESA. The final rule became effective on July 27, 2010. Under this ruling it was determined the Puget Sound/Georgia Basin DPS was discrete from other coastal canary rockfish populations and significant in relation to the entire species. Critical habitat has yet to be established for this DPS (75 FR 22276). Various restrictions have been placed on fishing to assist in the recovery of this threatened species (NOAA 2011a).

Yelloweye rockfish

The yelloweye rockfish *(Sebastes ruberrimus)* is a Pacific coast rockfish that ranges from northern Baja California to the Aleutian Islands in Alaska, but are most commonly found in central California northward to the Gulf of Alaska. As adult yelloweye rockfish age and increase in size, they generally move into deeper water; they also exhibit strong site fidelity to rocky bottoms and outcrops. Yelloweye rockfish are among the longest lived rockfish, living up to 118 years old. Yelloweye rockfish are fished directly and are often caught as bycatch in other fisheries, including salmon fisheries (NOAA 2011a).

The yelloweye rockfish is comprised of two DPSs: coastal and Puget Sound/Georgia Basin. The Puget Sound/Georgia Basin DPS was listed as threatened by NOAA on April 28, 2010 and is the only yelloweye rockfish DPS protected under the ESA. The final rule became effective on July 27, 2010. Under this ruling, it was determined the Puget Sound/Georgia Basin yelloweye rockfish DPS was discrete from other coastal yelloweye rockfish populations and significant in relation to the entire species. Critical habitat has yet to be established for this DPS due to the lack of currently available information to assess impacts of designation and incomplete information pertaining to the physical and biological features essential to conservation (75 FR 22276). Various restrictions have been placed on fishing to assist in the recovery of this threatened species.

Chinook salmon

Chinook salmon *(Oncorhynchus tshawytscha)* is one of several species of salmon that have some evolutionarily significant units (ESUs) listed as endangered or threatened by the USFWS. In the U.S., Chinook salmon are found from the Bering Strait off Alaska's coast, south to Southern California. Chinook salmon are an anadromous species of fish that spawn in freshwater rivers and streams and mature in the ocean. Juvenile Chinook may spend from 3 months to 2 years in freshwater before migrating to estuarine areas as smolts, and then to the ocean to feed and mature. Salmonid species on the west coast of the U.S. have experienced dramatic declines in abundance during the past several decades as a result of human activities and natural factors.

NOAA Fisheries has identified seventeen Chinook salmon ESUs that occur within the SWFSC research area and of these two are considered endangered: Sacramento Winter Run and Upper Columbia River Spring Run ESUs. Seven Chinook salmon ESUs are listed as threatened: California coastal, Central Valley spring-run, lower Colombia River, Puget Sound, Snake River fall-run, Snake River spring/summer-run and upper Willamette River (NOAA 2011a). The remaining eight ESUs are not ESA listed and considered generally abundant.

Chum salmon

Chum salmon *(Oncorhynchus keta)* is a species with a wide geographic and spawning distribution but the Columbia River ESU and Hood Canal summer-run ESU have been listed as threatened under the ESA. Chum salmon range farther along the shores of the Arctic Ocean than any other salmonids; major spawning populations are found only as far south as Tillamook Bay on the northern Oregon coast. Chum salmon spawn in the lowermost reaches of rivers and streams, typically within 62 miles (100 kilometers) of the ocean, often near springs. Chum salmon migrate, almost immediately after hatching, to estuarine and ocean waters. This means that the survival and growth of juvenile chum salmon depends less on freshwater conditions and more on favorable estuarine and marine conditions.

NOAA Fisheries has identified four chum salmon ESUs that occur within the SWFSC research area and of these two are considered threatened under the ESA: Hood Canal Summer-run and Columbia River ESUs (NOAA 2011a). The Puget Sound/Strait of Georgia and Pacific Coast chum salmon ESUs are currently not listed under the ESA.

Coho salmon

Coho salmon *(Oncorhynchus kisutch)* is an anadromous fish that were historically distributed throughout the North Pacific Ocean from central California to Point Hope, Alaska, through the Aleutian Islands, and from the Anadyr River, Russia, south to Hokkaido, Japan. It is probable that coho salmon inhabited most coastal streams in Washington, Oregon, and central and northern California. Coho spend the first half of their life cycle rearing and feeding in streams and small freshwater tributaries. The remainder of their life cycle is spent foraging in estuarine and marine waters of the Pacific Ocean. Coho salmon prefer to spawn in small streams with stable gravel substrates.

NOAA Fisheries has identified seven coho salmon ESUs that occur within the SWFSC research area. The Central California Coast coho salmon ESU is listed as endangered under the ESA and three are listed as threatened: (Southern Oregon/Northern California Coasts, lower Columbia River, and Oregon Coast coho salmon ESUs (NOAA 2011a). The Puget Sound/Strait of Georgia, Southwest Washington and Olympic Peninsula coho salmon ESUs are currently not listed under the ESA.

Sockeye salmon

Sockeye salmon *(Oncorhynchus nerka*) inhabit riverine, marine, and lake environments from the Klamath River in Oregon and its tributaries north and west to the Kuskokwim River in western Alaska. With the exception of certain river-type and sea-type populations of sockeye, the vast majority of sockeye salmon spawn in or near lakes, where the juveniles rear for 1 to 3 years prior to migrating to sea. As sockeye generally require lakes for a portion of their life cycle, their distribution in river systems depend on the presence of usable lakes in the system; therefore, their distribution and abundance may be more intermittent than for other Pacific salmon. Seven recognized ESUs occur within the SWFSC research areas however only two are listed under the ESA: Snake River ESU, endangered, and Ozette Lake ESU, threatened.

Steelhead trout

Steelhead trout (*Oncorhynchus mykiss*) occur along the entire Pacific Coast in streams with deep low-velocity pools. Of the 15 recognized DPSs within the SWFSC research area, one DPS (Southern California) is listed as endangered and 10 are listed as threatened (Upper Columbia River, Snake River Basin, Middle Columbia River, Lower Columbia River, Upper Willamette River, South-Central California Coast, Central California Coast, North California, California Central Valley and Puget Sound ESUs) (NOAA 2011a). The Oregon Coast ESU is considered a species of concern. While all O. mykiss hatch in gravel-bottomed, fast-flowing, well-oxygenated rivers and streams, some stay in fresh water all their lives; these fish are then named rainbow trout. Unlike other Pacific salmonids, steelhead can spawn

more than one time. Adults migrate from the marine environment to their natal freshwater streams and rivers in order to spawn.

Green sturgeon

The green sturgeon *(Acipenser medirostris)* is the most broadly distributed, wide-ranging, and most marine-oriented species in the sturgeon family. The green sturgeon ranges from Mexico to Alaska (and possibly beyond) in marine waters, and are observed in bays and estuaries up and down the west coast of North America. Green sturgeon use both freshwater and saltwater habitat, using deep pools in large, turbulent, freshwater rivers to spawn. Green sturgeon are believed to spend the majority of their lives in nearshore oceanic waters, bays, and estuaries. Younger fish reside in fresh water, while adults only return to freshwater for spawning after they reach 15 years of age and are over 4 feet (1.3 meters.) in length. Likely threats to green sturgeon are: insufficient freshwater flow rates in spawning areas, contaminants such as pesticides, bycatch in fisheries, potential poaching for caviar, introduction of exotic species, small population size, impassable barriers, and elevated water temperatures. In October 2009, NMFS designated critical habitat for the Southern DPS (NOAA 2011a).

The green sturgeon is comprised of two DPSs that qualify as species under the ESA: the Northern DPS, extending from the Eel River of northern California north to British Columbia, and the Southern DPS, extending from the Eel River of northern California south to the Sacramento-San Joaquin Delta, California. NMFS published a final rule on April 7, 2006 listing the Southern DPS as threatened (71 FR 17757), which took effect on June 6, 2006. Critical habitat for the Southern DPS was designated on October 9, 2009 (74 FR 52300) and includes freshwater, estuarine and marine habitat from Cape Flattery, Washington south to the Sacramento-San Joaquin Delta, California (Figure 3.2-1). A principal factor in the decline of the Southern DPS of green sturgeon is the reduction of their spawning area to a limited portion of the Sacramento River.

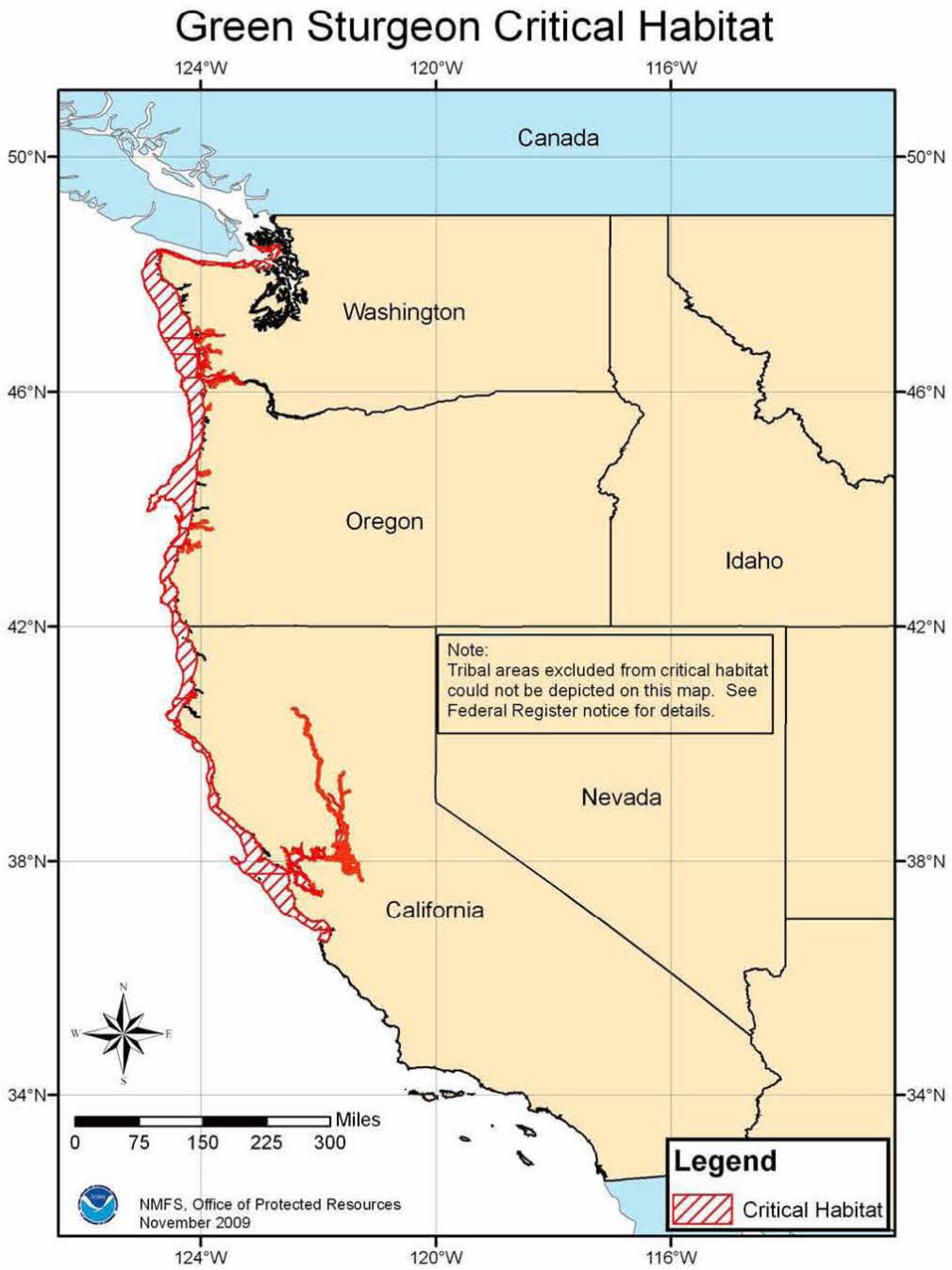


Figure 3.2-1 Green sturgeon critical habitat

Pacific eulachon/smelt

The Pacific eulachon *(Thaleichthys pacificus)* is found in the eastern Pacific Ocean, ranging from northern California to southwest Alaska and into the southeastern Bering Sea. Eulachon occur in nearshore ocean waters and up to 1000 feet (300 meters) in depth, returning for a brief time to spawn in their natal streams. Typically, eulachon spend 3 to 5 years in saltwater before returning to freshwater to spawn from late winter through mid-spring. During spawning, eulachon eggs are fertilized in the water column and after fertilization the eggs sink and adhere to the gravel and coarse sand river bottoms. Most adults die after spawning and eggs hatch in 20 to 40 days. After hatching, the larvae are then carried downstream and are dispersed by estuarine and ocean currents. Juvenile eulachon move from shallow nearshore areas to mid-depth areas. Habitat loss and degradation threaten the eulachon, particularly in the Columbia River basin.

The Pacific eulachon is comprised of two DPSs: A Northern DPS, extending from the US-Canada border north into the southeastern Bering Sea, and a southern DPS, extending from the US-Canada border south to central California at Point Conception. In March 2010, NMFS listed the Southern DPS of eulachon as threatened under the ESA (75 FR 13012). In October 2011, NMFS designated critical habitat for the Southern DPS of Eulachon (76 FR 65324) (NOAA 2011a). Critical habitat includes freshwater creeks and rivers and their associated estuaries within the states of California, Oregon and Washington (Figure 3.2-2).

Figure 3.2-2 Designated Critical Habitat for Southern DPS of Eulachon

Totoaba

The totoaba *(Totoaba macdonaldi)* is listed as an endangered species throughout its range (44 FR 29478). Critical habitat has not been designated for this species. Totoaba mainly inhabit the upper half of the Gulf of California and are primarily found in the top 75 feet (22.8 meters) of the water column. Totoaba school and migrate northward in the winter to the Colorado River delta where they remain for weeks before spawning in the spring. After spawning, the adults migrate south along the west coast, while the juveniles remain in the upper gulf for 2 years. Totoaba begin reproducing at 6 years of age for females and 7 years of age for males, and are believed to live up to 25 years. Totoaba are the largest of the Scianenidae family and have been measured at over 6.5 feet and over 220 pounds (99.8 kilograms). Threats to this species include a lack of freshwater, and disruption of salinity levels due to dams in the Colorado River, as well as fishing pressure from commercial and sport fishermen. Juveniles have also been taken as by-catch in shrimp fisheries. The Mexican government has been imposing fishery restrictions to assist in conservation efforts since the 1940s (NOAA 2011a).

3.2.1.2 Target Species

Target species are those fish which are managed for commercial and recreational fisheries and are the subject of SWFSC research surveys for stock assessment purposes. For the purposes of this EA, only those species that have had an average research catch of over 100 kilograms per year over the last 5 years are described.

California Current Research Area

Table 3.2-1 displays a list of target species in the CCRA and their stock and management status. For information on life history traits and habitat for each of the species, please see the Pacific Fishery Management Council's website: http://www.pcouncil.org .

Table 3.2-1 Target species in the California Current Research Area

Stock status information is from the Pacific Fishery Management Council website.

Species	Scientific Name	Stock Status	Fishery Management Council	Fishery Management Plan (FMP)	Survey name
Blue shark	*Prionace glauca*	Not overfished, abundant	PFMC	Highly Migratory Species (HMS) FMP	California Cooperative Oceanic Fisheries Investigation (CalCOFI) HMS
Chinook salmon	*Oncorhynchus tshawytscha*	Most non ESA-listed stocks are not overfished	PFMC	Pacific Coast Salmon FMP	CalCOFI Juvenile Salmon Survey
Coho salmon	*Oncorhynchus kisutch*	Non ESA-listed stocks are not overfished	PFMC	Pacific Coast Salmon FMP	CalCOFI Juvenile Salmon Survey
Common Thresher Shark	*Alopias vulpinus*	Not overfished	PFMC	HMS FMP	CalCOFI HMS
Jack mackerel	*Trachurus symmetricus*	Monitored	PFMC	Coastal Pelagic Species (CPS) FMP	CalCOFI Juvenile Salmon Survey
North Pacific Albacore	*Thunnus alalunga*	Not overfished, abundant	WCPFC PFMC WPFMC NPFMC	HMS FMP and Fishery Ecosystem Plan for Pelagic Fisheries of the Western Pacific	CalCOFI HMS
Northern Anchovy	*Engraulis mordax*	Monitored	PFMC NPFMC	CPS FMP	CalCOFI CPS Juvenile Rockfish Survey Juvenile Salmon Survey

Species	Scientific Name	Stock Status	Fishery Management Council	Fishery Management Plan (FMP)	Survey name
Pacific hake (whiting)	*Merluccius productus*	Not overfished	PFMC	Pacific Coast Groundfish FMP	CalCOFI Sardine Survey Juvenile Rockfish Survey Juvenile Salmon Survey
Pacific mackerel	*Scomber japonicus*	Not overfished	PFMC	CPS FMP	CalCOFI Juvenile Salmon Survey Thresher Shark Survey
Pacific sardine	*Sardinops sagax*	Not overfished	PFMC	CPS FMP	CalCOFI CPS Juvenile Rockfish Survey Juvenile Salmon Survey Thresher Shark Survey
Pacific swordfish	*Xiphias gladius*	Not overfished, abundant	PFMC	HMS FMP	HMS Longline and Habitat Surveys Swordfish Tagging using Deep-set Buoy Gear
Shortfin mako shark	*Isurus oxyrinchus*	Not overfished	PFMC	HMS FMP	HMS Thresher Shark survey
Yellowtail rockfish	*Sebastes flavidus*	Not overfished	PFMC	Pacific Coast Groundfish FMP	CPS Juvenile Rockfish Survey COAST Habitat surveys

Eastern Tropical Pacific Research Area

Sampling of fish species in the ETPRA is very limited and is not oriented toward stock assessments of any target species. Marine mammal studies conducted in this area have identified some common prey species, including lanternfish, flying fish, anchovies, sardines, and herring.

Antarctic Research Area

In the ARA, most surveys are focused on krill. The periodic bottom-trawl surveys are intended to monitor the recovery of several finfish species that had been subject to severe overfishing in the past. The finfish fishery in the Antarctic was closed in 1990 by the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) due to the decimation of several fish stocks in the 1970s and 1980s (NOAA 2011b). Table 3.2-2 shows the primary species that were caught in the most recent SWFSC bottom trawl survey (Antarctic Marine Living Resources [AMLR] Program 2009). These species have not been subject to full stock assessment analysis. For life history and distribution information, see Van Cise (2009).

Table 3.2-2 Finfish species with catches of greater than 100 kg in the 2008/2009 Antarctic bottom trawl survey.

Species	Scientific Name
Blackfin icefish	*Chaenocephalus aceratus*
Mackerel icefish	*Champsocephalus gunnari*
Ocellated icefish	*Chionodraco rastrospinosus*
Humped rockcod	*Gobionotothen gibberifrons*
Grey rockcod	*Lepidonotothen squamifrons*
Black rockcod	*Notothenia coriiceps*
South Georgia icefish	*Pseudochaenichthys georgianus*

3.2.1.3 Prohibited Species and Highly Migratory Fish Species

Prohibited Fish Species

Prohibited species are those species caught as bycatch during commercial fisheries that cannot be retained under provisions of one or more FMPs, unless authorized by another applicable law (PFMP 2007). Prohibited species in the SWFSC region are the great white shark, basking shark, megamouth shark, Pacific halibut, and Pacific salmon. Pacific salmon are described in the ESA-listed species section above; the others are described below.

Great white shark

Great white sharks *(Carcharodon carcharias*) are found off the Pacific coast from southeast Alaska to California, around the Hawaiian Islands, in the eastern Pacific, and rarely, in the central Pacific. This species can be found in coastal waters, along continental shelves and islands, particularly near seal or sea lion colonies, and offshore in the open ocean (NOAA 2011c). Female great white sharks are believed to mature when they are 13-14 feet in length and typically have few young per brood. The great white shark's low productivity, its accessibility in certain localized areas, and its appeal to trophy hunters, make it especially vulnerable to overfishing. The species has been protected in the state of California since 1995

and may not be removed except for scientific and educational purposes under state permit; finning is prohibited.

Basking shark

The basking shark *(Cetorhinus maximus)* is designated as a species of concern by NOAA and the north Pacific stock of this species is listed as endangered by the International Union for Conservation of Nature (IUCN). The IUCN is a global union of states, governmental agencies, and non-governmental organizations in a partnership that assesses the conservation status of species. While found globally, the basking shark is most commonly observed in coastal temperate waters. The basking shark is the second largest shark species and is a filter feeder, foraging near the base of the food web. This species is recommended for protection because it is highly vulnerable to depletion due to its low productivity. The basking shark was targeted heavily in the 1950s in the U.S. and 1970s in Canada and the eastern North Pacific population does not appear to have recovered since that time. Despite decades with no directed fishing pressure, basking sharks are still impacted by human activities; they are struck by vessels and caught incidentally in a range of fishing gear including longlines, nets, and the lines from prawn traps (NOAA 2011a).

Megamouth shark

Megamouth sharks *(Megachasma pelagio)* are extremely rare and little is known about this species. The IUCN characterizes megamouth sharks as "Data Deficient". Megamouths are thought to be filter feeders and despite their rarity, four individuals have been caught in the drift gillnet fishery in recent years. Protection is recommended because of extreme rarity and uniqueness of this species (PFMC 2011).

Halibut

Pacific halibut *(Hippoglossus stenolepis)* are found in coastal waters from southern California, to the west coast of Alaska. Halibut are most commonly found in the central Gulf of Alaska, particularly near Kodiak Island (NOAA 2012a). Halibut are also found on the other side of the Pacific, from the Gulf of Anadyr in Russia to Hokkaido, Japan. Juveniles live in shallow, near-shore waters off Alaska and British Columbia and move to deeper water as they age. Adults migrate seasonally from shallow summer feeding grounds to deeper winter spawning grounds (NOAA 2012a). Males sexually mature when they are 8 years old and females can reproduce as early as 12 years of age. Halibut spawn during the winter in deep water along the continental slope, mainly in the Bering Sea, Aleutian Islands, Gulf of Alaska, and south to British Columbia. Females can have between 500,000 and 4 million eggs, depending on their age (NOAA 2012a). Scientists believe females release their eggs in batches over several days during the spawning season and eggs hatch 12 to 15 days later. The halibut larvae float close to the surface where they remain for about 6 months, until they reach their adult form and settle to the bottom in shallow water (NOAA 2012a). While not a highly migratory species, halibut are important as incidental catch in some HMS fisheries and so are recommended to be prohibited, except to authorized fishers (PCOUN 2011).

Highly Migratory Fish Species

HMS are designated due to their wide geographic distribution and their significant, but variable migrations across oceans for the purpose of feeding or reproduction (PFMC 2011). Their extensive geographic ranges extend beyond the 200-mile EEZ found offshore of the U.S., making them more available for harvest by multiple fisheries and more challenging to manage (PFMC 2011). HMS in the Pacific Region that are actively managed under the HMS FMP include: tunas (North Pacific albacore, yellowfin, bigeye, skipjack, and northern bluefin); sharks (common thresher, shortfin mako, and blue); billfish/swordfish (striped marlin and Pacific swordfish); and dorado, also known as dolphinfish or mahi-mahi (PFMC 2011).

North Pacific albacore tuna

The North Pacific albacore tuna (*Thunnus alalunga*) is an abundant, circumglobal species. North Pacific albacore, particularly juveniles, begin their expansive migration in the spring and early summer in waters off Japan, move into inshore waters off the U.S. Pacific coast by late summer, then spend the late fall and winter in the western Pacific Ocean. The timing and distance of the albacore tunas' migrations in a given year depend largely on oceanic conditions. Less is known about the movements of albacore in the South Pacific Ocean, where juveniles move southward from the tropics when they are about a foot in length and then head eastward to about 130°W. When the fish reach sexual maturity at 5 to 6 years of age, they return to waters centered around 20°N to 20°S latitude to spawn (NOAA 2011d).

Pacific bigeye tuna

Bigeye tuna (*Thunnus obesus*) is an abundant species ranging across the Pacific Ocean between northern Japan and the north island of New Zealand in the western Pacific, and from 40°N to 30°S in the eastern Pacific Ocean. Bigeye tuna are capable of large scale migrations and move freely within broad regions of favorable water temperature and dissolved oxygen levels. Juvenile and small adult bigeye tuna school at the surface, sometimes with skipjack and juvenile yellowfin tunas. Schools may associate with floating objects or large, slow moving marine animals such as whale sharks or manta rays. Once reaching sexual maturity at around 3 years of age, bigeyes are capable of spawning throughout the year in tropical waters and seasonally at higher latitudes at water temperatures above 75° F. Bigeye tuna release millions of eggs per spawning event, which float on the top layer of the ocean, buoyed at the surface by a single oil droplet, until they hatch (NOAA 2011d).

Pacific northern bluefin tuna

The Pacific northern bluefin tuna (*Thunnus orientalis*) ranges throughout the Northern, Eastern, and Western Pacific and across the high seas, where they are fished by Japanese, Korean, Taiwanese as well as U.S. fisheries. Bluefin tuna larvae have only been found in the vicinity of Japan and between Japan and the Philippines, so it is assumed that spawning occurs only in those areas (Inter-American Tropical Tuna Commission [IATTC] 2002). Some fish remain in the Western Pacific Ocean, while others migrate to the Eastern Pacific Ocean during the first 2 years of life, eventually returning to the Western Pacific Ocean.

Skipjack tuna

The skipjack tuna (*Katsuwonus pelamis*) is an abundant species made up of two stocks in the Pacific Ocean, one in the eastern Pacific Ocean and one in the western and central Pacific Ocean. Skipjack tuna live mostly in the open ocean, though they do spend part of their life cycle in nearshore waters. Skipjacks are often found in large schools swimming in surface waters throughout the Pacific. Skipjack tuna reach sexual maturity early, once they reach around 1.3 feet (4 meters) in length, and are capable of spawning almost daily. The maximum life span is estimated between 8 to 12 years (NOAA 2011d).

Yellowfin tuna

The yellowfin tuna (*Thunnus albacares*) is a healthy species found throughout the tropical and sub-tropical waters of the Pacific Ocean. Yellowfin are known to gather around drifting flotsam, fish aggregating devices (FADs), anchored buoys, dolphins and other large marine animals. Yellowfin tuna reach sexual maturity at approximately 2 years of age and spawn frequently, but are short lived with a maximum life span of 6 to 7 years (NOAA 2011d).

Pacific Swordfish

The North Pacific Swordfish *(Xiphias gladius)* is a healthy species found worldwide in all tropical, subtropical, and temperate seas, though little is known of their migration patterns. Swordfish are abundant

near boundary zones where there are sharp gradients of temperature and salinity. Swordfish reach sexual maturity around 5 to 6 years of age and about 5-5.5 feet (1.6 meters) in length and have a maximum life span of at least 9 years. Swordfish do not seem to have a specific spawning season or grounds, they spawn throughout the year in equatorial waters, but in higher latitudes spawning is restricted to spring and summer (NOAA 2011d).

Striped marlin

The striped marlin *(Tetrapturus audax)* is a healthy species, though the stock structure is not known. Striped marlin are widely distributed throughout most tropical and sub-tropical waters of the Pacific and Indian oceans and fishery data indicate a horseshoe-shaped distribution across the central north- and central south Pacific with a continuous distribution along the west coast of the Central Americas. Movements tend to be diffuse as striped marlin do not to form dense schools, but occur singularly or in small groups, usually segregated by size. Adult fish are found in the north- and south- central Pacific where spawning occurs, in the central Pacific and off central Mexico. Sub-adult fish move east toward the coast of Mexico where they are found in high abundance around the tip of the Baja peninsula, Striped marlin are not reproductively active while off southern California (NOAA 2011d).

Dorado

The dorado *(Coryphaena hippurus)*, also known as dolphinfish or mahi mahi, is found in tropical and subtropical waters of all oceans. Dorado are unmonitored, but it is believed the population is stable and is able to withstand a relatively high level of exploitation. Dorado reach sexual maturity at 4 to 5 months of age and are prolific spawners, reproducing repeatedly. Spawning is thought to occur year round in temperate waters, above 75°F, but peaks vary with latitude. Dorado spawning grounds appear to be in the North Pacific in waters less than 50 nautical miles from islands and banks off the continents, they appear to spawn on the continental shelf. The lifespan of dorado is thought to be five years for a female, longer for males (NOAA 2011d).

Blue shark

Blue sharks *(Prionace glauca)* are found in warm seas worldwide and are likely the most wide-ranging of all sharks. Male blue sharks reach sexual maturity around 4 to 5 years of age, while females reach maturity between 5 and 6 years of age. Blue sharks bear fully formed, live young in litters averaging approximately 30 pups. Mating occurs in late spring to early winter, the gestation period is about 9-12 months and off the coast of California parturition reportedly occurs in early spring (NOAA 2011e). Young pups found in the California-Oregon drift net catch suggest the nursery habitat may extend northward to off the Columbia River mouth. It is believed that the maximum life span is 20 years.

In the North Pacific, seasonal migrations occur with northward movements extending into the Gulf of Alaska as waters warm during the summer months, and southward movements occurring during the winter months (NOAA 2011e). In U.S. West Coast waters, mature females are thought to start their northward journey in early spring as warm water moves northward, while juveniles of both sexes follow closely; large males start later and tend to stay further offshore. Blue sharks tagged off southern California have been recaptured to the south off Baja, California and Acapulco, Mexico; northward to off Oregon, and westward to off the Hawaiian Islands and Midway Islands in the central Pacific. These recaptures indicate a wide ranging stock that may overlap with the population fished by longliners in the central Pacific Ocean (NOAA 2011e).

3.2.1.4 Other Fish Species

Hundreds of fish species have been caught during the course of SWFSC research that may not be subject to formal stock assessments or belong to one of the categories above. Table 3.2-3 displays a list of these

species that have an average catch of over 100 kilograms per year during SWFSC surveys over the last 5 years.

Table 3.2-3 Other fish species caught in the California Current Research Area

Species	Scientific Name	Survey name
Blue lanternfish	*Tarletonbeania crenularis*	CalCOFI CPS Juvenile Rockfish Survey
Common Mola (ocean sunfish)	*Mola mola*	CalCOFI HMS
Jacksmelt	*Atherinopsis californiensis*	Juvenile Salmon Survey Thresher Shark Survey
Opah	*Lampris regius*	HMS
Pacific angel shark	*Squatina californica*	Thresher Shark Survey
Pelagic stingray	*Dasyatis violacea*	HMS Thresher Shark Survey
Soupfin shark	*Galeorhinus galeus*	CalCOFI Thresher Shark Survey
Spiny dogfish	*Squalus acanthias*	CalCOFI HMS Juvenile Salmon Survey Thresher Shark Survey

3.2.2 Marine Mammals

The marine mammal species listed in Table 3.2-4 occur in the areas frequented by the SWFSC research surveys in the CCRA, ETPRA and the ARA. Marine mammal species encountered during transit to and from the AMLR study sites are included with Antarctic species in Table 3.2-4. All marine mammals are federally protected under the U.S. Marine Mammal Protection Act (MMPA) of 1972. In addition, seven species of whales occurring in the SWFSC research areas are listed as endangered under the ESA, two pinnipeds and one fissiped are listed as threatened under the ESA, and two dolphin species in the ETP are considered depleted under the MMPA. The survey areas also encompass designated critical habitat for several species. Threatened and endangered species encountered in the SWFSC survey areas are described in Section 3.2.2.2. Non-ESA listed marine mammals that have historically been taken during SWFSC research activities are described in Section 3.2.2.3. Information provided here summarizes data on stock status, abundance, density, distribution and habitat, and auditory capabilities, as available in published literature and reports, including marine mammal stock assessments.

Table 3.2-4 Marine mammal species encountered in the SWFSC California Current, Eastern Tropical Pacific, and Antarctic Research Areas.

Species		CCRA	ETPRA	ARA	Federal ESA/MMPA Status[1]
Common Name	**Scientific Name**				
Cetaceans					
Harbor porpoise	*Phocoena phocoena*	X			-
Burmeister's porpoise	*Phocoena spinipinnis*		X		-

Species		CCRA	ETPRA	ARA	Federal ESA/MMPA Status[1]
Common Name	**Scientific Name**				
Spectacled porpoise	*Phocoena dioptrica*			X	-
Dall's porpoise	*Phocoenoides dalli*	X			-
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	X	X		-
Dusky dolphin	*Lagenorhynchus obscurus*		X	X	-
Peale's dolphin	*Lagenorhynchus australis*			X	-
Hourglass dolphin	*Lagenorhynchus cruciger*			X	-
Fraser's dolphin	*Lagenodelphis hosei*		X		-
Risso's dolphin	*Grampus griseus*	X	X	X	-
Bottlenose dolphin	*Tursiops truncatus*	X	X		-
Short-beaked common dolphin	*Delphinus delphis*	X	X		-
Long-beaked common dolphin	*Delphinus capensis*	X	X		-
Rough-toothed dolphin	*Steno bredanensis*		X		-
Striped dolphin	*Stenella coeruleoalba*	X	X		-
Spinner dolphin	*Stenella longirostris*		X		-
-"Whitebelly"	*Stenella longirostris longirostris*		X		-
-Central American	*Stenella longirostris centroamericana*		X		-
-Eastern	*Stenella longirostris orientalis*		X		Depleted
Pantropical spotted dolphin					
-Offshore form	*Stenella attenuata attenuata*		X		Depleted[2]
-Coastal form	*Stenella attenuata graffmani*		X		-
Commerson's dolphin	*Cephalorhynchus commersonii*			X	-
Black (Chilean) dolphin	*Cephalorhynchus eutropia*			X	-
Northern right whale dolphin	*Lissodelphis borealis*	X			-
Southern right whale dolphin	*Lissodelphis peronii*			X	-
Killer whale	*Orcinus orca*	X	X	X	-
-Southern Resident DPS		X			Endangered
Pygmy killer whale	*Feresa attenuata*		X		-
False killer whale	*Pseudorca crassidens*		X		-
Short-finned pilot whale	*Globicephala macrorhynchus*	X	X		-
Long-finned pilot whale	*Globicephala melas edwardii*			X	-
Melon-headed whale	*Peponocephala electra*		X		-
Cuvier's beaked whale	*Ziphius cavirostris*	X	X	X	-
Baird's beaked whale	*Berardius bairdii*	X	X		-
Arnoux's beaked whale	*Berardius arnuxii*			X	-
Mesoplodont beaked whales	*Mesoplodon spp.*	X	X	X	-
Gray's beaked whale	*Mesoplodon grayi*			X	-
Strap-toothed whale	*Mesoplodon layardii*			X	-
Peruvian beaked whale	*Mesoplodon peruvianus*		X		-

Species		CCRA	ETPRA	ARA	Federal ESA/MMPA Status[1]
Common Name	**Scientific Name**				
Southern bottlenose whale	*Hyperoodon planifrons*			X	-
Pygmy or Dwarf sperm whale	*Kogia breviceps or K. sima*	X	X		-
Sperm whale	*Physeter macrocephalus*	X	X	X	Endangered
Humpback whale	*Megaptera novaeangliae*	X	X	X	Endangered
Blue whale	*Balaenoptera musculus*	X	X	X	Endangered
Fin whale	*Balaenoptera physalus*	X	X	X	Endangered
Sei whale	*Balaenoptera borealis*	X	X	X	Endangered
Bryde's whale	*Balaenoptera edeni*	X	X		-
Common minke whale	*Balaenoptera acutorostrata*	X	X		-
Antarctic minke whale	*Balaenoptera bonaerensis*			X	-
Gray whale	*Eschrichtius robustus*	X			Delisted[3]
Southern right whale	*Eubalaena australis*			X	Endangered (foreign)
Pinnipeds					
California sea lion	*Zalophus californianus*	X	X		-
Steller sea lion -eastern subspecies (DPS)	*Eumetopias jubatus monteriensis*	X			Threatened
South American sea lion	*Otaria byronia*		X	X	-
Guadalupe fur seal	*Arctocephalus townsendi*	X	X		Threatened
Northern fur seal	*Callorhinus ursinus*				
-Pribilof Islands stock		X			Depleted
-San Miguel Island stock		X			-
South American fur seal	*Arctocephalus australis*			X	-
Antarctic fur seal	*Arctocephalus gazella*			X	-
Sub-Antarctic fur seal	*Arctocephalus tropicalis*			X	-
Northern elephant seal	*Mirounga angustirostris*	X	X		-
Southern elephant seal	*Mirounga leonina*			X	-
Harbor seal	*Phoca vitulina richardsii*	X			-
Leopard Seal	*Hydrurga leptonyx*			X	-
Weddell Seal	*Leptonychotes weddellii*			X	-
Crabeater Seal	*Lobodon carcinophagus*			X	-
Ross seal	*Ommatophoca rossii*			X	-
Fissipeds					
Sea otter					
-Northern subspecies	*Enhydra lutris kenyoni*	X			-[4]
-Southern subspecies	*Enhydra lutris nereis*	X			Threatened

[1]Denotes ESA listing as either endangered or threatened, or MMPA listing as depleted. By default, all species listed under the ESA as threatened or endangered are also considered depleted under the MMPA. All marine mammal stocks are considered protected under the MMPA.

[2]The northeastern offshore form of Pantropical spotted dolphin is listed as depleted under the MMPA

[3]The eastern North Pacific stock of gray whales was removed from the list of threatened and endangered species in 1994; the western North Pacific stock remains endangered.

[4]The northern sea otter is listed as a state endangered species by Washington State; the southwestern DPS, which occurs in Alaska is listed as threatened under the ESA.

3.2.2.1 Marine Mammal Acoustics and Hearing

Marine mammals rely on sound production and reception for social interactions (e.g., reproduction, communication), to find food, to navigate, and to respond to predators. General reviews of cetacean and pinniped sound production and hearing may be found in Richardson et al. (1995), Edds-Walton (1997), Wartzok and Ketten (1999), and Au (2000). Interfering with these functions through anthropogenic noise could result in potential adverse impacts.

Southall et al. (2007) provided a comprehensive review of marine mammal acoustics including designating functional hearing groups. Assignment was based on behavioral psychophysics (the relationship between stimuli and responses to stimuli), evoked potential audiometry, auditory morphology, and, for pinnipeds, whether they were hearing through air or water. Because no direct measurements of hearing exist for baleen whales, hearing sensitivity was estimated from behavioral responses (or lack thereof) to sounds, commonly used vocalization frequencies, body size, ambient noise levels at common vocalization frequencies, and cochlear measurements. Table 3.2-5 presents the functional hearing groups and representative species or taxonomic groups for each; most species found in the SWFSC project areas are in the first two groups, low frequency cetaceans (baleen whales) and mid frequency cetaceans (odontocetes).

Table 3.2-5 Summary of the five functional hearing groups of marine mammals.

Functional Hearing Group	Estimated Auditory Bandwidth	Species or Taxonomic Groups
Low Frequency Cetaceans **(Mysticetes–Baleen whales)**	7 Hertz (Hz) to 22kilohertz (kHz) (best hearing is generally below 10 kHz, higher frequencies result from humpback whales)	All baleen whales
Mid- Frequency Cetaceans **(Odontocetes—Toothed whales)**	150 Hz to 160 kHz (best hearing is from approximately 10-120kHz)	Includes species in the following genera: Steno, Tursiops, Stenella, Delphinus, Lagenodelphis, Lagenorhynchus, Lissodelphis, Grampus, Peponocephala, Feresa, Pseudorca, Orcinus, Globicephala, Physeter, Hyperoodon, Ziphius, Berardius, Mesoplodon
High-frequency Cetaceans **(Odontocetes)**	200 Hz to 180 kHz (best hearing is from approximately 10-150kHz)	Includes species in the following genera: Phocoena, Phocoenoides, Kogia, Cephalorhynchus
Pinnipeds in water	75 Hz to 75 kHz (best hearing is from approximately 1-30 kHz)	All seals, fur seals, sea lions
Pinnipeds in air	75 Hz to 30 kHz (best hearing is from approximately 1-16 kHz)	All seals, fur seals, sea lions

Source: based on Southall et al. 2007 and modified from DON 2008b.

3.2.2.2 Threatened and Endangered Marine Mammals

This section only discusses species listed as threatened and endangered under the ESA; Table 3.2-4 lists all marine mammal species encountered in the SFWSC California Current, Eastern Tropical Pacific, and Antarctic Reserves.

Killer whale

Status and trends: In 2005, NMFS listed the Puget Sound southern resident killer whale (SRKW) DPS as an endangered species under the ESA. The minimum population estimate of the SRKW DPS as reported in Carretta et al. (2011) is 85 whales based on direct counts of known individuals. The potential biological removal (PBR) level for this stock is calculated as the minimum population size (85) times one-half the default maximum net growth rate for cetaceans (half of four percent) times a recovery factor of 0.1, resulting in a PBR of 0.17 whales per year from the SRKW DPS. None of the other populations of killer whales that occur in SWFSC research areas are listed under the ESA.

Barlow and Forney (2007) estimated the density of killer whales in the CCE (California Current Ecosystem, as defined in the application for Letter of Authorization), regardless of ecotype, at 0.71 killer whales/1,000 km^2.

No defined ecotypes have been recognized for the ETP, although observed pursuit and predation on marine mammals would suggest the occurrence of transients in the area (Olson and Gerrodette 2008, Pitman et al. 2007, Rasmussen et al. 2004). Genetic analysis from biopsy samples indicate that the whales differ genetically from northeast Pacific resident killer whales (Pitman et al. 2007). The only available estimate of abundance for killer whales in the ETP is 8,500 (4,700-15,900; 95 percent confidence interval) based on surveys conducted 1986-1990 (Wade and Gerrodette 1993).

Information on the status, population trends, and distribution in the AMLR survey area are scant but suggest that killer whales are abundant. Line-transect surveys yielded estimates of 25,000 killer whales in the Southern Ocean (Ford 2009). During the 2008/2009 AMLR surveys to estimate abundance and map krill and fish, marine mammal observers recorded a density of 0.0015 killer whales/ km^2 within the survey area (Santora et al. 2009).

Distribution and habitat preferences: Killer whales are found in all oceans and are second only to humans as the most widely spread of all mammals (Ford 2009). They most commonly occur in coastal and temperate waters of high productivity. The range of SRKWs during the spring, summer, and fall includes the inland waters of Puget Sound, Strait of Juan de Fuca, and Southern Georgia Strait. The southern residents also occur in the coastal waters off the coast of Oregon, Washington, and Vancouver Island and in recent years off the central California coast and the Queen Charlotte Islands. As summarized by Carretta et al. (2011), most sightings of the SRKW stock have occurred in the summer in inland waters of Washington and southern British Columbia. The complete winter range of this stock is uncertain.

Killer whales are found throughout the ETP and occur year-round (Dalheim et al. 1982 cited in Olson and Gerrodette 2008). They have been sighted both offshore and nearshore, including off the coasts of Costa Rica and Panama (Hamilton et al. 2009, May-Collado et al. 2005, Rasmussen et al. 2004).

Behavior and life history: Killer whales are very social and the basic social unit is based on maternal relationship and linked by maternal decent. Females give birth between 11 and 16 years of age with a five-year interval between births. Gestation is 15-18 months and weaning is about 1-2 years after birth. Males attain sexual maturity at about 15 years of age. Life expectancy for females is about 50 years with a maximum of 80-90; males typically live to about 29 years of age (Ford 2009). Killer whales have no natural predators, but neonatal mortality is high with nearly 46 percent dying in the first 6 months (Ford 2009).

The SRKW DPS primarily feeds on salmon, especially Chinook salmon returning to rivers in Washington and southern British Columbia. Resident killer whale pods in Puget Sound exhibit cooperative food

searching but perhaps not food capture (Hoelzel 1993). Transient killer whales feed on seals, sea lions, and young or smaller cetaceans (Ford 2009) with an optimal group size of at least three whales needed to efficiently chase and capture marine mammal prey (Baird et al. 1992).

Sperm whale

Status and trends: Sperm whales are listed as endangered under the ESA, and consequently the California to Washington stock is considered as a depleted and strategic stock under the MMPA. The most precise and recent estimate of sperm whale abundance for this stock is 971 (Coefficient of Variation = 0.33) based on ship surveys conducted in 2005 (Forney 2007) and 2008 (Barlow 2010). The minimum population estimate for sperm whales in this region is 751 whales with a calculated PBR of 1.5 sperm whales per year. The annual rate of kill and serious injury (0.4 per year) is less than the calculated PBR for this stock (1.5). Total human-caused mortality is greater than 10 percent of the calculated PBR and, therefore, cannot be considered to be approaching zero mortality and serious injury (M&SI) rate.

Barlow and Forney (2007) estimated the density of sperm whales in the CCE at 1.70 whales/1000 km^2.

Sperm whales in the ETP were considered one stock for the purposes of estimating abundance. Gerrodette and Forcada (2002) estimated sperm whale abundance in the ETP in 2000 as 4,145 individuals (354-12,114; 95 percent confidence interval). This was down from an estimated 26,652 in 1999 and was the lowest estimate derived between 1986 and 2000 (the highest was 49,653). Reasons for differences in estimates include the likelihood of missing sperm whales on prolonged dives, difficulty in accurately estimating group size, and the possibility that whales, whose range extends beyond the survey boundaries, move readily into or out of the survey area (Gerrodette and Forcada 2002).

There is no information on status and trends of sperm whales within the SWFSC AMLR survey area. Female and young sperm whales are not often seen in higher latitudes; males can be found over almost any ice-free deep water area including waters within the SWFSC AMLR survey area (Whitehead 2009). However, there are no estimates of sperm whale density within the survey area.

Distribution and habitat preferences: As described by Carretta et al. (2011, and citations therein), populations of sperm whales exist in waters of the CCRA throughout the year. They are distributed across the entire North Pacific and into the southern Bering Sea in summer, but the majority are thought to be south of 40° N in winter. Sperm whales are found year round in California waters, but they reach peak abundance from April through mid-June and from the end of August through mid-November.

Recent summer/fall surveys in the ETP show that although sperm whales are widely distributed in deep waters of the area, their relative abundance decreases towards the middle of the tropical Pacific (near the International Whaling Commission stock boundary at 150° W) and tapers off northward towards the tip of Baja California. Sperm whales in the ETP are predominantly females and immature animals. They are capable of extensive movements which they adapt over an array of temporal and spatial scales relative to the distribution of resources. Movements of 1,000 kilometers (e.g., between the Galápagos Islands and mainland Ecuador or Panama) are common (Whitehead et al. 2008). Males are rare in the area, primarily due to their high-latitude non-breeding distribution and late age at which they return to the breeding areas (Whitehead et al. 2008).

Behavior and life history: Females reach sexual maturity at about age 9 when roughly 9 meters long and they give birth about every 5 years; gestation is 14-16 months (Whitehead 2009). Sperm whales consume numerous varieties of deep water fish and cephalopods.

Humpback whale

Status and trends: The humpback whale is listed as endangered under the ESA throughout its range. In the North Pacific, there are at least three separate populations, all of which migrate between specific summer/fall feeding areas and winter/spring calving and mating areas.

The California/Oregon/Washington stock spends the winter in coastal waters of Mexico and Central America, and the summer along the west coast from California to British Columbia. The Central North Pacific stock spends winters in Hawaii and summers in Alaska, and its distribution may partially overlap with that of the California/Oregon/Washington stock off the coast of Washington and British Columbia (Clapham 2009). Finally, the Western North Pacific stock spends winters near Japan and probably migrates to the Bering Sea and Aleutian Islands in summer. There is some mixing between these populations, though they are still considered distinct stocks. The California/Oregon/Washington stock and the central North Pacific stocks occur in SWFSC CCE research areas.

The minimum estimate for humpback whales in the California/Oregon/Washington population based on line-transect and mark-recapture methods is 1,878, and the population is thought to be growing at about 6-7 percent per year (Calambokidis et al. 2009, Carretta et al. 2011). The PBR level for this stock is calculated as the minimum population size (1,878) times one half the estimated population growth rate for this stock times a recovery factor of 0.1, resulting in a PBR of 22.5. Because this stock spends approximately half its time outside the U.S. EEZ, the PBR allocation for U.S. waters is 11.3 whales per year. The estimated annual M&SI due to entanglement (3.2/year), other anthropogenic sources (zero), plus ship strikes (0.4/year) in California is less than the PBR allocation of 11.3 for U.S. waters. Based on strandings and at sea observations, annual humpback whale M&SI in commercial fisheries is greater than 10 percent of the PBR; therefore, total fishery M&SI is not approaching zero M&SI rate. However, the stock appears to be increasing in abundance (Carretta et al. 2011).

The minimum population estimate for the Central North Pacific stock of humpback whales, calculated from counts of unique individuals, is 5,833 whales. Using a maximum net productivity rate of 0.07, and a recovery factor of 0.3, the PBR for the central North Pacific stock is calculated to be 61.2 whales.

Barlow and Forney (2007) estimated the density of humpback whales in the CCE at 0.83 whales/1,000 km^2.

Humpback whales wintering in the coastal regions of the ETP - notably Costa Rica to Peru - are from both the northern and southern hemispheres. Costa Rica is unique as a region of geographic overlap for stocks of humpback whales that feed off California (California/Oregon/Washington stock) and off the Antarctic Peninsula and southern Chile (Breeding Stock G) (Acevedo and Smultea 1995, Calambokidis et al. 2000, Félix and Botero-Acosta 2011, Rasmussen et al. 2007). Peak numbers occur off Costa Rica during January to March and August to October, the northern and southern hemisphere humpback whale wintering seasons, respectively (May-Collado et al. 2005, Rasmussen et al. 2004).

No abundance estimates have been calculated for humpback whales in the ETP.

In the Southern Hemisphere, humpbacks feed in circumpolar waters around the Antarctic and migrate to relatively discrete breeding grounds in tropical waters to the north (Clapham 2009). There is no information on the status and population trends for humpback in the Antarctic, however, during the 2008/2009 AMLR surveys to estimate abundance and map krill and fish, marine mammal observers recorded a density of 0.036 humpback whales/ km^2 within the survey area (Santora et al. 2009).

Distribution and habitat preferences: Humpback whales are found in all oceans of the world and migrate from high latitude feeding grounds to low latitude calving areas. They are typically found in coastal or shelf waters in summer and close to islands and reef systems in winter (Clapham 2009). Humpbacks primarily occur near the edge of the continental slope and deep submarine canyons, where upwelling concentrates zooplankton near the surface for feeding. They often feed in shipping lanes which makes them susceptible to mortality or injury from large ship strikes (Douglas et al. 2008).

Behavior and life history: Humpback whales are known for their spectacular aerial behaviors and complex songs of males. They breed in warm tropical waters after an 11 month gestation period; calves feed independently after about 6 months. Humpback whales feed on euphausiids and various schooling fishes, including herring, capelin, sand lance, and mackerel (Clapham 2009).

Blue whale

Status and trends: Blue whales are listed as endangered under the ESA. The best estimate of blue whale abundance in the U.S. West Coast feeding stock component of the eastern North Pacific stock is 2,497 (Coefficient of Variation = 0.24) (Carretta et al. 2011). Barlow and Forney (2007) estimated the density of blue whales in the CCE at 1.36 whales/1,000 km^2. The minimum population is approximately 2,046 blue whales with a calculated PBR of 12.2 (Carretta et al. 2011). Because whales in this stock spend approximately three quarters of their time outside the U.S. EEZ, the PBR allocation for U.S. waters is one-quarter of this total, or 3.1 whales per year. The annual incidental mortality and injury rate (1.0/year) from ship strikes is less than the calculated PBR for this stock. To date, no blue whale mortality has been associated with California gillnet fisheries; and the total fishery M&SI rate is approaching zero.

Blue whales in the ETP also belong to the eastern North Pacific stock (Carretta et al. 2010, Stafford et al. 1999). The most recent estimate of abundance for blue whales in the ETP is 1,415 (1,078-2,501; 95 percent confidence interval) (Wade and Gerrodette 1993).

There is no information on status and trends of blue whales within the SWFSC AMLR survey area. In the Southern Ocean, where the blue whale was historically most abundant, it is rare today with abundance estimates of 1,700 whales and discrete feeding stocks (Sears and Perrin 2009).

Distribution and habitat preferences: The blue whale has a worldwide distribution in circumpolar and temperate waters. Seasonal migrations of blue whales are driven by food requirements. Poleward movements in the spring allow the whales to take advantage of high zooplankton production in summer, while movement toward the subtropics in the fall allows blue whales to reduce their energy expenditure while fasting and to avoid ice entrapment. The eastern North Pacific Stock of blue whales ranges from the northern Gulf of Alaska to the ETP (Carretta et al. 2011). Most of this stock is believed to migrate south to spend the winter and spring in high productivity areas off Baja California, in the Gulf of California, and on the Costa Rica Dome (a large, 300-500 km^2, relatively stationary eddy centered near 9° N and 89° W).

Behavior and life history: Blue whales reach sexual maturity at 5-15 years of age; length at sexual maturity in the Northern Hemisphere for females is 21-23 meters and for males it is 20-21 meters (Sears and Perrin 2009). Females give birth about every 2-3 years in winter after a 10-12 month gestation; longevity is thought to be at least 80-90 years (Sears and Perrin 2009). Blue whales occur primarily in offshore deep waters (but sometimes near shore, e.g. the deep waters in Monterey Canyon, CA) and feed almost exclusively on euphausiids.

Fin whale

Status and trends: Fin whales are listed as endangered under the ESA, and consequently the California to Washington stock is considered as a depleted and strategic stock under the MMPA. The best estimate of fin whale abundance in California, Oregon, and Washington waters out to 300 nm is 3,044 (Coefficient of Variation = 0.18) whales, the geometric mean of line transect estimates from summer/autumn ship surveys conducted in 2005 (Forney 2007) and 2008 (Barlow 2010). The minimum population estimate is 2,624 fin whales with a calculated PBR of 16 whales per year. Barlow and Forney (2007) estimated the density of fin whales in the CCE at 1.84 whales/1,000 km^2. The total incidental mortality due to fisheries (zero) and ship strikes (1.0/year) is less than the calculated PBR (16). Total fishery mortality is less than 10 percent of PBR and the M&SI rate may be approaching zero.

Fin whales sightings are rare in the ETP (Carretta et al. 2010, Wade and Gerrodette 1993). Only one fin whale was recorded north of the study area along the coast of Baja California between 1986 and 1990 (Wade and Gerrodette 1993) and 10 out of 13 fin whales sighted during surveys from 1998 to 2008 were also along the Baja coast (Jackson et al. 2004, 2008, Kinzey et al. 1999, 2000, 2001).

Population status and trends information for fin whales in the SWFSC AMLR survey area are lacking. However, during the 2008/2009 AMLR surveys to estimate abundance and map krill and fish, marine

mammal observers recorded a density of 0.084 fin whales/ km^2. within the survey area (Santora et al. 2009).

Distribution and habitat preferences: Fin whales are distributed widely in the world's oceans and occur in both the Northern and Southern Hemispheres between 20–75° latitude (DON 2008b). In the northern hemisphere, they migrate from high Arctic feeding areas to low latitude breeding and calving areas. The North Pacific population summers from the Chukchi Sea to California, and winters from California southward.

Behavior and life history: Fin whales become sexually mature between 6 to 10 years of age, and reproduce primarily in the winter. Gestation lasts about 11 months and nursing occurs for 6 to 11 months (Aguillar 2009). Fin whales feed on planktonic crustaceans, including *Thysanoessa* sp. and *Calanus* sp., as well as schooling fish including herring, capelin and mackerel (Aguilar 2009).

Sei whale

Status and trends: Sei whales are listed as endangered under the ESA, and consequently the eastern North Pacific stock is automatically considered as a depleted and strategic stock under the MMPA. The best estimate of abundance for California, Oregon, and Washington waters out to 300 nm is 126 (Coefficient of Variation = 0.53) sei whales, the unweighted geometric mean of the 2005 and 2008 estimates (Barlow and Forney 2007, Forney 2007, Barlow 2010). Barlow and Forney (2007) estimated the density of sei whales in the CCE at 0.09 whales/1,000 km^2. The minimum population estimate is 83, with a calculated PBR of 0.17 sei whales per year. Total estimated fishery mortality is zero and therefore is approaching zero M&SI rate. The total incidental mortality due to ship strikes is greater than the calculated PBR (0.17).

The estimated pre-whaling population of sei whales in the Southern Hemisphere was about 100,000; in 1980 the population was thought to be 24,000 whales (Horwood 2009). Sei whales are occasionally seen during transit of Drake's Passage, the sub-antarctic and around South America, however the population status and trends in this area are not known.

Distribution and habitat preferences: As summarized in Horwood (2009) and DON (2008a,b), sei whales have a worldwide distribution but are found primarily in cold temperate to subpolar latitudes rather than in the tropics or near the poles (Horwood 2009). Sei whales spend the summer months feeding in subpolar higher latitudes and return to lower latitudes to calve in the winter. There is some evidence from whaling catch data of differential migration patterns by reproductive class, with females arriving at and departing from feeding areas earlier than males. For the most part, the location of winter breeding areas is unknown.

Behavior and life history: Sei whales mature at about 10 years for both sexes. They 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. On feeding grounds, the distribution is largely associated with oceanic frontal systems (Horwood 2009). In the North Pacific, sei whales feed along the cold eastern currents (Perry et al. 1999). Prey includes calanoid copepods, krill, fish, and squid. The dominant food for sei whales off California during June through August is the northern anchovy, while in September and October they eat mainly krill.

Southern Right Whale

Status and trends: Southern right whales are listed as endangered under the ESA and designated as depleted under the MMPA. The total abundance of Southern right whales in 1997 was 7,571 whales with those in some areas increasing at 7-8 percent annually. Assuming continued increase during the period from 1997 to the present, the total abundance could currently exceed 15,000 animals (Kenney 2009). Abundance in the CCAMLR survey area during 2000, which included the Scotia Sea and Antarctica

Peninsula, was estimated to be 1,755 (Coefficient of Variation = 61.67) right whales (Reilly et al. 2004). Estimates of status and trends specific to the SWFSC AMLR survey area are not available.

Distribution and habitat preferences: Southern right whales are found in the middle latitudes of the Southern Ocean between approximately 20° and 60° S. Multiple stocks have been hypothesized to reside near Argentina/Brazil, South Africa, east Africa, western Australia, southeastern Australia, New Zealand, and Chile. They migrate annually between high-latitude feeding grounds and low-latitude calving and breeding grounds. Feeding grounds for this species appears to be offshore, pelagic regions in areas of high productivity (Kenney 2009). Calving often occurs in shallow coastal waters and bays.

Behavior and life history: Right whales have a three year reproductive cycle; mating likely occurs in or near the calving grounds. DON (2008a) summarized the literature on northern right whale foraging behavior; it is that likely southern right whale foraging behavior is similar. Dives of 5-15 minutes or longer have been reported, but can be much shorter when feeding. Foraging dives in the feeding high-use areas are frequently near the bottom and the average depth of a dive was strongly correlated with both the average depth of peak copepod abundance and the average depth of the mixed layer. Killer whales and large sharks are likely predators of Southern right whales.

Steller Sea Lion: Eastern Subspecies

Status and trends: A recent paper has proposed that the two recognized Steller sea lion stocks (eastern and western) be formally designated as two subspecies (Phillips et al. 2009). Presently the eastern subspecies (*Eumetopias jubatus monteriensis*), which includes those that occur from California to Prince William Sound, Alaska, is listed as threatened under the ESA; the western subspecies (*E. j. jubatus*) is listed as endangered. The vernacular name for the eastern subspecies has been proposed as Loughlin's northern sea lion; the western subspecies is to remain as Steller sea lion. The geographic separation for the subspecies designation is at 144° W, near Cape Suckling, AK (Loughlin 1997). However since the vernacular designation of the eastern subspecies as Loughlin's northern sea lion is new, the vernacular Steller sea lion will be used in this document.

Based on extrapolations from non-pup and pup surveys, the total population of the eastern stock of Steller sea lions is estimated to be within the range of 58,334-72,223 with a minimum population estimate of 52,847 and a PBR of 2,378 (Allen and Angliss 2011). This stock is listed as threatened under ESA. Overall the stock has been increasing at about 3.1 percent per year since the 1970s with the population more than doubling in size by 2004, principally in Southeast Alaska (Pitcher et al. 2007).

Critical habitat in California and Oregon is defined as an area 3,000 feet from important rookeries and haulout sites and 3,000 feet above these sites.

NOAA is proposing to remove the eastern Steller sea lion from the list of endangered wildlife after a biological status review determined the species is recovering sufficiently. The status review shows the population has met recovery criteria outlined in the recovery plan developed by NOAA fisheries in 1992 and revised in 2008.

Distribution and habitat preferences: The eastern subspecies of Steller sea lion is present year round within the CCRA, with peak numbers in late summer, fall, and winter (Carretta et al. 2011). Telemetry studies show that in winter adult females may travel far out to sea into water greater than 1,000 meters deep (Merrick and Loughlin 1997), and juveniles less than 3 years of age travel nearly as far (Loughlin et al. 2003). Sea lions commonly occur near and beyond the 200 meter depth contour. Some individuals may enter rivers in pursuit of prey.

Behavior and life history: Steller sea lions breed from late May to early July throughout the range at rookeries located on remote islands and rocks. One pup is born annually after a 9 month gestation period. Steller sea lions are opportunistic predators, feeding primarily on a wide variety of fishes and

cephalopods. Some of the more important prey species include Pacific whiting, walleye pollock, Atka mackerel, Pacific herring, capelin, Pacific sand lance, Pacific cod, and salmon (Loughlin 2009).

Guadalupe fur seal

Status and trends: Guadalupe fur seals are listed as a threatened species under the ESA, and consequently their stocks are automatically considered as depleted and strategic under the MMPA. The state of California lists the Guadalupe fur seal as a fully protected mammal and it is also listed as a threatened species in the Fish and Game Commission California Code of Regulations. The population was estimated by Gallo (1994) to be about 7,408, derived by multiplying the number of pups (counted and estimated) by a factor of 4.0. The minimum size of the population in Mexico can be estimated using an actual count of 3,028 hauled out seals with a PBR of 91 Guadalupe fur seals. There is insufficient information to determine whether the fishery mortality in Mexico exceeds the PBR for this stock. The total U.S. fishery M&SI for this stock is less than 10 percent of the calculated PBR and, therefore, can be considered to be approaching zero M&SI rate. The population is growing at approximately 13.7 percent per year.

Distribution and habitat preferences: Guadalupe fur seals pup and breed mainly at Isla Guadalupe, Mexico (Arnould 2009; Carretta et al. 2011 and citations therein). The population is considered to be a single stock because all individuals are recent descendants from one breeding colony at Isla Guadalupe, Mexico. Individuals have been sighted as far north as central California, and as far south as Zihuatanejo, Mexico. Guadalupe fur seals are seasonally present in low numbers in California waters.

Behavior and life history: Definitive data are lacking on life history of Guadalupe fur seals, but most species in the genus reach sexual maturity at 3-5 years of age; males also mature at about the same age but are unable to attain reproductive status (obtain a reproductive territory) until 7-10 years of age. Guadalupe fur seals pup in June-July. Southern fur seals, including the Guadalupe fur seal, feed on a variety of prey including fish, cephalopods and crustaceans, depending on prey abundance and location. Most southern fur seals forage in upwelling zones, oceanic fronts, or continental shelf-edge regions (Arnould 2009). Specific foraging and dive information is not known for the Guadalupe fur seal. But other species in this genus forage mainly in the surface mixed layer (<50-60 meters) at night (Arnould 2009).

Sea Otter: Southern and Northern Subspecies

Status and trends: Three subspecies of sea otters are recognized: *E.l. lutris* (which occurs primarily in Russia), *E.l. kenyoni* (the Northern subspecies which occurs primarily in Alaska and Washington state), and *E.l. nereis* (the Southern subspecies which occurs in central California). The Southern subspecies of sea otters is listed as threatened under the ESA. The 2009 spring survey of sea otters in central California found 2,654 otters, 3.8 percent lower than the 2008 count and the 3-year average was 2813, a decline of -0.46 percent from 2008.

Although otters off Washington State are descended from the Amchitka Island sea otters and are thus related to the southwest Alaska DPS recently listed as threatened under the ESA, they are geographically isolated from the southwest Alaska population by hundreds of kilometers and are not included in the listing. In Washington state, 65 sea otters were counted in 1985, increasing to 276 sea otters in 1991 and 814 sea otters in 2005 (Jameson and Jeffries 2005). Lairdre et al. (2002) estimated the carrying capacity of sea otters in Washington at 1,836 individuals.

Distribution and habitat preferences: Sea otters are non-migratory, full time residents in Pacific coastal areas. They rarely wander more than a few miles from their established feeding grounds (Kenyon 1981). Otters prefer a protected inshore area with a rocky bottom and an abundance of kelp (Riedman 1990).

Behavior and life history: Sea otters pup in late winter and early spring, and the pups are weaned in late summer and early fall. They forage on a variety of marine invertebrates, including sea urchins, throughout

the entire depth range from intertidal areas out to at least 40 meters (Estes et al. 2009). Feeding occurs both at day and night. Sea otters are preyed upon by white sharks, killer whales, and, infrequently, Steller sea lions.

3.2.2.3 Non-ESA Listed Marine Mammals that have been taken during the course of historical SWFSC research activities.

Pacific white-sided dolphin

Status and trends: Pacific white-sided dolphins are not listed as threatened or endangered under the ESA nor as depleted under the MMPA. The 2005-2008 geometric mean abundance estimates for California, Oregon and Washington waters based on the two most recent ship surveys is 26,930 with a minimal population estimate of 21,406 dolphins. Barlow and Forney (2007) estimated the density of Pacific white-sided dolphins in the CCE at 20.93 dolphins/1,000 km^2. The PBR is 193 animals. No long-term trends in the abundance of Pacific white-sided dolphins in California, Oregon and Washington are suggested based on historical and recent surveys (Carretta et al. 2011). The average annual human-caused mortality in 2000-2006 (1.4 animals) is estimated to be less than the PBR (193), and therefore they are not classified as a strategic stock under the MMPA. The total fishery M&SI for this stock is less than 10 percent of the calculated PBR and, therefore, can be considered to be approaching zero M&SI rate.

Distribution and habitat preferences: As summarized in Carretta et al. (2011, and citations therein), Pacific white-sided dolphins are endemic to temperate waters of the North Pacific Ocean, and are common both on the high seas and along the continental margins. Off the U.S. west coast, Pacific white-sided dolphins have been seen primarily in shelf and slope waters. Sighting patterns from recent aerial and shipboard surveys conducted in California, Oregon and Washington suggest seasonal north-south movements, with animals found primarily off California during the colder water months and shifting northward towards Oregon and Washington as water temperatures increase in late spring and summer.

Behavior and life history: As summarized from Black (2009, and citations therein) calving occurs from May to September. Age and length of maturation varies by area with females becoming sexually mature at 8-11 years with a 4 to 5 year calving interval. Prey species include cephalopods (30 species known to be consumed) and schooling fishes (at least 60 species) (Black 2009).

Northern right-whale dolphin

Status and trends: Northern right-whale dolphins in California, Oregon and Washington are not listed as threatened or endangered under the ESA, nor as depleted under the MMPA. A multi-year average abundance estimate is the most appropriate for management within U.S. waters; the 2005-2008 geometric mean abundance estimate for California, Oregon and Washington waters based on the two ship surveys is 8,334 (Coefficient of Variation = 0.40) northern right-whale dolphins with a minimum population estimate for 2005-2008 of 6,019 dolphins; the PBR is 48 dolphins per year (Carretta et al. 2011). Barlow and Forney (2007) estimated the density of northern right-whale dolphins at 9.75 dolphins/1,000 km^2.

The average annual human-caused mortality in 2002-2006 (4.8 animals) is estimated to be less than the PBR (48), and therefore they are not classified as a "strategic" stock under the MMPA. The total fishery M&SI for northern right-whale dolphins is less than 10 percent of the calculated PBR and, therefore, can be considered to be approaching zero M&SI rate (Carretta et al. 2011).

Distribution and habitat preferences: Northern right-whale dolphins occur in the survey area year-round, but their abundance and distribution vary seasonally. This species is most abundant off central and northern California in nearshore waters in winter. They occur off Oregon and Washington except in winter; peak abundance occurs along the continental slope in fall (Carretta et al. 2011; DON 2008b). Right-whale dolphins prefer cool-temperate and subarctic waters in the North Pacific. They tend to be offshore oceanic cetaceans with rare inshore sightings (Lipsky 2009).

Behavior and life history: Sexual maturity occurs at about 10 years of age. Although calving seasonality is unknown, small calves are seen in winter and early spring. They tend to be gregarious and travel in groups of up to 2,000-3,000 in the North Pacific. Their diet consists primarily of squid and mesopelagic fish.

California sea lion

Status and trends: California sea lions in the U.S. are not listed as endangered or threatened under the ESA or as depleted under the MMPA. Based on extrapolations from pup counts, the population is estimated at 238,000 sea lions, and it is growing at 5.6 percent per year (Carretta et al. 2011). The minimum population estimate for the U.S. stock is 141,842 sea lions. The calculated PBR for this stock is 8,511 animals (Carretta et al. 2011). California sea lions are not considered a strategic stock under the MMPA because total human-caused mortality is likely to be less than the PBR (8,511). The total fishery M&SI rate for this stock is likely above 10 percent of the calculated PBR and, therefore, cannot be considered to be approaching a zero M&SI rate.

Distribution and habitat preferences: California sea lions breed in three geographic regions which are used to separate the subspecies into three stocks: (1) the U.S. stock begins at the U.S./Mexico border and extends northward into Canada; (2) the Western Baja California stock extends from the U.S./Mexico border to the southern tip of the Baja California Peninsula; and (3) the Gulf of California stock includes the Gulf of California from the southern tip of the Baja California peninsula (Carretta et al. 2011). The primary rookeries are located on the California Channel Islands of San Miguel, San Nicolas, Santa Barbara, and San Clemente. As summarized in Carretta et al. (2011) and DON (2008b, and references therein) their distribution shifts to the northwest in fall and to the southeast during winter and spring, probably in response to changes in prey availability.

Behavior and life history: California sea lion numbers ashore increase rapidly in May when males establish breeding territories. Birth to a single pup occurs from May through June and pups are weaned in about 10-12 months (Heath and Perrin 2009). California sea lions feed primarily on Pacific whiting, Pacific herring, salmonids, dogfish sharks, and squid.

Northern fur seal

Status and trends: Northern fur seals are divided into two stocks in U.S. waters: Eastern Pacific stock (Pribilof Islands and Bogoslof Island) and San Miguel Island stock. The Pribilof Islands northern fur seal population was designated as depleted pursuant to the MMPA in 1988 because it declined to less than 50 percent of levels observed in the late 1950s and there was no compelling evidence that the northern fur seal carrying capacity of the Bering Sea had changed substantially (NMFS 2007). The San Miguel Island stock is not designated as depleted. The minimum population estimate for the Pribilof Islands stock is 642,265 fur seals and for the San Miguel Island stock it is 5,395 fur seals. The calculated PBR for the San Miguel Island stock is 324 fur seals per year; the calculated PBR for the Pribilof Islands stock is 13,809 fur seals per year (Carretta et al. 2011; Allen and Angliss 2011).

Distribution and habitat preferences: NMFS (2007) summarized northern fur seal distribution. They are endemic to the North Pacific Ocean. During the winter the southern limit of their range extends across the Pacific Ocean from southern California to the Okhotsk Sea and Honshu Island, Japan. In the spring most northern fur seals migrate north to breeding colonies in the Bering Sea. The largest breeding colonies are located on St. Paul and St. George islands in the Pribilof Islands and compose approximately 74 percent of the worldwide fur seal population. Other breeding colonies are located in the Commander Islands (Russia) in the western Bering Sea and on Robben Island (Russia) in the Okhotsk Sea that compose approximately 15 and 9 percent of the population, respectively. Small breeding colonies are also located on the Kuril Islands in the western North Pacific, Bogoslof Island in the central Aleutian Islands, and on San Miguel Island off the southern California coast. Northern fur seals are primarily pelagic in the

winter months, but occasionally haul-out onto land for brief periods. The subpolar continental shelf and shelf break from the Bering Sea to California are feeding grounds while fur seals are at sea.

Behavior and life history: Northern fur seals feed on schooling fish and gonatid squid, although the species consumed vary with location and season (Sinclair et al. 1996).

From November to March Northern fur seals remain north of about 35° N latitude without coming ashore. In March and April they gather along continental shelf breaks and begin to migrate to their respective breeding islands (Gentry 2009). Males come ashore and acquire breeding territories in late May and June and most pups are born in July, nursed for about 4 months and weaned in October or November. They are a highly migratory species and typically return to their natal sites to breed.

3.2.3 Birds

3.2.3.1 Threatened and Endangered Species

The ESA allows the USFWS to list bird species as endangered or threatened regardless of which country the species lives in. Although greater legal protections are given to ESA-listed species within the U.S. EEZ, the law also protects listed species wherever they occur from potentially adverse interactions with people and entities subject to U.S. jurisdiction, such as the SWFSC and its researchers. Table 3.2-6 identifies the ESA-listed species occurring within the SWFSC CCRA and ETPRA. No ESA-listed species are likely to encounter SWFSC research activities in the ARA. The brown pelican (*Pelecanus occidentalis*) was delisted in 2009 due to recovery (74 FR 59444).

Table 3.2-6 ESA-listed Birds Occurring in the SWFSC Research Areas.

Species		CCRA	ETPRA	Federal ESA Status
Common Name	**Scientific Name**			
Short-tailed albatross	*Phoebastria albatrus*	X		Endangered
Hawaiian dark-rumped petrel	*Pterodroma sandwichensis*		X	Endangered
Galapagos petrel	*Pterodroma phaeopygia*		X	Threatened (foreign)
Newell's shearwater	*Puffinus auricularis newelli*		X	Threatened
Humboldt penguin	*Spheniscus humboldti*		X	Threatened (foreign)
Galapagos penguin	*Spheniscus mendiculus*		X	Endangered (foreign)
California least tern	*Sterna antillarum browni*	X		Endangered
Marbled murrelet	*Brachyramphus marmoratus*	X		Threatened

California Current

Short-tailed albatross

The short-tailed albatross is the largest of the three albatross species found in the North Pacific Ocean. The species used to be the most abundant albatross in the North Pacific but was almost exterminated by feather and meat hunters on its Japanese breeding grounds in the early 1900s. The short-tailed albatross was listed as endangered by the USFWS in 2000 and a Final Recovery Plan was published in 2008 (USFWS 2008). Conservation efforts have helped the population grow at near-maximum rates but the total population is still less than 3,000 birds (USFWS 2009). Major threats to this species include natural

threats to their nesting habitat on volcanic islands, mortality in longline fisheries, and ingestion of plastic debris (USFWS 2008).

California least tern

The least tern is the smallest member of the gull family. The west coast population of least tern (California least tern) was listed as endangered by the USFWS in 1970, and a recovery plan was published in 1980 (USFWS 1985). Major threats to this species include human use and development of nesting habitat and predation on adults, eggs, and young by birds and mammals, and habitat loss due to encroachment of vegetation (USFWS 1985, USFWS 2006).

Marbled murrelet

The marbled murrelet is a small seabird that occurs from Alaska to northern Mexico. The southern population was listed as threatened in Washington, Oregon, and California in 1992 due to habitat loss from logging and coastal development, susceptibility to oil spills, and mortality in gill-net fisheries (USFWS 1997b).

Eastern Tropical Pacific

Hawaiian dark-rumped petrel

The Hawaiian dark-rumped petrel occurs in the central subtropical Pacific and nests only in the Hawaiian Islands. This species was listed as an endangered species by the USFWS in 1967 due to its limited distribution and the marginal status of known breeding populations. The Hawaiian dark-rumped petrel and Newell's shearwater recovery plan was finalized in 1983 (USFWS 1983). Major threats to this species include attraction to and disorientation by artificial lights leading to exhausted birds landing in dangerous situations and colliding with power lines and other structures, habitat destruction, and predation by non-native terrestrial mammals (USFWS 2011).

Galapagos petrel

The Galapagos petrel is endemic to the Galapagos Islands, Ecuador and breeds in the archipelago. This species was listed under the ESA as a foreign threatened species in 2010 (75 FR 235). It has been classified as critically endangered by the International Union for Conservation of Nature (IUCN) since 1994 due to extreme declines in population in the past three generations. Major threats include predation, habitat degradation, and mortality in fishing nets (IUCN 2011).

Newell's shearwater

Newell's shearwaters occur in the central subtropical Pacific and breed exclusively in the Hawaiian Islands (Ainley at al. 1997). This species was listed as threatened in 1982 due to limited distribution and the marginal status of known breeding populations (USFWS 1983). Major threats to this species include predation on nesting grounds by non-native terrestrial mammals, human disturbance, and destruction of nesting habitat. The Newell's Shearwater depends on tuna to force prey within its reach. These tuna are targeted in commercial fisheries which decrease their abundance and cause foraging shearwaters to exert more energy to find schools of tuna (Ainley et al. 1997).

Humboldt penguin

The Humboldt penguin occurs in the coastal areas of Peru and Chile, with some occurring in Colombia and Ecuador. This species was listed under the ESA as a foreign threatened species in 2010 (75 FR 45497). Humboldt penguin was classified by the IUCN in 2002 as vulnerable due to a reduction in the number of breeding colonies of these birds (IUCN 2011b). Major threats include nesting habitat loss and

degradation from guano mining and invasive species, pollution, competition with fisheries for prey species, and entanglement and drowning in gill nets and long line fishing gear (UNEP WCMC 2003). One study found that 8 of 19 tagged birds were found dead due to entanglement in gill nets (Wallace et al. 1999).

Galapagos penguin

The Galapagos penguin is endemic to the Galapagos Islands and was listed as a foreign endangered species in 1970 (35 FR 8941) due to its very restricted breeding range and declining population. This is the most northern breeding penguin, nesting on the equator, but it relies on the cold currents around the Galapagos to support rich prey fish populations. The major conservation concerns include introduced predators on nest islands and the adverse effects of El Nino events on forage fish, resulting in major population declines of the penguins in 1982–83 and 1997–98 (Boersma 1998, Vargas et al. 2005).

3.2.3.2 Other Bird Species

There are many seabird species that occur in the three SWFSC fisheries research areas that may potentially interact with research vessels and gear. However, birds have never been caught incidentally in SWFSC fisheries surveys. The following accounts give brief overviews of the marine bird communities in the research areas. Additional information of the natural history, habitats, and conservation status of marine birds in each research area can be found in the first references cited in each section, which are incorporated by reference.

California Current

The California Current Ecosystem supports over 150 species of breeding and migrating seabirds, including sea ducks, loons, grebes, albatross, petrels, shearwaters, storm-petrels, tropicbirds, boobys, cormorants, pelicans, phalaropes, gulls, terns, murres, murrelets, auklets, and puffins (Mills et al. 2005). All species likely to occur in the California Current research area are protected by the Migratory Bird Treaty Act (16 U.S.C. 703 *et. seq.*) as well as conservation laws in Canada and Mexico. Some species travel long distances over the ocean and have many potentially adverse interactions with humans and their activities, such as commercial and recreational fisheries and oil spills from transport vessels and offshore oil wells. Human activities on land can also affect them at sea or at inland nest sites, including agricultural and urban runoff contamination and land clearing for resource development (Mills et al. 2005). However, natural factors such as changes in ocean currents, prey availability, and severe weather can drive population fluctuations for many species (Ainley and Hyrenbach 2007). The impacts of climate change on weather, ocean chemistry, and oceanographic patterns and the ecological effects on different bird species is a topic of considerable interest and research (Sydeman et al. 2009).

Eastern Tropical Pacific

The ETP supports about 100 species of seabirds (Balance et al. 2006). The most common seabirds found in the ETP include a variety of shearwaters, tropicbirds, boobies, terns, frigatebirds, petrels, phalaropes, gulls, noddy's, and jaegers (Olson et al. 2001). A study of the ecology of seabird communities in the ETP selected 10 of the most abundant species as "indicator species" for the ETP environment (Balance et al. 2002). These species represented a wide range of the different foraging strategies used by seabirds. Four of these species were highly dependent on tunas and dolphins to chase small schooling fish from deeper waters up to the surface where the birds could prey on them. These were considered "tuna-obligate" species: Juan Fernandez petrel (*Pterodroma externa*), wedge-tailed shearwater (*Puffinus pacificus*), red-footed booby (*Sula sula*), and sooty tern (*Sterna fuscata*). ETP tuna purse seine fishermen will often target aggregations of birds knowing that there may be schools of tuna below. Despite such close associations between seabirds and tuna, seabirds have not been observed to be caught in purse seines

during tuna fishing operations in the ETP and observer reports indicate that birds very rarely become caught in cables or the power block of tuna purse seine vessels (Olsen et al. 2001).

The remaining six indicator species were not dependent upon tuna for successful foraging and were considered "tuna-independent" species (Balance et al. 2002). Four species, wedge-rumped storm-petrel (*Oceanodroma tethys*), Leach's storm-petrel (*Oceanodroma leucorhoa*), northern phalarope (*Phalaropus lobatus*), and red phalarope (*P. fulicarius*) are closely associated with oceanographic features (fronts) that consistently concentrate planktonic prey and other associated free-swimming prey. The Tahiti petrel (*Pseudobulweria rostrata*) specialized in scavenging squid floating on the surface while the white-winged petrel (*Pterodroma leucoptera*) took mainly myctophids (lanternfish) during twilight or night time. There were consistent distribution patterns on a large scale (e.g. around oceanographic fronts) but great variability over time in smaller areas as seabirds moved large distances to find the best foraging sites (Balance et al. 2002). The Tahiti petrel showed evidence of population decline but none of the other species had noticeable population trends and there was no distinction in this regard between tuna-obligate and tuna-independent species (Balance et al. 2002).

Antarctic

The most common seabirds found in the ARA include a variety of petrels, albatross, shearwaters, fulmars, prions, terns, skuas, jaegars, sheathbills, gulls, shags, and penguins (CCMALR 2006). The most common species seen during AMLR surveys include cape petrel (*Daption capense),* chinstrap penguin (*Pygocelis antarctica),* southern fulmar (*Fulmarus glacialoides),* prions (*Pachyptila spp.),* blue petrel (*Halobaena caerulea),* white-chinned petrel (*Procellaria aequinoctialis),* and black-browed albatross (*Thalassarche melanophrys)* (Van Cise 2009). During the summer months the birds feed on zooplankton, krill, cephalopods, and fish (Woehler and Croxall 1997).

Seabirds found in Antarctica may be breeding later in response to climate change. This observed trend is due to a reduction (12-20 percent) in the sea ice, which has been linked to a decline in krill and other marine organisms' numbers and the late break-up of sea ice (Barbraud and Weimerskirch 2006).

The CCAMLR Working Group on Incidental Mortality Associated with Fishing identifies 20 species of seabirds that are most at risk from longline fisheries. Albatross, petrels and shearwaters are sensitive to mortality from fishing due to a low reproductive rate, delayed maturity, and the importance of high adult survival rates for population stability (Bartle 1990). Albatross and petrels are attracted to vessels in the longline tuna fishery and trawl fisheries. Shearwaters are more likely to be incidentally caught in near shore set nets (Taylor 2000).

Gulls, terns, skuas and jaegars populations are most likely to be affected by changes in prey availability while sheathbills could be affected by entanglement in fishing related marine debris coming onshore (Jouventin et al. 1996). Penguins are susceptible to capture in near shore set nets, and also commercial and recreational gill nets. Cormorants and shags are susceptible to capture in near shore nets and effects from prey reduction due to competition with commercial fisheries (Brothers et al. 1999, Norman 2000).

3.2.4 Sea Turtles

Five species of sea turtles can be found within the area of the proposed SWFSC research activities: leatherback, olive ridley, green, loggerhead, and hawksbill sea turtles. The SWFSC research activities cover an extremely large area therefore it is likely that all life history phases and associated size classes for these particular species occur within the SWFSC research area. Additional background information on the range-wide status of these species has been published in a number of documents, including sea turtle status reviews and biological reports (NMFS and USFWS 1995, Hirth 1997, USFWS 1997a, Marine Turtle Expert Working Group 1998, 2000, NMFS and USFWS 2009), as well as recovery plans for the leatherback sea turtle (NMFS and USFWS 1992, 1998a), olive ridley sea turtle (USFWS and NMFS 1992), green sea turtle (NMFS and USFWS 1991b, 1998b), loggerhead sea turtle (NMFS and USFWS

1998c), and hawksbill sea turtle (NMFS and USFWS 1998d). A synopsis of the biological data on leatherback sea turtles was released in 2012 (NMFS and USFWS 2012). The synopsis is current with peer reviewed literature published to early 2009.

3.2.4.1 Threatened and Endangered Species

All of the sea turtles found in the area of the SWFSC research activities are listed as threatened or endangered under the federal ESA. The information presented in the following species accounts is primarily from the NOAA Fisheries Office of Protected Resources (OPR) website (NOAA 2011g), available online at: http://www.nmfs.noaa.gov/pr/species/turtles/.

Table 3.2-7 ESA-listed Sea Turtles found within the CCRA and ETPRA.

Common Name	Scientific Name	Status
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Olive Ridley sea turtle	*Lepidochelys olivacea*	Endangered
Green sea turtle	*Chelonia mydas*	Endangered
Loggerhead sea turtle	*Carretta carretta*	Endangered
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered

Leatherback Sea Turtles

Leatherback sea turtles are widely distributed throughout the oceans of the world and are found in waters of the Atlantic, Pacific, Caribbean, and the Gulf of Mexico (Ernst and Barbour 1972). The leatherback sea turtle is the largest living turtle and ranges farther than any other sea turtle species, exhibiting broad thermal tolerances that allow it to forage into the colder waters (NMFS and USFWS 1995). They can consume twice their own body weight in prey per day, feeding exclusively on soft-bodied invertebrates like jellyfish and tunicates. Sea nettle jellyfish and other species of the genus *Chrysaora* are preferred prey for leatherback sea turtles. The Pacific Ocean leatherback population is generally smaller in size than that in the Atlantic Ocean. In the Pacific, the IUCN notes that most leatherback nesting populations have declined more than 80 percent. In other areas of the leatherback's range, observed declines in nesting populations are not as severe, and some population trends are increasing or stable.

Critical habitat for the leatherback turtle was designated in areas adjacent to St. Croix, U.S. Virgin Islands in 1979. However, in 2007, NMFS received a petition to expand the designation. In January 2010, NMFS responded to the petition and formally proposed to expand the current designated critical habitat to include an estimated 70,600 square miles off of the western coast of the U.S. In January 2012, NMFS made a final determination and designated two areas as critical habitat for leatherbacks off the West Coast (77 FR 4170). One area extends from Point Arena to Point Arguello along the California coast east of the 3,000 meter depth contour (16,910 square miles) and the second extends from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 meter depth contour (Figure 3.2-3).

The boundaries of the critical habitat areas were determined by two primary elements that are essential for the conservation of leatherbacks: occurrence of prey species (primarily jellyfish) and migratory pathways to foraging areas. NMFS did not consider commercial fishing, fishing gear, or vessel traffic as potential threats to the leatherback in the critical habitat expansion (75 FR 319). There are no potential fisheries that would target jellyfish, and the bycatch of jellyfish in existing fisheries is limited. For migratory corridors, NMFS determined that only permanent or long-term structures would be considered an impediment to the passage of the turtles.

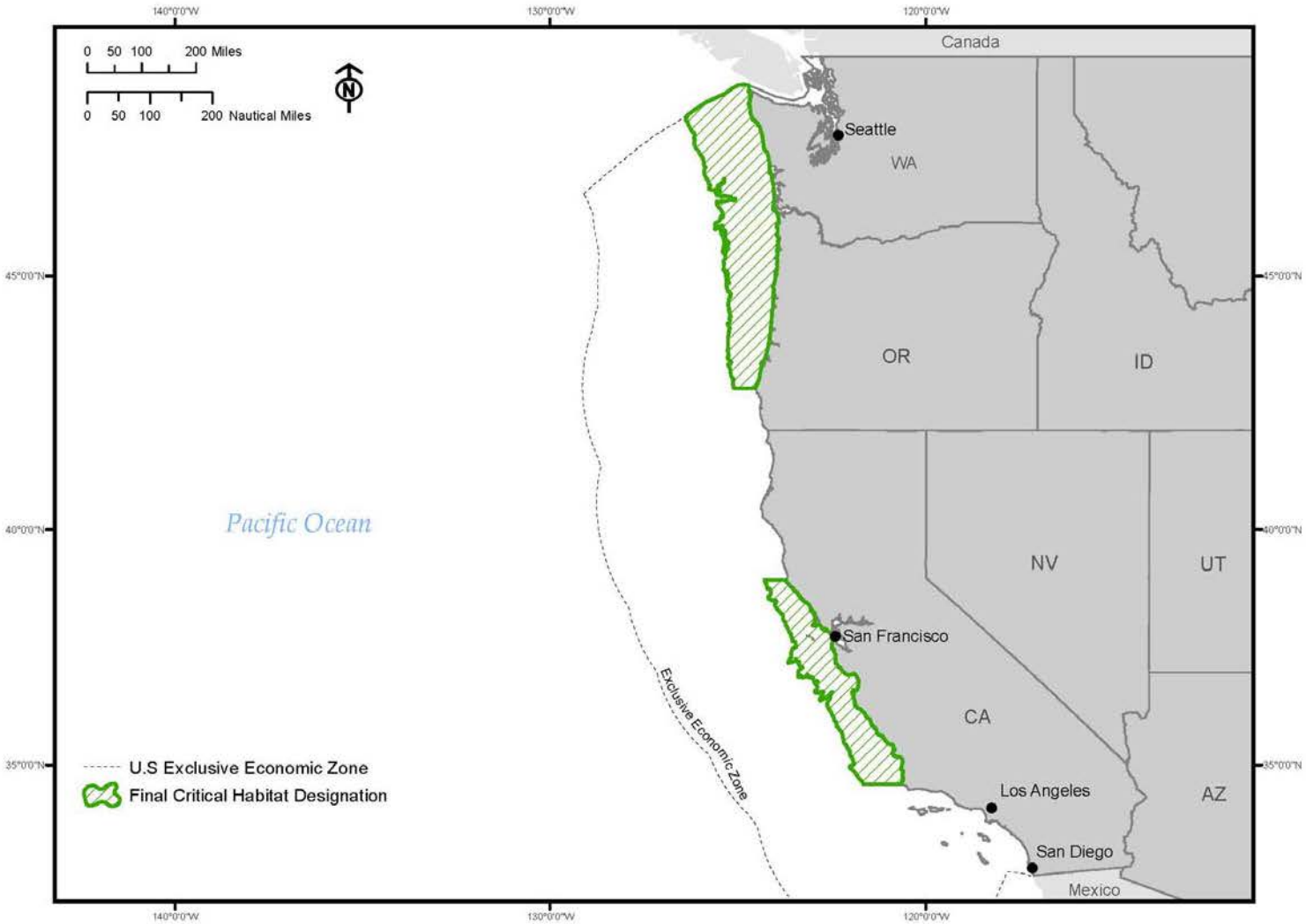


Figure 3.2-3 Designated Critical Habitat for the Leatherback Sea Turtle

Declines in the leatherback population have resulted from fishery interactions as well as exploitation of the eggs (Ross 1996). Eckert and Lien (1999) and Spotila et al. (1996) reported that adult mortality has also increased significantly, particularly as a result of driftnet and longline fisheries. Zug and Parham (1996) attributed the sharp decline in leatherback populations to the combination of the loss of long-lived adults in fishery related mortality, and the lack of recruitment, stemming from elimination of annual influxes of hatchlings because of egg harvesting. Leatherbacks are also susceptible to entanglement in lobster and crab pot gear.

Olive Ridley Sea Turtle

Olive ridley sea turtles migrate annually between pelagic foraging areas and coastal nesting areas. Trans-Pacific ships have observed olive ridleys over 2,400 miles (4,000 kilometers) from shore. Olive ridleys are globally distributed in the tropical regions of the South Atlantic, Pacific, and Indian Oceans. In the Eastern Pacific, they occur from Southern California to Northern Chile. In the eastern Pacific, arribadas (massive synchronized nesting events) occur from June through December on certain beaches on the coasts of Mexico, Nicaragua, and Costa Rica and on a single beach in Panama.

The breeding population of Olive ridley sea turtle on Mexico's Pacific coast is listed as endangered under the ESA. All other olive ridley sea turtle populations are listed as threatened under the ESA. Degradation of nesting beaches, ongoing directed harvest, and bycatch in fisheries have all contributed to the decline of the species. In the eastern Pacific Ocean, killing sea turtles and collecting their eggs has occurred for hundreds of years. However, Eguchi et al. (2007) suggest reviewing that status, as their best estimate of abundance of olive ridleys in the ETP is 1.39 million and the population is still increasing, indicating that the protection programs that began in the 1990s are effective.

Green Sea Turtle

Green sea turtles are distributed globally. In the eastern North Pacific, green turtles have been sighted from Baja California to southern Alaska, but most commonly occur from San Diego south. In the central Pacific, green turtles occur around most tropical islands, including the Hawaiian Islands. Adult green turtles that feed throughout the main Hawaiian Islands undergo a long migration to French Frigate Shoals in the Northwest Hawaiian Islands, where the majority of nesting and mating occurs (NMFS and USFWS 1998b).

Green sea turtle populations are currently listed as threatened and endangered by the IUCN. Only the breeding populations in Florida and the Pacific coast of Mexico are listed as ESA endangered. All remaining populations of green sea turtles are listed as ESA threatened. Impacts to the green sea turtle population are similar to those discussed above for other sea turtles species. As with the other species, fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like dredging, pollution, and habitat destruction account for an unknown level of other mortality. Removal of green sea turtles has been recorded by sea sampling coverage in the pelagic driftnet, pelagic longline, sea scallop dredge, southeast shrimp trawl, and summer flounder bottom trawl fisheries.

Loggerhead Sea Turtle

Loggerhead sea turtles occur throughout the temperate and tropical regions of the Pacific, Atlantic, and Indian Oceans in a wide range of habitats. These include open ocean, continental shelves, bays, lagoons, and estuaries (NMFS and USFWS 1991 and 1995; Witherington et al. 2006). Loggerhead sea turtles are primarily benthic feeders, opportunistically foraging on crustaceans and mollusks (Wynne and Schwartz 1999; Witherington et al. 2006). Under certain conditions, they may also scavenge fish (NMFS and USFWS 1998c).

The loggerhead sea turtle is the most abundant of the sea turtles listed as threatened or endangered in the U.S. waters. In the eastern Pacific, loggerheads have been reported as far north as Alaska, and as far south as Chile. In the U.S., occasional sightings are reported from the coasts of Washington and Oregon, but most records are of juveniles off the coast of California. The west coast of Mexico, including the Baja Peninsula, provides critically important developmental habitats for juvenile loggerheads.

In September of 2011 NMFS and the USFWS determined that the loggerhead sea turtle is composed of nine DPS listed as threatened or endangered. In the Pacific Ocean two were named: the North Pacific Ocean population and the South Pacific Ocean population; both are listed as endangered. As of yet there is no critical habitat associated with these DPS (76 FR 58868).

Loggerheads face threats on both nesting beaches and in the marine environment. The greatest cause of decline and the continuing primary threat to loggerhead turtle populations worldwide is incidental capture in fishing gear, primarily in longlines and gillnets, but also in trawls, traps and pots, and dredges. The main anthropogenic threats impacting loggerhead nesting habitat include the destruction and modification of coastal habitats worldwide. Beachfront lighting, placement of erosion control structures and other barriers to nesting, vehicular and pedestrian traffic, sand extraction, beach erosion and pollution, beach sand placement, removal of non-native vegetation and planting of non-native vegetation all represent serious threats to loggerhead nesting habitat (NMFS and USFWS 2009). Directed harvest for loggerheads still occurs in many places (e.g., Cuba and Mexico) and is a serious and continuing threat to loggerhead recovery.

Hawksbill Sea Turtle

The hawksbill sea turtle is uncommon in the waters of the continental U.S. Hawksbills prefer coral reefs, such as those found in the Caribbean and Central America. Hawksbills feed primarily on a wide variety of sponges but also consume bryozoans, coelenterates, and mollusks. Hawksbill turtles use different habitats at different stages of their life cycle, but are most commonly associated with healthy coral reefs. Oceanic stage juveniles are believed to occupy the "pelagic" environment. In the Pacific, the pelagic habitat of hawksbill juveniles is unknown. After a few years in the pelagic zone, small juveniles recruit to coastal foraging grounds; their size at recruitment is approximately 15 inches (38 centimeters) in carapace length in the Pacific. This shift in habitat also involves a shift in feeding strategies, from feeding predominantly at the surface to feeding below the surface primarily on animals associated with coral reef environments. Here, juveniles begin feeding on a varied diet. In the Indo-Pacific, hawksbills continue eating a varied diet that includes sponges, other invertebrates, and algae (NOAA 2011g).

Hawksbills nest sporadically in the southern part of the Baja peninsula, and juveniles and sub-adults forage along the coast along the Pacific Rim. The largest concentrations of nesting hawksbills in the Pacific occur on remote oceanic islands of Australia and in the Indian Ocean (e.g., Republic of Seychelles). In the U.S. Pacific, hawksbills nest only on main island beaches in Hawaii, primarily along the east coast of the island of Hawaii. Hawksbill nesting has also been documented in American Samoa and Guam (NOAA 2011g).

Hawksbills face threats on both nesting beaches and in the marine environment with the primary global threat to hawksbills being the loss of coral reef communities. In the Pacific, directed harvest of nesting females and eggs on the beach and hawksbills in the water is still widespread. Directed mortality is a major threat to hawksbills in American Samoa, Guam, the Republic of Palau, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, and the Republic of the Marshall Islands (NMFS and USFWS 1998d). In addition to directed harvest, increased human presence is a threat to hawksbills throughout the Pacific. In particular, increased recreational and commercial use of nesting beaches, beach camping and fires, litter and other refuse, general harassment of turtles, and loss of nesting habitat from human activities negatively impact hawksbills. Incidental capture in fishing gear (primarily in gillnets) and vessel strikes also adversely affect the species' recovery (NOAA 2011g).

3.2.5 Invertebrates

3.2.5.1 Threatened and Endangered Species

Two invertebrate species found within the SWFSC region are listed as endangered under the ESA: the black abalone (*Haliotis cracherodii*), and the white abalone (*Haliotis sorenseni*). Brief descriptions are given for each of these species including habitat, distribution, and factors leading to population decline.

Black abalone

The black abalone is a large marine gastropod mollusk found in rocky intertidal and subtidal habitats where the bedrock provides deep crevices for shelter. The range of the black abalone is from about Point Arena in northern California to Bahia Tortugas and Isla Guadalupe, Mexico. They are rare north of San Francisco and south of Punta Eugenia. The black abalone has been listed by the ESA as endangered since January, 2009 (74 FR 1937). A lethal disease, withering syndrome, is thought to have caused mass mortalities of 95 percent or greater in virtually all investigated locations. The disease is most prevalent in the southern portion of the black abalone range, where the water temperature is warmer or where water temperatures are elevated by thermal discharge of power plants. Overfishing is also a primary factor leading to the decline of black abalone, which were fished intermittently from the 1950s up to their listing under the ESA in 2009. Other factors responsible for decline include illegal harvest, habitat destruction, natural predation, and competition (NOAA 2009b).

White abalone

The white abalone is an herbivorous, marine, rocky benthic, broadcast spawning gastropod that is found in open low and high relief rock or boulder habitat that is interspersed with sand channels. The historic range of white abalone extended from Point Conception, California, to Punta Abreojos, Baja California, Mexico. The current range is limited to along the mainland coast in Santa Barbara County and at some of the offshore islands and banks in the middle portion of the range. No recent information on current range is available for Baja California (NOAA 2008). White abalone is currently listed as endangered throughout its range (66 FR 29054). The most significant threat to white abalone is the long-term effects that overfishing has had on the species. Commercial fisheries in California were closed in 1996, which proved to be inadequate for the recovery of the species. Based on commercial fishery data, the population of white abalone in Mexico is thought to be depleted, but the species status in Mexico remains largely unknown. White abalone are also vulnerable to various bacterial and parasitic infections (NOAA 2008). This species is currently protected by the ESA and a recovery plan was finalized by USFWS in 2008.

3.2.5.2 Target Species

Market squid (*Doryteuthis opalescens*) and Antarctic krill (*Euphausia superba*) are the only invertebrate species within the SWFSC research areas that are considered 'target' species for the purposes of this EA.

Market Squid

Market squid inhabit the California Current and Eastern Tropical Pacific research areas from Baja Mexico to Alaska. They generally live within 200 miles of shore, and their life cycles involve four stages: eggs, paralarvae, juveniles, and adults. Market squid have a lifespan of 4 to 10 months, and have a mixed coloration of milky white and iridescent purple. Color changes occur rapidly in response to environmental conditions. Squid have eight arms and two longer feeding tentacles. Males are larger and more robust than females. Similar to most squid species, market squid possess an ink sac, which serves as a defense mechanism by expelling ink to confound predators (CDFG 2005b).

Market squid are less than 3 millimeters long at hatching and grow to an average mantle length of 152 millimeters at the time of spawning. Adult market squid move off the continental shelf by day and can be

found to depths of 500 meters; they return to the surface at night to hunt. At some point the squid move towards shore to spawn where aggregations can reach millions of individuals. Market squid are terminal spawners; spawning occurs at the end of their lifespan. In California, commercial fisheries target adult market squid during spawning events in limited geographic areas. The distribution of market squid in known fishing areas is dramatically affected by environmental conditions, especially during El Niño events when landings are minimal (CDFG 2005b).

Antarctic Krill

Antarctic krill are small shrimp-like crustaceans that feed on phytoplankton and algae from the lower surfaces of pack ice. Antarctic krill can be found in surface waters, where phytoplankton is most abundant. It is uncommon to find this species below 100 meters. Antarctic krill are distributed throughout the Antarctic region, but are most heavily concentrated around the polar front where the Southern Ocean meets the other major oceans. Most krill are found within the boundaries of minimal and maximum annual sea ice, and around South Georgia. The circumpolar biomass of krill is estimated to be 60-155 million metric tons (Quetin and Ross 2009). Antarctic krill are widely recognized as a major link between primary producers and several species of Antarctic consumers including baleen whales, penguins, seals, sea birds, squid, and fishes, and thus krill are a vital component of the Antarctic food web (Lascara et al. 1999, Quetin and Ross 2009). In the 1960s, krill became a commercially harvested species, and continues to be harvested by several nations. Concern over population decline prompted the creation of the Biological Investigations of Marine Antarctic Systems and Stocks program in the 1970s (Lascara et al. 1999), and the species is also studied by NMFS and AMLR. The CCAMLR manages the Antarctic krill fishery using a sophisticated and comprehensive system (NMFS and PFMC 2008).

3.2.5.3 Other Species

The following species shown in Table 3.2-8 are not listed as threatened or endangered under the ESA, nor are they targeted by commercial fisheries in the SWFSC research areas. However, these species have been encountered during SWFSC research surveys (SWFSC 2011).

Table 3.2-8 Other Invertebrate Species found within SWFSC Research Areas.

Common Name	Scientific Name
Abraliopsis felis	*Abraliopsis felis*
Crystal Jelly	*Aequorea aequorea*
Moon Jellyfish	*Aurelia aurita*
Chiroteuthis calyx	*Chiroteuthis calyx*
Pacific Sea Nettle	*Chrysaora jellyfish*
Sandpaper Squid	*Cranchia scabra*
Humboldt Squid	*Dosidicus gigas*
Krill	*Euphausiacea*
Rex Sole	*Glyptocephalus zachirus*
Armhook Squid	*Gonatopsis*
Boreopacific Armhook Squid	*Gonatopsis borealis*
Heteropoda	*Heteropod*
Comb Jelly	*Hormiphora cucumaris*
Lechia Dislocate	*Lechia pacifica (dislocata)*

Common Name	Scientific Name
Opulescent Market Squid	*Doryteuthis opalescens*
Octopus (unidentified)	*Octopodidae*
Octopus Squid	*Octopoteuthis deletron*
Boreal Clubhook Squid	*Onychoteuthis borealijaponicus*
Eggyolk Jelly	*Phacellophora camtchatica*
Jewel Squid	*Pterygioteuthis gemmata*
Jellyfish (unidentified)	*Scyphozoa*
Shrimp spp (unidentified)	*Sergestid*
Hairysnail spp (unidentified)	*Trichotropidae*
Green Abalone	*Haliotis fulgens*
Pink Abalone	*Haliotis corrugata*
Pinto Abalone	*Haliotis kamtschatkana*
Antarctic Coral	*Flabellum curvatum*
Antarctic Coral	*Flabellum thouarsii*

Pacific Krill

Two species of krill, *Euphausia pacifica* and *Thysanoessa spinifera*, found in the CCRA have the potential to become fishery targets. Krill is found near the surface, where phytoplankton is most abundant. *E. pacifica* ranges through the subarctic Pacific, from the Gulf of Alaska to 25 N latitude, while *T. spinifera* occurs from the southeastern Bering Sea south to northern Baja California. Krill provide a critical link between phytoplankton and upper level predators, including species that are commercially important fish or ecologically important protected marine mammals and birds. There are international markets for krill and krill products, although no fisheries in the EEZ are authorized (NMFS and PFMC 2008). The PFMC in cooperation with NMFS have implemented a ban on commercial fishing for all species of krill in West Coast federal waters. The krill prohibition was adopted as Amendment 12 to the Coastal Pelagic Species Fishery Management Plan. The krill harvest prohibition was originally proposed to the PFMC and NMFS by NOAA's Office of National Marine Sanctuaries.

3.3 SOCIAL AND ECONOMIC ENVIRONMENT

Activities associated with the intent and implementation of fisheries research have several implications for the social and economic environment affected by SWFSC fisheries research. These include providing guidance for federally managed commercial and recreational fisheries, providing information associated with international treaty obligations, and direct and indirect expenditures on goods and services associated with fisheries research.

The 1996 amendments to the MSA require assessment, specification, and description of the effects of conservation and management measures on participants in fisheries, and on fishing communities (NMFS 2007b). The eighth National Standard for Fishery Conservation and Management in the MSA states:

> *Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities,*

and (B) to the extent practicable, minimize adverse economic impacts on such communities.

Other laws and policies also require attention to potential social and economic effects on communities. This includes Executive Order 12898 on environmental justice, which directs agencies to assess actions that may disproportionately affect low income and minority populations (Norman et al. 2007). For these reasons, the NMFS Economics and Social Science Program conducts community studies and develops statistical methodologies and economic models to identify and describe communities substantially engaged in fishing. This information is ultimately used by fishery managers, whose decisions balance the needs of a variety of fisheries communities and users.

NMFS provides an annual report, *Fisheries Economics of the United States* (NMFS 2010) which provides an annual analysis of states' economic participation in fisheries. NMFS also provides *Fishing Communities of the United States* (NMFS 2009) which estimates community engagement and dependence on managed fisheries. Factors included in the estimations include commercial market conditions, recreational fishing expenditures and levels of participation, key species, and community profiles. The profiles are developed with data about the home ports of vessels' participation in a particular fishery, the residence of commercial or recreational fishing participants, port landings, and the location of processing and service facilities.

There are ongoing efforts to refine 2000 U.S. Census data via demographic and economic statistics, community surveys and harvest data collected from other federal and state sources, as well. Most U.S. and state community fisheries data are not collected at the community level, so it must be geographically disaggregated from more global statistics. NMFS helps sponsor studies such as *West Coast Marine Fishing Communities*, which profile fishery communities at the county level (Langdon-Pollock 2004). In addition, the community profiles contain an emphasis on social and cultural factors that could influence economic behavior, and fishing groups' reactions to management actions.

SWFSC research is conducted in three oceanographic areas; the California Current, Eastern Tropical Pacific, and Antarctic marine ecosystems. Activities in the California Current influence the communities on the coasts of Washington, Oregon, and California. Research activities in the California Current are provided by both the Southwest Fisheries Center, which concentrates in waters off the California Coast, and the Northwest Fisheries Science Center, which operates primarily off the Oregon and Washington coasts. It should be noted that there are complex economic and demographic interactions with U.S. ports in other research areas, especially the Northern Pacific Region (Alaska).

Research voyages and field stations in the Antarctic and/or Eastern Tropical Pacific ecosystems have limited interaction with foreign ports, and therefore have minor social and economic influence there. The categorization of indirect influences there is primarily biological, and related to the health of global fisheries ecosystems, especially for migratory species.

3.3.1 Commercial Fisheries

Table 3.3-1 shows landings and revenue data for 2000 to 2010 for the Pacific region. Key commercial species for the region include albacore tuna, crab, flatfish, hake, rockfish, sablefish, salmon, sardines, shrimp, squid, and other shellfish. Squid and sardines accounted for the largest volume of landings in California. The largest volume of landings for Oregon and Washington included hake and sardines.

Table 3.3-1 Commercial Landings, Revenue, and Top Species for California, Washington, and Oregon 2007-2010.

	All Species		Top Species					
	Pounds	Revenue	Pounds	Revenue	Price per Pounds	Top Species	Top Species Percent of All Species (Pounds)	Top Species Percent of All Species (Revenue)
California								
2007	348,825,756	$127,579,646	178,480,103	$8,218,158	$0.05	Pacific sardine	46.38%	6.44%
2008	323,884,364	$120,860,944	126,944,832	$7,575,420	$0.06	Pacific sardine	39.19%	6.27%
2009	373,369,978	$150,382,503	203,866,868	$56,524,336	$0.28	California market squid	54.60%	37.59%
2010	437,868,856	$176,151,276	288,474,809	$71,160,775	$0.25	California market squid	65.88%	40.40%
Oregon								
2007	253,543,186	$97,298,426	90,036,691	$4,551,001	$0.05	Pacific sardine	35.51%	4.68%
2008	195,688,351	$103,042,323	55,510,987	$6,829,815	$0.12	Pacific hake	28.37%	6.63%
2009	198,894,579	$104,706,112	53,466,222	$3,782,855	$0.07	Pacific hake	26.88%	3.61%
2010	201,478,532	$104,653,225	57,016,705	$5,413,957	$0.09	Pacific hake	28.30%	5.17%
Washington								
2007	194,449,356	$216,118,553	91,272,225	$7,120,781	$0.08	Pacific hake	46.94%	3.29%
2008	173,176,427	$232,841,042	67,158,518	$7,249,021	$0.11	Pacific hake	38.78%	3.11%
2009	163,937,071	$227,773,331	36,378,355	$2,333,951	$0.06	Pacific hake	22.19%	1.02%
2010	189,486,419	$255,332,411	58,899,671	$4,104,643	$0.07	Pacific hake	31.08%	1.61%

Source: (NOAA 2011f)

Fisheries Economics of the United States 2010 analyzed data for 2009 (NMFS 2010. In that year, squid accounted for 51 percent of 2009 landings, but only 14 percent of revenue. For 2009, California had the largest number of seafood industry jobs (120,583) and seafood sales in the U.S. Washington had the fourth largest number of jobs (57,643) nationwide, and was third in sales. Oregon seafood industry jobs were estimated at 13,754 (NMFS 2010). Washington had the highest landings revenue in the Pacific region with $228 million. California ($150 million) and Oregon ($102 million) followed. California contributed the most pounds landed (372 million pounds), followed by Oregon (198 million pounds) and Washington (164 million pounds). Fishermen in the Pacific region landed 894 million pounds of finfish and shellfish in 2009. This was 32 percent less than in 2000. The decrease was in the finfish category, with shellfish on the increase (NMFS 2010).

Key commercial species, accounting for 91 percent of landings revenue for the Pacific region, include albacore tuna, crab, flatfish, hake, rockfish, sablefish, salmon, sardines, shrimp, squid, and other shellfish (NMFS 2010). Hake and squid accounted for 51 percent of 2009 landings, but only 14 percent of revenue.

The most active west coast commercial fishing ports, in landings of fish and shellfish, from 2000 to 2010 were: Los Angeles and Port Hueneme-Oxnard-Ventura, California; Astoria and Newport, Oregon; and Westport, Washington. Table 3.3-2 shows the landings data.

Table 3.3-2 Top Commercial Landings Locations in California, Oregon and Washington 2000-2010.

Year	U.S. Rank	Port	Millions of Pounds	Millions of Dollars
2000	7	Los Angeles, CA	254.7	$38.10
	9	Port Hueneme-Oxnard-Ventura, CA	162.2	$20.20
2001	7	Los Angeles, CA	219.1	$29.80
	10	Port Hueneme-Oxnard-Ventura, CA	104.8	$12.60
2002	8	Los Angeles, CA	170.1	$20.90
	10	Astoria, OR	106.9	$23.70
2003	9	Astoria, OR	114.1	$25.60
	12	Los Angeles, CA	88.7	$16.50
2004	9	Astoria, OR	135.8	$19.90
	11	Newport, OR	111.2	$29.60
2005	9	Los Angeles, CA	139.7	$26.60
	11	Westport, WA	122.8	$36.70
2006	8	Los Angeles, CA	164.5	$30.20
	9	Astoria, OR	164.2	$33.00
2007	10	Los Angeles, CA	141.3	$18.70
	11	Westport, WA	120	$32.00
2008	9	Los Angeles, CA	123.6	$22.70
	11	Westport, WA	111.1	$43.40
2009	9	Port Hueneme-Oxnard-Ventura, CA	141.3	$42.70
	11	Westport, WA	111.1	$43.40
2010	7	Los Angeles, CA	186.8	$37.80
	14	Astoria, OR	100.9	$30.50

Source: (NOAA 2011f)

3.3.2 Recreational Fisheries

NMFS estimates recreational fishing data annually, based on a variety of sources. For the U.S. West Coast, data are partially derived from mail and phone surveys, with contacts sampled from saltwater and freshwater fishing licenses. NMFS uses an input/output economic model to estimate patterns in direct, indirect, and induced effects (Gentner and Steinback 2008).

In the Pacific region in 2009, 1.8 million recreational anglers fished in 6.3 million trips. Over 64 percent of total anglers in 2009 were residents of a coastal county. Employment was primarily generated by expenditures on recreational fishing trips (private or rental boat, for-hire boat, or shore-based trips) and

expenditures on durable equipment. Gentner and Steinback (2008) estimated the economic effects of recreational fishing sales at the state level for 2006, shown in Table 3.3-3.

Table 3.3-3 Estimated Recreational Fishing Expenditure Impacts, 2006 (in thousands, except for jobs).

	Sales	Direct Impact	Indirect Impact	Induced Impact	Total Impact	Jobs	Taxes
California	$3,026,230	$2,023,316	$795,299	$880,561	$3,699,176	18,300	$534,006
Oregon	$253,090	$160,290	$55,754	$67,535	$293,578	2,527	$40,806
Washington	$1,358,002	$664,283	$225,489	$237,148	$1,126,920	11,025	$170,789

Source: (Gentner and Steinback 2008)

Key Pacific region recreational species include albacore and other tunas, barracuda, bass, bonito, croakers, flatfishes, greenlings, mackerel, rockfishes and scorpionfishes, salmon, sculpins, and surfperches. Barracuda, bass, and bonito were the most commonly caught group over the last 10 years, averaging 3.9 million fish annually, with an average of 66 percent released rather than harvested. In 2009, however, the catch declined by 76 percent. In 2009 the largest key species groups caught were rockfish and scorpionfish. 2.7 million rockfish and scorpionfish were caught, primarily off California, and 74.3 percent were harvested (NMFS 2010).

3.3.3 Fishing Communities

In 2000, 1,004 communities in the U.S. had economic interaction with Pacific west coast fisheries, as evidenced by permits, vessel registrations, location of landings, and seafood processing plants. NMFS has identified and profiled 125 fishing ports on the U.S. West Coast with significant engagement in commercial and/or recreational fisheries (Norman et al. 2007). They were primarily selected because of pounds and value of commercial fish landed, and vessel statistics. As shown in Figure 3.3-1, this includes 53 communities in California, 32 in Oregon, and 40 in Washington. Many are home ports for fishing vessels that spend part of the year fishing in Alaska, evident in that they hold both Pacific and North Pacific permits (NMFS 2009).

3.3.3.1 California Fishing Communities:

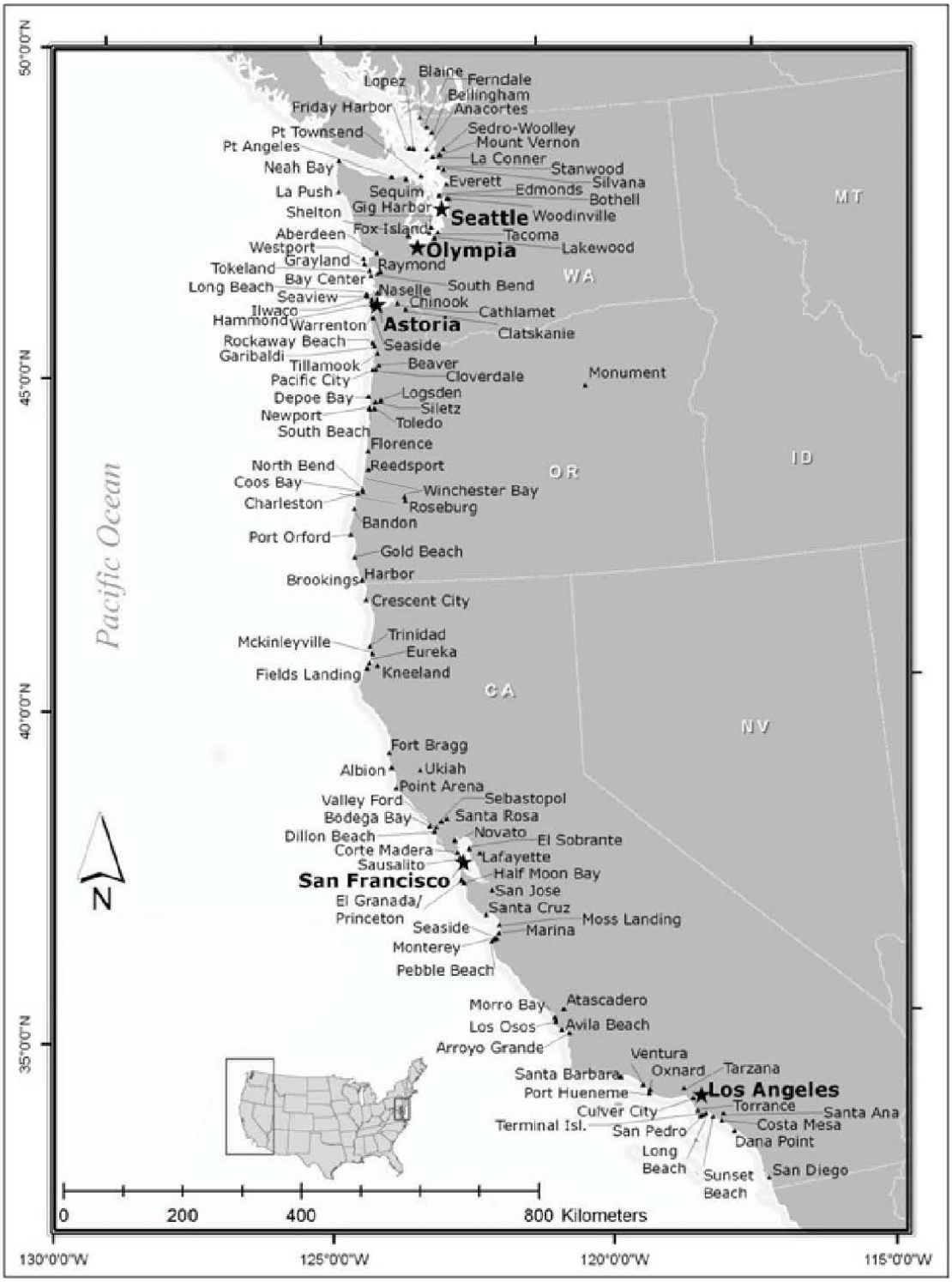
Albion, Arroyo Grande, Atascadero, Avila Beach, Bodega Bay, Corte Madera, Costa Mesa, Crescent City, Culver City, Dana Point, Dillon Beach, El Granada, El Sobrante, Eureka, Fields Landing, Fort Bragg, Half Moon Bay, Kneeland, Lafayette, Long Beach, Los Angeles, Los Osos, Marina, McKinleyville, Monterey, Morro Bay, Moss Landing, Novato, Oxnard, Pebble Beach, Point Arena, Port Hueneme, Princeton, San Diego, San Francisco, San Jose, San Pedro, Santa Ana, Santa Barbara, Santa Cruz, Santa Rosa, Sausalito, Seaside, Sebastopol, Sunset Beach, Tarzana, Terminal Island, Torrance, Trinidad, Ukiah, Valley Ford, and Ventura.

3.3.3.2 Oregon Fishing Communities:

Astoria, Bandon, Beaver, Brookings, Charleston, Clatskanie, Cloverdale, Coos Bay, Depoe Bay, Florence, Garibaldi, Gold Beach, Hammond, Harbor, Logsdon, Monument, Newport, North Bend, Pacific City, Port Orford, Reedsport, Rockaway Beach, Roseburg, Seaside, Siletz, Sisters, South Beach, Tillamook, Toledo, Warrenton, and Winchester Bay.

3.3.3.3 Washington Fishing Communities:

Aberdeen, Anacortes, Bay Center, Bellingham, Blaine, Bothell, Cathlamet, Chinook, Edmonds, Everett, Ferndale, Fox Island, Friday Harbor, Gig Harbor, Grayland, Ilwaco, La Conner, La Push, Lakewood, Long Beach, Lopez, Mount Vernon, Naselle, Neah Bay, Olympia, Port Angeles, Port Townsend, Raymond, Seattle, Seaview, Sedro-Woolley, Sequim, Shelton, Silvana, South Bend, Stanwood, Tacoma, Tokeland, Westport, and Woodinville.



Source: (Norman et al. 2007)

Figure 3.3-1 U.S. West Coast Fishing Communities.

Each community profile contains a description of people and place, infrastructure, and economic involvement in the fisheries. The 2000 median population for the top fishing communities combined was 84,038. The communities tend to be smaller in population, though some large cities, such as Los Angeles and Seattle, dominate because of centralized vessel services and fish processing facilities located there (NMFS 2009). Fifty-five percent of Washington's profiled communities had a population less than 5,000. Correspondingly, 71 percent of Oregon and 27 percent of California communities also had populations less than 5,000 (Norman et al. 2007).

NMFS estimated economic indicators for fishing communities, based largely on 2000 U.S. Census data (NMFS 2009). However, economic indicators have changed since 2000. For example, in 2000, state unemployment percentages were 5.0 in California, 4.7 in Washington, and 5.0 in Oregon. By 2011, unemployment rates rose to 12.4, 9.2, and 10.4 percent, respectively, more than doubling in California and Oregon. Nationwide, 2011 unemployment in the Agriculture, Forestry, Fishing and Hunting sector was almost double that of unemployment overall, at 16 percent (USDOL 2011).

In 2000, the percentage of California households below the poverty level was 10.6. Most of NMFS' California fishing communities had similar rates, with the exception of Crescent City (33.7), Point Arena (24.1), and San Pedro (13.2). Oregon's poverty level rate was 7.9, and all fishing communities exceeded that rate except Depoe Bay at 5.5 percent. Washington's level was 7.3 percent, with La Push and Neah Bay exceeding that at 20.0 and 26.3 percent (NMFS 2009).

3.3.4 SWFSC Operations

The SWFSC's operations have a direct economic influence on the U.S. communities and ports in which they operate. Their current operating budget is approximately $50 million annually of which approximately 25 percent is transferred on an annual basis and is considered non-permanent funding. These funds are distributed among five research divisions and the corporate services that support them. The SWFSC headquarters, The Torrey Pines Court Laboratory, and The La Jolla Shores Drive Laboratory are located in La Jolla, California. The Fisheries Ecology Division is based in Santa Cruz, California, adjacent to UC Santa Cruz's Long Marine Laboratory, and the Environmental Research Division is based in Pacific Grove, California. The SWFSC operates three field stations in California located in Arcata, Granite Canyon, and Piedras Blancas. On the Antarctic Peninsula, the SWFSC's Antarctic Ecosystem Research Division maintains two field stations located at Cape Shirreff on Livingston Island and at Copacabana in Admiralty Bay on King George Island. The ETPRA includes waters extending from Mexico to Peru.

Approximately $22 million is spent on the collection of survey data. These costs include ship time, aircraft time, equipment and logistics costs, contracts and overtime for U.S. government employees. Approximately 60 percent of this is spent on surveys in the California Current, 15 percent is spent on surveys in the ETP, and 35 percent is spent on surveys in the Scotia Sea (SWFSC personal communication 2012). California assesses taxes on oceanographic research vessels at 4 percent of their full cash value (Norman et al. 2007).

Voyages supporting data collection have only limited influence on the economies of ports of call in Mexico and South America. For example, during the 2009/2010 Antarctic research season, the R/V Moana Wave made three calls to Punta Arenas, Argentina, spending 10 days in port, for the purpose of transferring supplies to South Shetland Islands in support of 35 scientists and technicians at Cape Shireff (Van Cise 2010).

ENVIRONMENTAL EFFECTS CHAPTER 4

4.1 INTRODUCTION AND ANALYSIS METHODOLOGY

This chapter presents an analysis of the potential direct and indirect effects of the alternatives on the physical, biological, and social environments consistent with Section 1502.16 of the Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) regulations (40 Code of Federal Regulations [CFR] Part 1500) and NOAA Administrative Order 216-6 (Environmental Review Procedures for Implementing the National Environmental Policy Act). Four alternatives have been brought forward for detailed analysis (see Chapter 2):

- The Status Quo Alternative, where fisheries and ecosystem research programs conducted and funded by the Southwest Fisheries Science Center (SWFSC) would be performed as they have for the past five years. This is considered the No Action Alternative for ongoing programs under NEPA.
- The Preferred Alternative, where the SWFSC would conduct some new research activities and implement new protocols intended to mitigate impacts to protected species in addition to those described under the Status Quo Alternative.
- The Modified Research Alternative, where the SWFSC would conduct fisheries and ecosystem research with scope and protocols modified to minimize risks to protected species.
- The No Research Alternative, where the SWFSC would no longer conduct or fund fieldwork in marine waters for the fisheries and ecosystem research considered in the scope of this EA. This is also considered a No Action Alternative under another interpretation of NEPA.

In addition to a suite of fisheries and ecological research conducted or funded by the SWFSC as the primary federal action, the first three alternatives would also include issuance of five-year regulations and subsequent letters of authorization (LOAs) under Section 101(a)(5)(A) of the MMPA for the incidental, but not intentional, taking of marine mammals as the secondary federal action.

As was discussed in Chapter 1 of this Environmental Assessment (EA), the National Marine Fisheries Service (NMFS) is fundamentally a science-based agency, its primary mission being the stewardship of living marine resources through science-based conservation management. The first three alternatives evaluated in this EA clearly enable the SWFSC to collect additional scientific information that otherwise would not be fully replaced by other sources while the fourth alternative considered does not. In NMFS' view, the inability to acquire scientific information essential to managing fisheries on a sustainable basis and rebuilding overfished stocks would ultimately imperil the agency's ability to meet its mandate to promote healthy fish stocks and restore the nation's fishery resources. Similar concerns apply to the conservation and management of protected species, their habitats, and other marine ecosystem components. However, there are several plausible scenarios (such as federal budget cuts, legal actions against NMFS, or natural disasters affecting SWFSC facilities) where the research activities of the SWFSC could be severely curtailed or eliminated for a period of time. The No Research Alternative therefore allows NMFS to examine the effects on the human environment of discontinuing federally funded fisheries research in the SWFSC research areas.

The authors of the sections in this chapter are subject matter experts. They developed a discussion of the effects on each resource component based on their best professional judgment; relying on the collective knowledge of other specialists in their respective fields and the body of accepted literature. The impact assessment methodology consists of the following steps:

1) Review and understand the proposed action and alternatives (Chapter 2).
2) Identify and describe:
   a) Direct effects that would be "caused by the action and occur at the same time and place" (40 CFR § 1508.8(a)), and
   b) Indirect effects that would be "caused by the action and (would occur) later in time or farther removed in distance, but are still reasonably foreseeable" (40 CFR § 1508.8(b)).
3) Compare the impacts to the baseline conditions described in Chapter 3 and rate them as major, moderate, or minor. In order to help consistently assess impacts and support the conclusions reached, the authors developed a criteria table that defines impact ratings for the resource components (Table 4.1-1). The criteria provide guidance for the authors to place the impacts of the alternatives in an appropriate context, determine their level of intensity, and assess the likelihood that they would occur. Although some evaluation criteria have been designated based on legal or regulatory limits or requirements (see description of criteria for marine mammals below), others are based on best professional judgment and best management practices. The evaluation criteria include both quantitative and qualitative analyses, as appropriate to each resource. The authors then determine an overall rating of impacts to a given resource by combining the assessment of the impact components.

   As described in Section 1.4, the purpose of an EA is to determine whether significant environmental impacts could result from a proposed action. If significant impacts are discovered, an Environmental Impact Statement would need to be developed. If no significant impacts are discovered, NMFS can document the decision on the proposed action with a Finding of No Significant Impact. NOAA Administrative Order 216-6 provides guidance on how the agency should make determinations of significance in NEPA documents. Consistent with these guidelines, any overall rating of effects on the physical, biological, or social and economic environment that is considered "major" according to the criteria described in Table 4.1-1 will be considered "significant" from a NEPA perspective.

Table 4.1-1 Criteria for Determining Effect Levels

Resource Components	Assessment Factor	Effect Level		
		Major	Moderate	Minor
Physical Environment	Magnitude or intensity	Large, acute, or obvious changes that are easily quantified	Small but measurable changes	No measurable changes
	Geographic extent	> 10% of project area (widespread)	5-10% of project area (limited)	0-5% of project area (localized)
	Frequency and duration	Chronic or constant and lasting up to several months or years (long-term)	Periodic or intermittent and lasting from several weeks to months (intermediate)	Occasional or rare and lasting less than a few weeks (short-term)
	Likelihood	Certain	Probable	Possible
Biological Environment	Magnitude or intensity	Measurably affects population trend For marine mammals, mortality and serious injury greater than or equal to 50% of PBR[1]	Population level effects may be measurable For marine mammals, mortality and serious injury between 10% and 50% of PBR	No measurable population change For marine mammals, mortality and serious injury less than or equal to 10% of PBR
	Geographic extent	Distributed across range of a population	Distributed across several areas identified to support vital life phase(s) of a population	Localized to one area identified to support vital life phase(s) of a population or non-vital areas
	Frequency and duration	Chronic or constant and lasting up to several months or years (long-term)	Periodic or intermittent and lasting from several weeks to months (intermediate)	Occasional or rare and lasting less than a few weeks (short-term)
	Likelihood	Certain	Probable	Possible
Social and Economic Environment	Magnitude or intensity	Large, acute, or obvious changes that are easily quantified	Small but measurable changes	No measurable changes
	Geographic extent	Affects region (multiple states)	Affects state	Affects local area
	Frequency and duration	Chronic or constant and lasting up to several months or years (long-term)	Periodic or intermittent and lasting from several weeks to months (intermediate)	Occasional or rare and lasting less than a few weeks (short-term)
	Likelihood	Certain	Probable	Possible

[1]Potential Biological Removal (PBR).

Impact Criteria for Marine Mammals

The impact criteria for the magnitude of effects on marine mammals have been developed in the context of two important factors derived from the Marine Mammal Protection Act (MMPA). The first factor is the calculation of Potential Biological Removal (PBR) for each marine mammal stock. The MMPA defined PBR at 16 U.S.C. § 1362(20) as, "the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population." PBR was intended to serve as an upper limit guideline for fishery-related mortality for each species. Calculations of PBR are stock-specific and include estimates of the minimum

population size, reproductive potential of the species, and a recovery factor related to the conservation status of the stock (e.g., whether the stock is listed under the Endangered Species Act (ESA) or depleted under the MMPA). NMFS and USFWS are required to calculate PBR (if possible) for each stock of marine mammals they have jurisdiction over and to report PBR in the annual marine mammal stock assessment reports (SARs) mandated by the MMPA. The PBR metric has been used extensively to assess human impacts on marine mammals in many situations involving mortality and serious injury (M&SI) and is a recognized and acceptable metric used by NMFS' Office of Protected Resources in the evaluation of commercial fisheries incidental takes of marine mammals in US waters.

The second factor is the categorization of commercial fisheries with respect to their adverse interactions with marine mammals. Under Section 118 of the MMPA, NMFS must classify all US commercial fisheries into one of three categories based on the level of marine mammal M&SI that occurs incidental to each fishery, which it does in the List of Fisheries (LOF) published annually. Category III fisheries are considered to have a remote likelihood of or no known incidental M&SI of marine mammals. Category II fisheries are those that have occasional incidental M&SI of marine mammals. Category I fisheries are those that have frequent incidental M&SI of marine mammals. A two-tiered classification system is used to develop the LOF, with different thresholds of incidental M&SI compared to the PBR of a given marine mammal stock.

However, the LOF criteria is primarily used for managing commercial fisheries based on their actual levels of marine mammal M&SI and is not necessarily designed to assess impacts of projected takes on a given marine mammal stock. Because the analysis of direct impacts of SWFSC research on marine mammals in this EA is based on projected takes rather than actual takes, we use a similar but not identical model to the LOF criteria.

In spite of fundamental differences between SWFSC research activities and commercial fishing practices, it is appropriate to assess the impacts of incidental takes due to research in a manner similar to what is done for commercial fisheries for two reasons:

- SWFSC research activities are similar to many commercial fisheries in the fishing gear and types of vessels used, and
- SWFSC research plays a key role in supporting commercial fisheries.

As part of the NEPA impact assessment criteria (Table 4.1-1), if the projected annual M&SI of a marine mammal stock from all SWFSC research activities, as requested in their MMPA LOA application, is less than or equal to 10 percent of PBR for that stock, the effect would be considered minor in magnitude for the marine mammal stock, similar to the LOF's Category III fisheries that have a remote likelihood of M&SI with marine mammals with no measurable population change. Projected annual M&SI from SWFSC research activities between 10 and 50 percent of PBR for that stock would be moderate in magnitude for the marine mammal stock, similar to the LOF's Category II fisheries that have occasional M&SI with marine mammals where population effects may be measurable. Projected annual M&SI from SWFSC research activities greater than or equal to 50 percent of PBR would be major in magnitude for the marine mammal stock, similar to the LOF's Category I fisheries that have frequent M&SI with marine mammals which measurably affect a marine mammal stock's population trend. Note that NEPA requires several other components to be considered for impact assessments (see Table 4.1-1); the magnitude of impact is not necessarily the same as the overall impact assessment in a NEPA context.

In the MMPA LOA application, SWFSC estimated takes for each marine mammal stock are grouped by gear type (i.e., trawl gear and longline gear) with the resulting take request not apportioned by individual research activities (e.g., by survey). This precludes impact analysis at the individual activity or project level within the EA.

NMFS recognizes that more than one of its regional FSCs may interact with the same stock of marine mammals in the Pacific, namely the Northwest Fisheries Science Center (NWFSC), Alaska Fisheries

Science Center (AFSC), and Pacific Islands Fisheries Science Center (PIFSC), and that the collective impact from all of these FSCs on marine mammal stocks should be considered. The NWFSC, AFSC, and PIFSC are currently working on their own NEPA and MMPA compliance processes but have not yet developed estimates of future marine mammal incidental takes. Because the SWFSC projected takes include estimates for species that it has not taken historically, and the other three FSCs may do the same, the analysis of combined impacts based on projected takes from all FSCs cannot be completed at this time. However, historical data on incidental takes from these three other FSCs will be considered along with the contribution of the SWFSC in the Cumulative Effects section of this EA (Chapter 5). In the last five years (2008-2012), the only shared marine mammal stock that has been incidentally caught by both the NWFSC and the SWFSC is California sea lions (n = 3 for NWFSC and n = 21 for SWFSC). The only shared marine mammal stock that has been incidentally caught by both the AFSC and the SWFSC is the Eastern Pacific stock of northern fur seal (n = 1 for AFSC and n=1 for SWFSC). Because both of these stocks have large PBRs, NMFS does not anticipate incidental takes from NWFSC and AFSC research activities to substantially increase the collective impacts on marine mammal stocks shared with the SWFSC. The PIFSC has no history of incidental takes of marine mammals. When the NWFSC, AFSC, and PIFSC submit their LOA applications and supporting NEPA analyses, the total projected takes for shared stocks from all FSCs will be analyzed within those documents.

The contribution of SWFSC research activities to overall impacts on marine mammals will be aggregated with past, present, and reasonably foreseeable future impacts on marine mammals from commercial fisheries and other factors external to SWFSC research activities in the Cumulative Effects analysis in Chapter 5. NMFS will report all sources of M&SI in the annual marine mammal stock assessment reports (SARs), including any incidental M&SI takes that may occur from any of the FSCs. The cumulative effects analysis will use the same impact assessment criteria and thresholds as described in Table 4.1-1, only they will be applied to collective sources of M&SI and other types of impacts on marine mammals.

4.2 DIRECT AND INDIRECT EFFECTS OF ALTERNATIVE 1 – STATUS QUO ALTERNATIVE (NO-ACTION).

This section presents an analysis of the potential direct and indirect effects of Alternative 1 – Status Quo Alternative on the physical, biological, and social environment. Under this Alternative, fisheries research programs conducted and funded by the SWFSC would be performed as they have been over the previous five years. Potential direct and indirect effects were evaluated according to the criteria described in Table 4.1-1. A summary of the impact rating determinations for all topics evaluated under Alternative 1 is presented below in Table 4.2-1.

Table 4.2-1 Alternative 1 Summary of Effects

All conclusions refer to adverse effects unless noted.

RESOURCE	Physical Environment	Special Resource Areas	Fish	Marine Mammals	Birds	Sea Turtles	Invertebrates	Social and Economic
SECTION #	**4.2.1**	**4.2.2**	**4.2.3**	**4.2.4**	**4.2.5**	**4.2.6**	**4.2.7**	**4.2.8**
Research Area								
California Current	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Moderate-*beneficial*
Eastern Tropical Pacific	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor-*beneficial*
Antarctic	Minor	Minor	Minor	Minor	Minor	N/A	Minor	Minor-*beneficial*

4.2.1 Effects on the Physical Environment

The SWFSC conducts research in three distinct areas, the California Current Research Area (CCRA), Eastern Tropical Pacific Research Area (ETPRA), and the Antarctic Research Area (ARA). This section describes effects on the physical environment that would result from SWFSC research activities in these three areas under Alternative 1. These potential effects would generally include:

- Physical damage to benthic (seafloor) habitat
- Removal of organisms that produce structure.

Refer to Appendix A for a detailed description of the SWFSC research vessels and survey gear specifications.

Physical Damage to Benthic (Seafloor) Habitat

Physical impacts to seafloor habitat from SWFSC research would be limited; minimal bottom contact with two longline surveys in the CCRA and a bottom trawl survey occurring once every three years in the ARA (see Table 2.2-1). One of the longline surveys in the CCRA (sablefish) involves two or three 75-hook bottom longline sets per month and the other survey (thresher sharks) involves bottom contact only by small anchors for pelagic longline sets. The ARA bottom-trawl survey has historically involved 75 30-minute bottom trawls per survey. Under Alternative 1, it is assumed that a similar amount of survey effort would continue in the future.

Fishing gear that contacts the seafloor can physically damage seafloor habitat. Physical damage may include furrowing and smoothing of the seafloor as well as the displacement of rocks and boulders, and such damage can increase with multiple contacts in the same area (Morgan and Chuenpagdee 2003; Stevenson et al. 2004). In general, physical damage to the seafloor recovers within 18 months through the action of water currents and natural sedimentation, with the exception of rocks and boulders which may be permanently displaced (Stevenson et al. 2004). Seafloor composition is highly variable both within and between the SWFSC research areas. Silt, sand, clay, and gravel are abundant at particular sites within each research area. With the exception of rock and boulder displacement, any physical impacts to benthic habitat resulting from SWFSC survey activities would be expected to recover within 18 months.

Bottom-contact trawl gear can also increase turbidity and alter the chemical composition of water near the seafloor. However, these effects would be short-term, minor in magnitude, and limited in geographic extent.

The area of benthic habitat affected by SWFSC research each year would be a very small fraction of the total of the research areas. Direct and indirect effects would be localized, short-term in duration, and result in no measurable changes to seafloor habitat. Considering the small area affected and the limited magnitude of the physical effects, the overall effects of surveys on benthic habitat in the CCRA and ARA would be minor adverse.

Removal of Organisms That Produce Structure

Organisms such as cold water corals create structure on the seafloor that may provide important habitats for many organisms, including fish (Auster and Langton 1999, Cairns and Bayer 2009). Cold water corals are generally slow growing, fragile and long lived, which makes them particularly vulnerable to damage. Bottom contact fishing gear can break or disrupt corals, thereby reducing structural complexity, which may reduce species diversity of the corals and other animals that utilize this habitat (Freiwald et al. 2004).

The removal of structural organisms may only be reversible through natural recovery that may occur over hundreds of years (Freiwald et al. 2004). Cold-water corals such as *Flabellum thouarsii* and *Flabellum curvatum* are known to occur in the SWFSC ARA, although their exact distribution and abundance are poorly understood (Cairns 1982; Waller et al. 2008). Effects of SWFSC research activities on organisms

that produce structure would be independent of seasonal considerations because the organisms are not mobile and take long periods to recover.

Under Alternative 1, the SWFSC would implement as standard operating procedure numerous measures to reduce the likelihood, magnitude, and geographic extent of potential impacts to seafloor structural organisms. Rocky areas that are more likely to support corals would be avoided by using sonar to examine the bottom contours before surveys are conducted (Jones et al. 2009; Lockhart et al. 2009). Bottom trawl surveys would only be conducted on suitable benthic substrates, e.g. sand, silt, or gravel bottoms. Given the selection for bottom substrates and avoidance of coral areas, the removal of benthic organisms that produce structure for other species is unlikely. Effects would be considered minor adverse due in part to the small areal extent of surveys using bottom trawl. Effects resulting from the removal of organisms that produce structure would be limited to the ARA because the SWFSC does not use bottom trawl equipment in the CCRA and ETPRA. Direct and indirect effects would be localized, short-term in duration, and result in no measurable changes. Overall, impacts to seafloor structural organisms in the ARA would be considered minor adverse under the Status Quo Alternative according to the criteria in Table 4.1-1.

4.2.2 Effects on Special Resource Areas

Section 3.1.2 describes the special resource areas that occur in the same geographic areas as the SWFSC fishery research activities. This section describes the general types of effects that SWFSC fishery research activities under Alternative 1 may have on the following categories of special resource areas:

- Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC)
- Closed Areas
- Marine Protected Areas (MPAs) and National Marine Sanctuaries.

4.2.2.1 Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC)

Section 3.1.2.1 describes the areas designated as EFH within the SWFSC research areas. EFH applies to federally managed fish species in both state and federal jurisdictional waters throughout the range of the species within U.S. waters. Overlapping EFH areas for numerous federally-managed species, including over 82 species covered by the Pacific Coast Groundfish FMP, have been identified in areas where SWFSC research surveys occur (Pacific Fisheries Management Council [PFMC] 2008). As shown in Figure 3.1-3, when these EFHs areas are combined, groundfish EFH includes all waters less than 3,500 meters in depth from the mean higher high water line, and the upriver extent of saltwater intrusion in river mouths, to the seaward boundary of the U.S. Exclusive Economic Zone (EEZ) along the coasts of California, Oregon, and Washington (PFMC 2008). Where a species' range extends beyond U.S. waters, EFH stops at the boundary. HAPC are discrete subsets of EFH that provide important ecological functions or are especially vulnerable to degradation. Thus, no EFH or HAPC exist within the ARA, or in the portion of the ETPRA that lies outside of the U.S. EEZ.

Because the SWFSC does not employ bottom trawl or bottom contact equipment within the CCRA, which is the only SWFSC research area where federally designated EFH exists, no direct impacts to EFH or HAPC benthic habitat are expected according to the criteria in Table 4.1-1. Limited impacts to pelagic habitats may result from the use of active acoustic equipment within closed areas, however the duration of those impacts would be considered short-term and limited to the time over which the surveys occur, and the magnitude of such impacts would be minor adverse because the effects would not result in measurable changes to the environment. Given the small areas affected by SWFSC research activities within EFH and HAPC areas, effects would be considered localized in geographic extent. Such effects would be minor in intensity and short term in duration. No measurable changes to EFH or HPAC are expected to result from

SWFSC research activities. Under the Status-Quo Alternative, the overall effects of fisheries research on EFH and HAPC are considered minor adverse according to the criteria in Table 4.1-1.

Direct and indirect effects of SWFSC research activities on biological resources within EFH and HAPC areas are most accurately captured in the assessments of species groups, which are evaluated in Sections 4.2.3-4.2.7.

4.2.2.2 Closed Areas

California Current Research Area

Several SWFSC fisheries research surveys are partially conducted in closed fishing areas within the CCRA, such as the Coastal Pelagic Species (CPS) Survey, Juvenile Rockfish Survey, and Juvenile Salmon Survey (Table 2.2-1). These surveys use a combination of near-surface and midwater trawl gear, as well as various plankton nets, water sampling devices and acoustic survey equipment to collect information about species and their habitats. Survey activities that may occur within closed areas in the CCRA would have no direct impact on benthic habitats because the equipment used for these activities generally does not contact the seafloor The duration of any impacts to pelagic habitats, however unlikely, would generally not extend beyond duration of the survey period. Limited effects may result from the use of active acoustic equipment within closed areas, however the duration of those impacts would be considered short-term and limited to the time over which the surveys occur, and the magnitude of such impacts would be minor because the effects would not result in measurable changes to the environment. Effects of surveys on populations of individual species occurring within closed areas are addressed in the species specific sections of this report. In summary, the effects of SWFSC survey activities on closed areas within the CCRA are expected to be minor adverse according to the criteria in Table 4.1-1.

Eastern Tropical Pacific Research Area

The National Oceanic and Atmospheric Administration (NOAA) has not designated closed areas within the ETPRA. SWFSC research activities may occur within reserves, marine parks, and World Heritage Sites established by foreign governments within the ETPRA. For the purposes of this EA, these areas are considered MPAs, and the impacts of SWFSC survey activities on these areas are discussed in Section 4.2.2.3.

Antarctic Research Area

Closed areas within the ARA include those established by the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) conservation measures, as discussed in the *Schedule of Conservation Measures in Force 2010/11 Season* (CCAMLR 2010). Taking of all finfish, other than for scientific research purposes, is prohibited in CCAMLR statistical subareas 48.1 and 48.2, which overlap with the SWFSC ARA (see Section 3.1.2.3). An additional series of closed areas have been proposed as a management tool to determine the efficacy of small scale management units in the Antarctic krill fishery (Constable et al. 2000; Hill et al. 2009). Under Alternative 1, the survey equipment used in Antarctic closed areas would include various small, towed, fine-mesh nets designed to sample larval and juvenile fish and small pelagic invertebrates, water sampling devices, video recording equipment, and acoustic survey equipment, none of which would result in lasting impacts to the environment within closed areas. Although changes to the environment within closed areas resulting from the use of such equipment would be measureable during the survey activity, the duration of those effects would be short-term, localized and result in no measurable changes to closed areas within the ARA from survey activities.

SWFSC occasionally uses a hard-bottom trawl in order to collect information about demersal fish and benthic invertebrates within the ARA (Jones et al. 2009; Lockhart et al. 2009). Such surveys would occur once every three years and have historically involved 75 bottom trawl hauls per survey. Under Alternative 1, it is assumed that a similar amount of survey effort would continue in the future. Bottom trawl surveys

are conducted on the South Orkney Island shelf using a random, depth-stratified survey design, and stations are positioned to account for as wide a geographic range as time, sea conditions, and ice conditions permit (Jones et al. 2009). In all cases, hauls are taken only after initial acoustic reconnaissance is conducted to verify bottom conditions suitable for trawling. Bottom trawl surveys are only conducted on suitable benthic substrates, e.g., sand, silt or gravel bottoms with few large rocks or sharp surfaces that may damage the gear. Rocky areas that are more likely to support corals are avoided by using sonar to examine the bottom contours before surveys are conducted (Jones et al. 2009; Lockhart et al. 2009). The effects of SWFSC bottom trawl surveys on closed areas in the ARA may include furrowing and smoothing of the seafloor, and resuspension of bottom sediments. Given the selection for bottom substrates and avoidance of coral areas, the removal of benthic organisms that produce structure for other species within fishery closed areas is unlikely. As discussed in Section 4.2.1, bottom contact fishing gear can increase turbidity and alter the chemical composition of the water column near the seafloor. However, these effects are temporary and localized. Given the small number of survey stations in closed fishing areas and the minor magnitude and localized nature of the effects, these effects are considered minor adverse for research activities conducted using gear types similar to the ones currently in use. Under Alternative 1, the adverse impacts of SWFSC research activities on closed areas within the ARA would be minor adverse due to the short-term and infrequent nature of the survey activities, and the localized areal extent of the impacts.

4.2.2.3 Marine Protected Areas

Over 300 MPAs encompass a large fraction of the area where SWFSC research surveys are conducted (see Section 3.1.2.4). They include: California's State Marine Reserves (SMR), State Marine Parks (SMP), State Marine Conservation Areas (SMCA), and State Marine Recreational Management Areas (SMRMAs); Oregon's MPAs; Washington's MPAs; Wildlife Refuges; National Parks; and National Marine Sanctuaries, as well as Marine World Heritage Sites and Marine Management Areas established outside of the U.S. EEZ by international agencies and foreign governments. MPAs vary widely in the level and type of legal protection afforded to the sites' natural and cultural resources and ecological processes. Considering the wide range of conservation goals and varying degrees of legal protection associated with individual MPAs in the SWFSC research areas (see Section 3.1.2.4), it is impractical to assess the impacts of SWFSC research activities to those areas on a case-by-case basis. Locations of randomized sampling sites vary from year to year, and impacts of research surveys within particular MPAs would vary substantially over space and time. In general, the impacts to each of the MPAs are a subset of the impacts to specific physical, biological, and socioeconomic resources that are addressed in the resource specific sections of this EA.

National Marine Sanctuaries

National Marine Sanctuaries are MPAs with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or aesthetic qualities. The SWFSC CCRA includes areas designated in each of the five West Coast National Marine Sanctuaries: Channel Islands, Cordell Bank, Gulf of the Farallones, Monterey Bay and Olympic Coast. Section 304(d) of the National Marine Sanctuaries Act (NMSA) requires interagency consultation between the NOAA Office of National Marine Sanctuaries and federal agencies taking actions that are "likely to destroy, cause the loss of, or injure a sanctuary resource." Sanctuary consultation requires the federal action agency to submit a "sanctuary resource statement," which describes the agency action and its potential effects on sanctuary resources. Sanctuary resource statements are not necessarily separate documents prepared by the federal agency, and may consist of documents prepared in compliance with other statutes such as the NEPA. The following analysis describes the potential effects of SWFSC research activities on each of the five West Coast National Marine Sanctuaries, and provides the requisite information for a sanctuary resource statement pursuant to section 304(d) of the NMSA.

Several SWFSC fisheries research surveys occur partially within the boundaries of the West Coast National Marine Sanctuaries, including the Collaborative Optical Acoustical Survey Technology (COAST) surveys, California Cooperative Oceanic Fisheries Investigation (CalCOFI) surveys, Central California Sharks surveys, Cowcod surveys, Juvenile Rockfish surveys, Juvenile Salmon surveys, Leatherback Use of Temperate Habitat surveys, Juvenile Shark surveys, Pacific Ocean Observing System (PacOOS) surveys, CPS surveys, Highly Migratory Species (HMS) surveys, and Thresher Shark surveys (Table 4.2-2). These surveys use a combination of near-surface and midwater trawl gear, as well as various plankton nets, water sampling devices and acoustic survey equipment to collect information about species and their habitats.

Table 4.2-2 Number and percentage of SWFSC survey stations from 2007-2011 conducted within Pacific coast National Marine Sanctuaries.

Table indicates the number and percentage of survey stations (tows or longline sets) that have occurred within each of the Sanctuaries in the five-year period from 2007 through 2011. See Table 2.2-1 for information on the gear types and seasonality of each survey. Blank cells indicate that no survey effort occurs within the National Marine Sanctuary.

Survey Name	Total # Stations in survey	Olympic Coast NMS		Cordell Banks NMS		Gulf of the Farallones NMS		Monterey Bay NMS		Channel Islands NMS		Combined percentage of survey effort occurring in NMS
		# within NMS	% of total	# within NMS	% of total	# within NMS	% of total	# within NMS	% of total	# within NMS	% of total	
CalCOFI	1705					4	<1	45	3	17	1	4
Coastal Pelagic Species	671	12	2			4	1	28	4			7
Juvenile Rockfish	752			46	6	99	13	298	40	14	2	61
Juvenile Salmon	125			10	8	28	22	6	5			35
PacOOS	65							10	15			15
Highly Migratory Species	215*							10	5	10	5	10
Thresher Shark	308									2	1	1
COAST	1580									328	21	21
Habitat Surveys	255*					4	2	24	9	25	10	21
Marine Mammal Surveys	24994	387	2	92	0.37	160	0.64	689	3	247	0.99	6

*** includes only survey segments occurring partially within NMS.**

The types of effects on National Marine Sanctuaries resulting from SWFSC research are substantially the same as those discussed for physical, biological, and socioeconomic resources elsewhere in this EA.

These effects primarily involve the removal of fish and invertebrates in the water column through sampling with pelagic sampling equipment, adverse interactions with protected species, and the risk of accidental spills or contamination from vessel operation. Survey activities that may occur within National Marine Sanctuaries would not have an impact on benthic habitats because SWFSC does not use bottom contact trawl equipment within the sanctuaries Near-surface and midwater trawl gear, as well as various plankton nets, water sampling devices, and acoustic survey equipment would result in temporary impacts to pelagic habitat within the National Marine Sanctuaries (NMS). Presence of pelagic sampling equipment may result in short-term disturbance or displacement of pelagic species within NMS. The duration of impacts to pelagic habitats within NMS would generally not extend beyond the duration of the survey period. Localized disturbance may result from the use of active acoustic equipment within NMS, however the duration of those impacts would be considered short term and limited to the time over which the surveys occur, and the magnitude of such impacts would be minor because the effects would not result in measurable changes to the environment. Effects of surveys on populations of individual species occurring within NMS are addressed in the species specific sections of this report.

Amounts of biomass removed from sanctuaries are small, and the effects of biomass removal on biological populations, habitats, and biogeochemical cycles would be minor adverse. Table 4.2-3 shows mean annual biomass removal from NMS resulting from previous SWFSC surveys. Under Alternative 1, similar levels of research effort and biomass removal would continue. SWFSC would conduct a relatively small amount of research within National Marine Sanctuaries, and that research effort would result in the removal of very small amounts of biomass.

Table 4.2-3 Mean annual biomass removal from National Marine Sanctuaries from SWFSC surveys

Biomass removal from sanctuaries was calculated for species for which the average annual total catch (both within and outside of sanctuaries) exceeded 1000 kilograms (kg). Biomass removal was calculated by multiplying the total catch of each species for each survey by the fraction of survey effort occurring within each NMS for each survey. The table shows mean annual biomass removal from sanctuaries in kilograms combined for all surveys.

Biomass Removal (kg)					
Species	**Olympic Coast NMS**	**Cordell Banks NMS**	**Gulf of the Farallones NMS**	**Monterey Bay NMS**	**Channel Islands NMS**
Anchovy (*Engraulis mordax*)	7.68	48.75	131.26	132.35	7.02
Pacific hake (*Merluccius productus*)	13.43	11.52	29.52	107.97	4.37
Pacific sardine (*Sardinops sagax*)	7.51	180.82	506.65	178.59	8.67
Albacore (*Thunnus alalunga*)	0.00	0.00	0.10	1.12	0.42
Common Mola (*Mola mola*)	0.00	0.00	0.32	3.57	1.35
Shortfin mako shark (*Isurus oxyrinchus*)	0.00	0.00	0.00	0.00	25.50
Blue shark (*Prionace glauca*)	0.00	0.00	0.17	1.91	11.79
Common Thresher	0.00	0.00	0.16	1.80	20.81

Shark (*Alopias vulpinus*)					

SWFSC survey activities within NMS may result in adverse interactions with protected species, including marine mammals. Adverse interactions with marine mammals may include disturbance from vessels and active acoustic equipment and incidental take. Historically there has been one California sea lion taken within the Gulf of the Farallones NMS (2011) and three California sea lions taken within the Channel Islands NMS (2008). Within the Monterey Bay NMS there have been two Pacific white-sided dolphins taken (2010 and 2011) and nine California sea lions taken in one set (2008). A leatherback sea turtle was also accidentally captured within the Monterey Bay NMS, then released alive and apparently unharmed. Similar levels of interaction with protected species would be expected to result from the SWFSC research activities included under Alternative 1. Mitigation measures intended to mitigate adverse interactions with protected species are described in the subsequent sections of this document.

There are many MPAs within NMS that are managed for sustainable production and/or have restrictions for commercial or recreational fishing encompass a large fraction of the area where SWFSC research surveys are conducted (NOAA 2010c). These particular MPAs are managed by NMFS. SWFSC survey activities provide essential information related to the science-based management, conservation, and protection of living marine resources and ecosystem services within these areas. The information developed from SWFSC research activities is essential to the development of a broad array of fisheries, habitat, and ecosystem management actions taken not only by NMFS, but also by other federal, state, and international authorities. Adverse effects on MPAs resulting from SWFSC research activities are expected to be localized in areal extent, short-term in duration, and result in no measurable changes to the physical environment. However, sound science-based management practices dependent upon the data generated from SWFSC research surveys would offset the adverse effects described above. The overall direct and indirect effects of Alternative 1 on MPAs are therefore considered minor adverse according to the criteria described in Table 4.1-1.

4.2.3 Effects on Fish

This section describes the effects of fishery research activities under Alternative 1 on fish species in the SWFSC fisheries research areas of the CCRA, ETPRA, and ARA. The potential effects of research vessels, survey gear, and other associated equipment on fish species found in the research areas include:

- Mortality from surveys
- Disturbance and changes in behavior due to sound sources
- Contamination from discharges

Mortality from surveys

Direct mortality of fish occurs as a result of fisheries research surveys and tagging activities. Fish are caught in a variety of gear types however; these surveys provide important data regarding abundance and distribution, necessary for managers to maintain healthy populations and rebuild overfished/depressed stocks. Fisheries research surveys are also used to determine biomass estimates, abundance, and distribution of depressed and overfished stocks; these surveys also sample closed areas where depressed and overfished stocks are known to concentrate. The SWFSC also conducts surveys to provide indices of juvenile abundance that are used to identify and characterize the strength of year classes before fish are large enough to be harvested by commercial or recreational fisheries. Stock assessments based on accurate abundance and distribution data are essential to developing effective management strategies.

The SWFSC is made up of five research divisions that generate the scientific information necessary for the conservation and management of the region's fish, marine mammals and turtles, seabirds, and

invertebrates. They also conduct research on the impacts of environmental variability and climate change on marine ecosystems, and on fishery and conservation socio-economics. For more details regarding each of the five research divisions, see Chapter 1. Descriptions of the SWFSC vessel surveys, including type and frequency of fishing gear used are described in Table 2.2-1.

In terms of the amount of fish killed during research, the CPS survey, the Juvenile Salmon survey, Juvenile Rockfish survey, CPS survey, and CalCOFI surveys account for the greatest numbers of fish and weight of fish killed during research. The HMS survey, Swordfish Tagging using Deep-set Buoy Gear, and Thresher Shark survey primarily involve catching fish for tagging and then releasing them. The most extensive surveys conducted are the pelagic trawl surveys conducted throughout the CCRA.

Disturbance and changes in behavior due to sound sources

There are several potential mechanisms by which noise sources from research activities could disturb fish and alter behavior, including the physical movement of marine vessels and fishing gear through the water, gear contact with the substrate, and operational sounds from engines, hydraulic gear, and acoustic devices. In addition to fishing gear noise, commercial and recreational vessels are a common part of the ambient noise in the marine environment. At present, there are thousands of commercial, recreational, and fishing vessels in the SWFSC fishery research areas that contribute to background vessel noise.

Noise from active acoustic devices used on vessels conducting fisheries research could potentially cause effects to fish in the SWFSC research areas. The LOA application (Appendix C, Section 6.2) provides a description of the types of acoustic devices used on SWFSC research vessels and analyzes the potential effects on fish and other species. Please refer to Appendix C, Section 6.2 for more information regarding the hearing sensitivity of fish, the frequencies produced by fishery vessels and equipment, and the estimated effects to fish. Any resulting impacts to fish are expected to be localized, short-term, and unlikely to have any measurable effect on the population. In summary, the potential for SWFSC research to affect the behavior of fish is considered to be minor adverse according to the criteria in Table 4.1-1. This determination is applicable for all fish species, in all three research areas, and under all of the action alternatives, so this topic will not be discussed further.

Contamination from discharges

Contamination from spills and discharges can accumulate in the seafloor and marine life and have a toxic effect on the plants, animals, and humans through the food chain (NOAA 2010d). While there are no intentional discharges of pollutants from SWFSC or any other fisheries research vessels, there is the potential for accidental spills to occur. Discharge from vessels, whether accidental or intentional, may include sewage, ballast water, fuel, oil, miscellaneous chemicals, garbage, and/or plastics.

These chemicals include hydraulic fluids or fuel from a damaged vessel due to a collision or accident. Such an event would have a low probability of occurrence. Use of anti-fouling agents to prevent the accumulation of microorganisms, plants, algae, or animals on the hulls of vessels and other submerged surfaces may contribute low levels of dissolved metals or organic compounds to the environment. The modern antifouling agents used on SWFSC research vessels are not expected to result in any adverse effects to fish.

NOAA vessels are fully equipped to respond to emergencies, including fuel spills, and crews receive extensive safety and emergency response training. These precautionary measures help reduce the likelihood of fuel spills and increase the chance that they will be responded to and contained quickly. Additionally, all NOAA and ocean going vessels are subject to the regulations of MARPOL 73/78, the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (NOAA 2010 b). MARPOL includes six Annexes that cover discharge of oil, noxious liquid substances, harmful packaged substances, sewage, garbage, and air pollution (International Maritime Organization [IMO] 2010). Adherence to these regulations minimizes or negates the likelihood of

discharges of potentially harmful substances into the marine environment. Annex V specifically prohibits plastic disposal anywhere at sea and severely restricts discharge of other garbage (IMO 2010).

Oil spill prevention training and equipment may be more variable on commercial fishing vessels used in cooperative research, although all vessels are required to comply with U.S. Coast Guard (USCG) regulations on spills.

Discharge of contaminants from SWFSC vessels and SWFSC chartered vessels is possible, but unlikely, and if it occurs, would be isolated in both time and location and would likely be small in volume. Any resulting impacts to fish would be localized, short-term in duration, and not result in any measurable effects on the population. Therefore, effects from spills and discharges on fish are considered minor adverse according to the criteria in Table 4.1-1. As the potential effects of discharges, regulations governing discharges, and the likelihood of discharges is universal across the three research areas, this will not be discussed further in this analysis.

1.2.3.1 California Current Research Area

ESA-listed Species

The SWFSC does some directed research on ESA-listed Pacific salmon and only a few listed species have been caught incidentally in the CalCOFI, CPS, Juvenile Salmon, and Juvenile Rockfish surveys. There are no records of incidental catch of bocaccio, green sturgeon, yelloweye rockfish, or totoaba and no anticipated effect on these species under the Status Quo Alternative.

Four species of salmon have been caught in offshore research surveys. Of these salmon species, chum and sockeye salmon are rarely captured in research activities (average less than 1 kg per year). Chinook and coho salmon catch incidental to offshore surveys average 705 kg and 132 kg, respectively, each year. Juvenile Salmon Surveys, conducted since 2010, have accounted for an average biomass removal of 15 kg and 176 kg per year for coho and Chinook salmon, respectively. All juvenile salmon captured in these surveys are sacrificed for genetic analysis to determine Pacific salmon stock of origin. Pacific salmon are only assigned a specific stock of origin (i.e. ESU) when genetic test confidence levels are equal to or greater than a 90%, an approximate threshold. Genetic tests have been inconclusive for juvenile steelhead trout tissue samples however the average biomass removal of 5 kg per year is considered minimal. . Table 4.2-4 shows the mean biomass removal of ESA listed Pacific salmon ESU's from Juvenile Salmon surveys. No genetic analysis is conducted on Pacific salmon captured in CalCOFI research surveys.

Table 4.2-4 Mean biomass removal of ESA listed Pacific salmon ESU's from SWFSC Juvenile Salmon surveys.

Biomass removal was calculated by multiplying the mean average weight (0.15 kg) times the number of juvenile salmon harvested per ESU. Biomass removal estimates are limited to 2010 and 2011 surveys where genetic test confidence levels equal or exceed 90%.

ESU	ESA Status	Biomass Removal (kg)
Chinook Salmon		
California Coastal	Threatened	9.15
Central Valley Fall and Late Fall Run	Species of Concern	202.8
Snake River Fall Run	Threatened	0.45
Central Valley Spring	Threatened	6.0

ESU	ESA Status	Biomass Removal (kg)
Run		
Upper Columbia River Spring Run	Endangered	0.15
Upper Willamette River	Threatened	0.15
Puget Sound	Threatened	0.15
Lower Columbia River	Threatened	0.75
Sacramento River Winter Run	Endangered	0.75
Coho Salmon		
Central California Coastal	Endangered	3.15
Southern Oregon/Northern California Coasts	Threatened	14.25
Lower Columbia River	Threatened	6.45
Oregon Coast	Threatened	1.65

An average of 156 kg of canary rockfish are caught each year under the Status Quo Alternative. Compared to the estimated 2011 spawning biomass of 6,458 metric tons (mt) (Wallace and Cope 2011), mortality from SWFSC research accounts for a very small fraction of the population (0.002%) and is considered minor adverse. No genetic tests have been conducted on canary rockfish to determine what proportion, if any, belong to the Puget Sound/Georgia Basin threatened DPS. Pacific eulachon (< 1 kg per year) and steelhead trout (3.4 kg per year) are rarely encountered; these levels of mortality are considered minor for these species. Effects on ESA-listed fish species are expected to be occasional or rare, short-term in frequency and duration, localized, and result in no measurable population level effects. Therefore, overall effects on ESA-listed fish species are considered to be minor adverse according to the criteria in Table 4.1-1.

Target Species

Table 4.2-5 shows the average SWFSC research catch of target species in the CCRA over the past five years compared to the Allowable Biological Catch (ABC) or other metric for commercial harvests of these species. Only species that have been caught in quantities exceeding 100 kg per year are shown. In all cases for which there are fishing metrics for comparison, the SWFSC research catch represents much less than 0.1% of the ABC or other metric for the target species. For all target species in the CCRA, mortality from SWFSC research surveys is not expected to result in any measurable changes at the population level under the Status Quo Alternative and is therefore considered minor adverse.

Table 4.2-5 Relative Size of SWFSC Research Catch in California Current Research Area compared to Commercial Allowable Biological Catch (ABC).

Only target species caught in excess of 100 kg per year are shown.

Species	Stock Status	Average SWFSC Research Catch per year (kg) (2007-2011 data)	ABC Commercial Catch Reference Value (kg)	Average SWFSC Research Catch, Compared to ABC Reference Value (percentage)
Blue shark	Not overfished	900	N/A	N/A
Common Mola	Monitored	1,135	N/A	N/A
Common thresher shark	Not overfished	2,200	N/A	N/A
Jack mackerel	Monitored	392	31,000,000	0.0003%
Jacksmelt	Monitored	330	N/A	N/A
North Pacific albacore tuna	Not overfished	1,589	405,000,000	0.0039%
Northern anchovy	Monitored	1,201	34,750,000	0.0003%
Pacific hake (whiting)	Not overfished	1,045	2 million metric tons (mt) (2011 spawning biomass)	<0.0001%
Pacific mackerel	Not overfished	7,534	42,375,000	0.0178%
Pacific sardine	Not overfished	1,564	84,681,000	0.0019%
Shortbelly rockfish	Not overfished	412	23,500,000	<0.0001%
Shortfin mako shark	Not overfished	2,500	N/A	N/A
Spiny dogfish	Not overfished	189	1,584,000	0.0001%
Yellowtail rockfish	Not overfished	117	4,320,000	<0.0001%

Prohibited and Highly Migratory Fish Species

Prohibited species (as defined in section 3.2.1.3) that occur within the CCRA include the great white shark, basking shark, megamouth shark, Pacific halibut, and Pacific salmon. The effects of SWFSC research catches of Pacific salmon are described in the ESA-listed species section above. None of the other prohibited species have been taken during SWFSC surveys in the past five years. The effects of SWFSC research on prohibited species are expected to be localized, rare and short-term in frequency and duration, and result in no measurable population level effects. Therefore, effects are considered minor adverse under the Status Quo Alternative according to the criteria in Table 4.1-1.

HMS in the Pacific Region include tunas (North Pacific albacore, yellowfin, bigeye, skipjack, and northern bluefin); sharks (common thresher, shortfin mako, and blue); billfish/swordfish (striped marlin and Pacific swordfish); and dorado, also known as dolphinfish or mahi-mahi (PFMC 2011). Several of these HMS are also considered target species for research and commercial fisheries. The level of HMS catch is small compared to known harvests in commercial and recreational fisheries, and, in the case of the North Pacific albacore tuna, a fraction (0.0003%) of the ABC (Table 4.2-5). Dorado are rarely caught

and two Pacific swordfish have been killed in SWFSC research surveys. The effects of SWFSC research on HMS are considered minor adverse under the Status Quo Alternative.

4.2.3.2 Eastern Tropical Pacific Research Area

Under Alternative 1, SWFSC research activities would result in the removal of very small quantities of fish from the ETPRA, primarily larval and juvenile size classes caught in plankton nets. Overall catch of fish is approximately 1 kg per year under the Status Quo Alternative, which would not result in any measurable changes to fish populations in the Eastern Tropical Pacific (ETP). Effects are expected to be localized, short-term and therefore considered minor adverse for all fish species in the ETP.

4.2.3.3 Antarctic Research Area

In the ARA, SWFSC surveys are primarily focused on Antarctic krill, which are discussed within Section 4.2.7. The SWFSC also conducts periodic bottom trawl surveys in the South Orkney Islands area to monitor the recovery of several finfish that were overfished in the 1970s and 1980s. These surveys are only conducted every two or three years as funds and charter vessels become available. During the last research survey, conducted during the 2008-2009 season, only seven species were caught in totals greater than 100 kg Table 4.2-6. Although no commercial fisheries metrics have been determined for these species for many years, given the very small catches of all species and the periodic frequency of the finfish survey, the effects of SWFSC research mortality on fish species in the ARA is considered minor adverse according to the criteria in Table 4.1-1.

Table 4.2-6 SWFSC Research Catch in the Antarctic Research Area during bottom trawl surveys.

Data from Van Cise (2009). No information is available on current stock size or status for any species.

Species	SWFSC Research Catch per survey (kg) (2008-2009 data)
Blackfin icefish	1,920
Mackerel icefish	575
Ocellated icefish	618
Humped rockcod	2,628
Grey rockcod	505
Black rockcod	110
South Georgia icefish	656

4.2.3.4 Conclusion

The overall effects of SWFSC research activities on fish populations found in the CCRA, ETPRA, and ARA are considered minor adverse under the Status Quo Alternative since they are short-term in duration, of localized geographic extent, and are unlikely to result in measurable population change.

4.2.4 Effects on Marine Mammals

Section 3.2.2 describes the marine mammals that are likely to overlap with fishery research activities in the three SWFSC research areas. This section describes the potential effects of the SWFSC research activities on marine mammals under the Status Quo Alternative, including the mitigation measures that have been implemented in the past to reduce those effects. Because the secondary federal action considered in this EA is the promulgation of regulations and subsequent Letters of Authorization under Section 101(a)(5)(A) of the Marine Mammal Protection Act (MMPA), this section provides more information and analysis for effects on marine mammals than is presented for the analysis of effects on other resources, consistent with the needs of the MMPA authorization process.

The potential effects of research vessels, survey gear, sonar and other active acoustic devices, and other associated equipment on marine mammals include:

- Disturbance and behavioral responses due to acoustic equipment and vessel noise
- Injury or mortality due to ship strikes and gear interaction
- Changes in food availability due to research survey removal of prey and discards
- Contamination from discharges

The first part of the analysis in this section provides information on the mechanisms for these different types of effects. It also provides an analysis of some effects common to all three research areas. For some types of effects, the level of impact is similar for all species of marine mammals and the analysis is not repeated in the following subsections.

The second part of the analysis provides information on the effects of the SWFSC research activities on marine mammal species in each separate research area, including information needed for the MMPA authorization process. An application for promulgation of regulations and issuance of Letters of Authorization (referred to as the LOA application) for incidental take of marine mammals must include estimates of the numbers of animals that may be taken by serious injury or mortality, harassment that has the potential to injure (Level A harassment takes), and harassment that has the potential to disturb (Level B harassment takes). The SWFSC LOA application (Appendix C) only concerns the Preferred Alternative because that is the SWFSC's proposed action. However, the analysis of takes in the LOA application is based on essentially the same scope of research activities as the Status Quo Alternative and is therefore helpful in describing the potential effects of the Status Quo Alternative. For those research areas and marine mammal species where the effects of the Status Quo are considered the same or very similar to the Preferred Alternative, analysis provided in the LOA application is summarized and referenced in this section. Where the scope of activities differs between the Status Quo and Preferred Alternatives (e.g., in the ETP), the analysis of effects from the LOA application are summarized and referenced in the Preferred Alternative (Section 4.3.4). The following analysis focuses on the types of research gear most likely to have adverse interactions with marine mammals.

Disturbance and behavioral responses due to acoustic equipment

Several mechanisms exist by which research activities have the potential to disturb marine mammals and alter behavior, including the physical presence of marine vessels and fishing gear combined with operational sounds from engines, hydraulic gear, and acoustical devices used for navigation and research. The impacts of anthropogenic noise on marine mammals have been summarized in numerous articles and reports including Richardson et al. (1995), NRC (2005), and Southall et al. (2007). Marine mammals use hearing and sound transmission to perform vital life functions. Sound (hearing and vocalization/ echolocation) serves four primary functions for marine mammals, including: 1) providing information about their environment, 2) communication, 3) prey detection, and 4) predator detection. Introducing sound into their environment could disrupt those behaviors. The distances to which anthropogenic sounds

are audible depend upon source levels, frequency, ambient noise levels, the propagation characteristics of the environment, and sensitivity of the marine mammal (Richardson et al. 1995).

In assessing potential effects of noise, Richardson et al. (1995) suggested four criteria for defining zones of influence:

- Zone of audibility – the area within which the marine mammal might hear the sound. Marine mammals as a group have functional hearing ranges of 10 hertz (Hz) to 180 kilohertz (kHz), with highest sensitivities to sounds near 40 kHz (Ketten 1998, Kastak et al. 2005, Southall et al. 2007).
- Zone of responsiveness – the area within which the animal reacts behaviorally or physiologically. The behavioral responses of marine mammals to sound depend on: 1) acoustic characteristics of the noise source; 2) physical and behavioral state of animals at time of exposure; 3) ambient acoustic and ecological characteristics of the environment; and 4) context of the sound (e.g., whether it sounds similar to a predator) (Richardson et al. 1995, Southall et al. 2007). Temporary behavioral effects, however, often merely show that an animal heard a sound and may not indicate lasting consequences for exposed individuals (Southall et al. 2007).

  All of these factors that may affect the response of a marine mammal to a given noise can never be determined ahead of time. In lieu of having this information, NMFS uses a standardized noise level to help determine how many animals may be disturbed (harassed) by a given activity during the MMPA authorization process. NMFS currently uses a sound threshold of 160 decibels (dB) referenced to one micro pascal (re 1μPa) for the types of sound produced by the active acoustic sources considered here to determine the onset of behavioral harassment for marine mammals (Level B harassment takes) (NMFS 2005). Any animal exposed to impulse noises above this level is assumed to respond in a way consistent with the definition of a behavioral "take" under the MMPA, although NMFS acknowledges that some marine mammals may react to sounds below this threshold or may not react to sounds above this threshold.
- Zone of masking – the area within which the noise may interfere with detection of other sounds, including communication calls, prey sounds, or other environmental sounds.
- Zone of hearing loss, discomfort, or injury – the area within which the received sound level is potentially high enough to cause discomfort or tissue damage to auditory or other systems. NMFS considers exposure of marine mammals to this level of sound to be Level A harassment and has regulated some industrial and military activities to reduce the risk of such exposures.

The SWFSC has been using a variety of sonar and other acoustic systems during its research cruises to characterize marine habitats and fish aggregations and to monitor gear deployments. This acoustic equipment sends pulses of sound into the marine environment which provide information as they reflect back to the ship and are recorded (see Appendix A). The sounds produced by equipment used by the SWFSC range from 18-333 kHz and from 206 dB to 225 dB re 1μPa (Appendix C, Section 6.2). The LOA application (Appendix C, Section 7.2) categorized these acoustic sources based on operating frequency and output characteristics. Category 1 active acoustic sources include short range echosounders and acoustic Doppler current profilers (ADCPs). These have output frequencies >300 kilohertz (kHz), are generally of short duration, and have high signal directivity. Category 2 active acoustic sources include various single, dual, and multi-beam echosounders, devices used to determine trawl net orientation, and current profilers of lower output frequencies than category 1 sources. Output frequencies of category 2 sources range from 12 to 200 kHz, have short ping durations, and are usually highly directional for mapping purposes.

Although these acoustic systems have been used for years and may have been a source of disturbance for nearby marine mammals, no direct observations of disturbance have been documented, primarily because any such disturbance, if it occurred, would have taken place under water. For animals at the surface, it is very difficult to determine whether observed changes in behavior were caused by a given sound source or

by the physical presence of the vessel. In many cases it is likely to be a combination of visual and acoustic components that causes a disturbance. It may also be difficult to determine if an animal has actually changed its behavior to avoid a disturbance or if it is moving for other reasons (e.g., to pursue nearby prey). For these reasons there have been no records or documentation of how many animals may have been disturbed by vessels and/or acoustic equipment during research cruises in the past.

NMFS regulations for implementing the MMPA distinguish between Level B harassment that causes behavioral changes in the affected marine mammals and Level A harassment that has the potential to cause injury. Animals exposed to intense sounds may experience reduced hearing sensitivity for some period of time following exposure. This change in hearing threshold is known as noise induced threshold shift (TS). The amount of TS incurred is influenced by amplitude, duration, frequency content, temporal pattern, and energy distribution of the noise (Richardson et al. 1995, Southall et al. 2007). It is also influenced by characteristics of the animal, such as hearing range of the species, behavior, age, history of noise exposure, and health. The magnitude of TS generally decreases over time after noise exposure and if it eventually returns to zero, it is known as 'temporary threshold shift' (TTS). If TS does not return to zero after some time (generally on the order of weeks), it is known as 'permanent threshold shift' (PTS). Sound levels associated with TTS onset are generally considered to be below the levels that will cause PTS, which is considered to be auditory injury.

The current NMFS policy regarding Level A harassment is that cetaceans should not be exposed to impulsive sounds greater than 180 dB re 1 µPa and that pinnipeds should not be exposed to impulsive sounds greater than 190 dB re 1µPa (NMFS 2000). However, these criteria were established before information was available about minimum received levels of sound that would cause auditory injury in marine mammals. They are likely lower than necessary and are intended to be precautionary estimates above which physical injury may occur (Southall et al. 2007).

Southall et al. (2007) assessed the potential for discrete sound exposures to produce TTS and PTS in marine mammals and concluded that, for the kinds of relatively brief exposures associated with transient sounds such as the active acoustic sources used by the SWFSC for research, received sound pressure levels in the range of approximately 180-220 dB re 1µPa are required to induce the onset of TTS levels for most pinnipeds and odontocete cetaceans. Southall et al. (2007) also provided some frequency weighting functions for different marine mammal groups to account for the fact that impacts of noise on hearing depend in large part on the overlap between the range of frequencies in the sound source and the hearing range of the species. Based on the Southall et al. (2007) results, Lurton and DeRuiter (2011) modeled the potential impacts (PTS and behavioral reaction) of conventional echosounders on marine mammals. They estimated PTS onset at typical distances of 10 to 100 meters for the kinds of acoustic sources used in fisheries surveys considered here. They also emphasized that these effects would very likely only occur in the cone ensonified below the ship and that behavioral responses to the vessel at these extremely close ranges would very likely influence the probability of animals being exposed to these levels.

Animals are likely to avoid a moving vessel, either because of its physical presence or because of behavioral harassment resulting from exposure to sound from active acoustic sources. It is unlikely that animals would remain in the presence of a harassing stimulus absent some overriding contextual factor. Because of this likely avoidance behavior, as well as the source characteristics (i.e., intermittent pulsing and narrow cones of ensonification), the SWFSC has determined that the risk of animals experiencing repetitive exposures at the close range or of the duration necessary to cause PTS is negligible. The SWFSC therefore does not anticipate causing any Level A harassment by acoustic sources of marine mammals and the LOA application includes no such take estimates. The potential for this type of impact on marine mammals will not be discussed further in this EA.

However, the SWFSC anticipates that the use of active acoustic equipment in its research activities could cause Level B harassment of marine mammals. In its LOA application for the Preferred Alternative

(Appendix C), the SWFSC estimates the numbers of marine mammals that may be exposed to sound levels of 160 dB or above due to the use of acoustic sonars during research cruises (Level B harassment takes). The LOA application used the operational conditions and scope of work conducted in the past five years to estimate what may occur in the future under the Preferred Alternative. The Preferred Alternative would add longline sampling to an existing survey in the ETP but would otherwise be the same as the Status Quo Alternative as far as potential acoustic disturbance is concerned. The estimates of Level B harassment takes by acoustic sources presented in the LOA application therefore also represent potential numbers of animals affected under the status quo conditions.

As explained in the LOA application, these estimates attempt to quantify a very dynamic situation that has a great deal of unavoidable uncertainty regarding the propagation of sound in the water and distribution of marine mammals over very large areas. The scientific description of sound generated by sonar gear and its propagation through water is complicated, especially considering a sound source that is moving (on a vessel) through waters of different depths and properties (e.g., salinity and temperature) that affect sound transmission. The LOA application provides details on the assumptions that were made about the source levels and acoustic properties of sonar pulses, the directionality of the sound, and propagation/attenuation properties that were used to calculate an "ensonified zone" considered loud enough to harass marine mammals. One part of the SWFSC Level B harassment take calculation used a model of sound propagation from typical sonar equipment used during research to estimate the shape and dimensions of a typical ensonified zone $\geq$ 160 dB re 1 μPa, which was multiplied by the distance research ships travel with active sonar gear to derive an estimated total volume ensonified to the Level B harassment take guidelines.

Another aspect of this Level B harassment take estimation process subject to large uncertainty concerns the distribution and abundance of marine mammals in the area. No species is distributed evenly throughout its range; they are typically patchy in distribution with strong seasonal variations and preferences for certain zones within the water column. Although some preferred habitats and general distributions are known, there is no way to know exactly how many animals will be in any area at any point in the future. The estimation process therefore uses average density of each species within the different research areas to estimate how many may be affected within the ensonified volume. One refinement that has been built into the Level B harassment take model is to categorize each marine mammal species according to its typical dive depth range, which affects the size of the ensonified zone they may be exposed to. The estimation process is admittedly subject to great uncertainty and there is no way to assess how "realistic" these estimates are in terms of the number of animals that would be disturbed by the activity. However, the development of the Level B harassment take model was conservative in the sense that assumptions were made that would tend to overestimate the size of the ensonified volume and the number of animals affected (Appendix C, Section 6.2).

This EA (and the LOA application) must also assess what the likely biological effects may be for these estimated Level B harassment takes by acoustic sources. The LOA application (Appendix C, Section 7.2) provides an analysis of the potential effects of acoustic equipment used in SWFSC research on marine mammals (and other species). The analysis in this EA is a summary of the LOA application analysis and will be provided in the subsections on cetaceans and pinnipeds because of their different hearing ranges and frequencies used for communication, which determines what the effects of different acoustical equipment might be. This effort to examine the biological importance of acoustic disturbance requires knowledge about whether animals can perceive the sonar signals, their potential reactions to various types of sounds, and the conditions under which particular sound sources may lead to biologically meaningful effects (i.e., interference with feeding opportunities or critical social communication). Unfortunately, many key aspects of marine mammal behavior relevant to this discussion are very poorly known. Most of the data on marine mammal hearing and behavioral reactions to sounds comes from relatively few captive, trained animals and likely does not reflect the diversity of behaviors in wild animals. Some behavioral reactions, if they occur in one or more species, could substantially reduce the numbers of

animals exposed to high sound levels (e.g., swimming away from an approaching ship before sound levels reach the 160 dB level). Industrial projects such as seismic exploration for oil and gas and pile driving in relation to coastal developments are typically required to monitor marine mammal behavioral responses in relation to percussive industrial sounds but there have been few efforts to document behavioral responses to acoustic equipment commonly used in fisheries research.

Injury or mortality due to ship strikes and entanglement in gear

The Pacific coast of the U.S. includes numerous shipping lanes, active ports, and vessel traffic. Vessel collisions with marine mammals, or ship strikes, can lead to death by massive trauma, hemorrhaging, broken bones, or propeller wounds (Knowlton and Kraus 2001). Large whales, such as fin whales, are occasionally found draped across the bulbous bow of large ships upon arriving in port. Massive propeller wounds can be immediately fatal. If more superficial, the whales may survive the collisions (Silber et al. 2009). Jensen and Silber (2003) summarized large whale ship strikes world-wide and found that most collisions occurred in the open ocean involving large vessels. Commercial fishing vessels were responsible for four of 134 records (3%), and one collision (0.75%) was reported for a research vessel. Vessel speed appears to be key in determining the frequency and severity of ship strikes, with the potential for collision increasing at ship speeds of 15 knots (kts) and greater (Laist et al. 2001, Vanderlaan and Taggart 2007). In the relatively few recorded cases of ship strikes at speeds below 15 kts, the chance of mortality declines from approximately 80% at 15 kts to approximately 20% at 8.6 kts (Vanderlaan and Taggart 2007).). Certain areas with high densities of whales and high vessel traffic (e.g., Stellwagen Bank National Marine Sanctuary and North Atlantic right whales) have been subject to mandatory ship speed restrictions of less than ten knots to reduce the risk of ship strikes. Relatively high rates of blue whale and other large whale mortalities from ship strikes have occurred along the California coast in recent years and have led to increased efforts to map high risk traffic zones and develop mitigation technologies and strategies (Abramson et al. 2010). Voluntary ship speed restrictions in the Santa Barbara Channel have not been very effective in reducing average ship speeds in this high-risk ship strike area but adaptive management strategies with real-time monitoring of whale presence and ship locations may be more effective in reducing risks of ship strikes (Abramson et al. 2010). Reducing the co-occurrence of whales and vessels may be the only sure way to reduce ship strikes, but this is not always feasible (Silber et al. 2009).

No collisions with large whales have been reported from any fisheries research activities conducted or funded by the SWFSC in any of the three research areas. Transit speeds vary from 6-14 kts but average 10 kts. The vessel's speed during active sampling is typically 2-4 kts due to sampling design but these much slower speeds essentially eliminate the risk of ship strikes.

Given the relatively slow speeds of research vessels, the presence of bridge crew watching for obstacles at all times (including marine mammals), the presence of marine mammal observers on some surveys, and the small number of research cruises, ship strikes with marine mammals during the research activities described in this EA would be considered rare in frequency, localized in geographic scope, and unlikely to occur within the next five years. The potential for fisheries research vessels to cause serious injury or mortality to any cetaceans or pinnipeds due to ship strikes is considered minor adverse throughout the three SWFSC research areas using vessel types and protocols currently in use. This potential effect of research will not be discussed further in the following analysis.

In contrast to the unlikely risk of ship strikes, there is a well-documented history of marine mammals being injured and killed due to entanglement in trawl and longline fishing gear during SWFSC research activities (Tables 4.2-7 and 4.2-8). Four different species have been incidentally caught in SWFSC trawl gear in the past five years. Pacific white-sided dolphins have been caught most frequently, with 13 incidents involving 32 animals. California sea lions have been incidentally taken in seven incidents involving 17 animals. Northern fur seals have been caught three times, each time involving one animal. Northern right-whale dolphins have been caught only once but that incident involved six animals. In

addition, five California sea lions have been caught on longline gear, one animal each on five separate occasions.

The number of marine mammal takes during SWFSC fisheries research has varied substantially over the past five field seasons. After many years with no or very rare takes of marine mammals, the 2008 field season ended with a large number of marine mammals being taken (43 total, with 38 killed), including several "disaster sets" where multiple animals were taken at once, primarily with the Nordic 264 trawl during the CPS survey (also known as Sardine Survey). The CPS survey was suspended in 2008 due to the high number of takes and the SWFSC convened a panel of experts to examine the problem and develop more effective mitigation measures and formalized procedures (Hewitt 2009). Most of the mitigation measures that are part of the Status Quo Alternative have been implemented since 2009 as a result of that expert review, including development and deployment of a marine mammal excluder device (MMED) for the Nordic 264 trawl.

It is not clear why the number of takes was so high in 2008 or whether the mitigation measures implemented since then have actually been effective at reducing the number of takes. The record of takes in 2008, both in terms of the number of incidents and the total number of animals involved, was substantially higher than the previous year (2007) and subsequent years (2009-2012), which are similar in scope to each other (Table 4.2-7). The number of marine mammal takes has declined since 2009 relative to the 2008 season but takes have not been eliminated. There are many variables that influence the effectiveness of visual monitoring at any one time, including the lighting and sea state and the capabilities of the person assigned to watch, so it is impossible to determine an overall measure of effectiveness, such as how many animals may have been avoided with visual monitoring compared to having no monitors. It is also difficult to scientifically determine the effectiveness of gear modifications, such as the excluder device, because potential interactions would occur underwater and out of sight. The value of implementing some mitigation measures is therefore based on general principles and best available information even if their effectiveness at reducing takes has not been scientifically demonstrated.

Figures 4.2-1 and 4.2-2 show the spatial distribution of cetaceans and pinnipeds respectively that have been taken in SWFSC surveys from 2008-2012. The distribution of takes is fairly uniform and is almost entirely off the coast of California, which is where the CPS survey effort is most intensive and where the Juvenile Rockfish and Juvenile Salmon surveys are conducted. These three surveys account for all of the animals taken in trawl gear. The HMS and Thresher Shark surveys also take place off the coast of California and account for the captures of marine mammals (all pinnipeds) on longline gear. Although some trawl sets have taken more than one animal at a time, there does not appear to be any "hot spots" where marine mammal takes are concentrated. Rather, takes have been dispersed over a large area offshore of California where most of the fisheries research takes place.

Tables 4.2-7 and 4.2-8 indicate the date and time for all historical takes of marine mammals in trawl gear and longline gear respectively. Similar to the spatial distribution of the takes, there does not appear to be any obvious pattern of animals being taken only in particular seasons or times of day. In most years there are too few incidents to establish any trend. In 2008, takes occurred throughout the spring, summer, and early fall, which reflects when the surveys were conducted. Most takes occurred during the night, reflecting the higher number of takes during the CPS, which is conducted primarily at night.

The MMPA authorization process requires the applicant (SWFSC) to estimate how many marine mammals may be captured or entangled in the future under the proposed set of conditions. As is the case for Level B harassment takes by acoustic sources, the LOA application (Appendix C, Section 6.1) describes the methodology used to estimate the species and numbers of animals that may be taken by Level A harassment and serious injury or mortality during future research conducted under the Preferred Alternative. For the four species that have been taken historically during SWFSC research, the LOA application uses the calculated average annual numbers of takes that have occurred in the past five years and "rounds up" this annual average to the next highest number of animals. Since the LOA application

requests takes for a five-year period, this intentionally inflated annual average is multiplied by five to produce an estimate higher than the historic average take for each species that has been taken incidentally during SWFSC research. This methodology has been used in order to ensure accounting for the maximum amount of potential take in the future.

The LOA application also includes estimates for future incidental takes of a number of species that have not been taken historically but exist in the same areas and show similar types of behaviors as species that have been taken in the past. For these analogous and potentially vulnerable species, the SWFSC believes that the risk of future takes is low (i.e., that they would be rare events) but there is a potential for more than one animal to be caught at a time in trawls. For species that are considered analogous (i.e., similar behaviors, distribution, and abundance) to one of the four species that have been taken historically, the LOA application estimates the take of these analogous species based on the maximum number of similar animals that have been taken in any one incident historically. For example, five dolphin species were deemed to have a similar vulnerability to trawl gear as the Pacific white-sided dolphin. The maximum take of Pacific white-sided dolphins was 11 individuals in one trawl set in 2008; the LOA application therefore requests 11 takes for each of the five similar dolphin species over the five-year LOA period under the assumption that one incidence of capture is possible during that time, and that as many as 11 animals could be taken in such an incident. Nine California sea lions were taken in one trawl in 2008; the LOA application requests nine takes each of two similar pinniped species (Steller sea lions and harbor seals) over the five-year LOA period. In addition, the SWFSC has included estimates of a small number of less abundant cetaceans that may be taken in trawl and longline gear based on records of incidental takes in commercial fisheries that use similar gear and in similar areas as research activities. See Appendix C, Section 6.1, for a more detailed explanation of the LOA application estimation methodology.

The LOA application estimates of take are based on the scope of research and mitigation measures proposed under the Preferred Alternative. However, as was the case with the Level B harassment take analysis, the estimates of Level A harassment, serious injury, and mortality takes in the LOA application are relevant to the discussion of effects from the Status Quo Alternative for the CCRA and ARA and will be reported in this section. The analysis is different in the ETPRA because the LOA application includes a new longline survey that has not been conducted under the status quo conditions. The estimated takes in the ETPRA will be discussed under the Preferred Alternative (Section 4.3.4). The analysis of gear interaction effects is limited to the gear types that have a history of marine mammal takes in either SWFSC research or similar commercial fisheries in the research areas. Gear types and other scientific equipment that have no history of takes or adverse interactions with marine mammals and are very unlikely to result in takes in the future (e.g., small-mouthed nets designed to sample plankton and larval fish, CTD rosettes, and ROVs), are not discussed further.

Table 4.2-7 Historical takes of marine mammals in trawl gear during SWFSC surveys from 2008 to 2012

All takes have occurred in the CCRA. Data are from NMFS Protected Species Incidental Take database.

Survey Name	Protected Species Taken	Trawl Gear	Date (Time) Taken	# Killed	# Released Alive Injured[1]	# Released Alive Uninjured[1]	Total Taken
2012							
Coastal Pelagic Species (CPS)	Pacific white-sided dolphin	Nordic 264	Aug 24 (5:30 am)	2	0	0	2
CPS	Pacific white-sided dolphin	Nordic 264	Aug 18 (10:35 pm)	1	0	0	1
CPS	Pacific white-sided dolphin	Nordic 264	June 29 (11:20 am)	0	0	1	1
2011							
Juvenile Salmon (JS)	Pacific white-sided dolphin	Nordic 264	Sept 10 (5:30 pm)	6	0	0	6
JS	California sea lion	Nordic 264	Sept 9 (1:25 am)	1	0	0	1
CPS	Pacific white-sided dolphin	Nordic 264	April 3 (10:19 pm)	1	0	0	1
2010							
Juvenile Rockfish (JR)	Pacific white-sided dolphin[2]	Modified Cobb	Sept 10 (4:15 pm)	1	0	0	1
CPS	Pacific white-sided dolphin	Nordic 264	April 25 (12:30 am)	1	0	0	1
CPS	Pacific white-sided dolphin	Nordic 264	April 18 (8:20 am)	0	1	0	1
2009							
JR	California sea lion	Modified Cobb	May 25 (11:00 pm)	0	0	1	1
CPS	Pacific white-sided dolphin	Nordic 264	May 1 (4:00 am)	0	0	3	3
2008							
CPS	California sea lion	Nordic 264	Aug 14 (4:03 am)	9	0	0	9
CPS	Northern right whale dolphin	Nordic 264	Aug 9 (10:41 am)	6	0	0	6
CPS	Pacific white-sided dolphin	Nordic 264	Aug 9 (10:41 am)	11	0	0	11
CPS	Northern fur seal (SMI stock)	Nordic 264	Aug 3 (10:35 am)	1	0	0	1
CPS	Northern fur seal (SMI stock)	Nordic 264	July 31 (9:38 am)	1	0	0	1
CPS	California sea lion	Nordic 264	July 28 (7:38 am)	1	0	0	1
CPS	Pacific white-sided dolphin	Nordic 264	July 19 (3:05 am)	1	0	0	1

Survey Name	Protected Species Taken	Trawl Gear	Date (Time) Taken	# Killed	# Released Alive Injured[1]	# Released Alive Uninjured[1]	Total Taken
JR	California sea lion	Modified Cobb	June 15 (12:30 am)	1	0	2	3
CPS	Northern fur seal (EP stock)	Nordic 264	April 27 (2:36 am)	1	0	0	1
CPS	California sea lion	Nordic 264	April 27 (11:27 am)	1	0	0	1
CPS	Pacific white-sided dolphin	Nordic 264	April 26 (8:22 am)	2	0	0	2
CPS	Pacific white-sided dolphin	Nordic 264	April 21 (12:56 am)	1	0	0	1
CPS	California sea lion	Nordic 264	April 18 (5:46 am)	1	0	0	1
Total				**50**	**1**	**7**	**58**

[1] The determination of whether an animal was injured or not was made by the Chief Scientist or Officer in Charge on board the survey vessel and based on visible injuries only.

[2] This take occurred during gear trial operations outside of the typical survey season and using non-standard survey protocols.

Table 4.2-8 Historical takes of marine mammals in longline gear during SWFSC surveys from 2008 to 2012.

All takes have occurred in the CCRA.

Survey Name	Protected Species Taken	Trawl Gear	Date (Time) Taken	# Killed	# Released Alive Injured	# Released Alive Uninjured	Total Taken
2012							
Highly Migratory Species (HMS)	California sea lion	Longline	June 23 (0:40 am)	0	1	0	1
2010							
HMS	California sea lion	Longline	July 27 (6:00 pm)	0	1	0	1
2009							
Thresher Shark	California sea lion	Longline	Sept 18 (4:00 pm)	0	0	1	1
2008							
HMS	California sea lion	Longline	Sept 15 (midnight)	0	0	1	1
HMS	California sea lion	Longline	Sept 6 (midnight)	0	0	1	1
Total				**0**	**2**	**3**	**5**

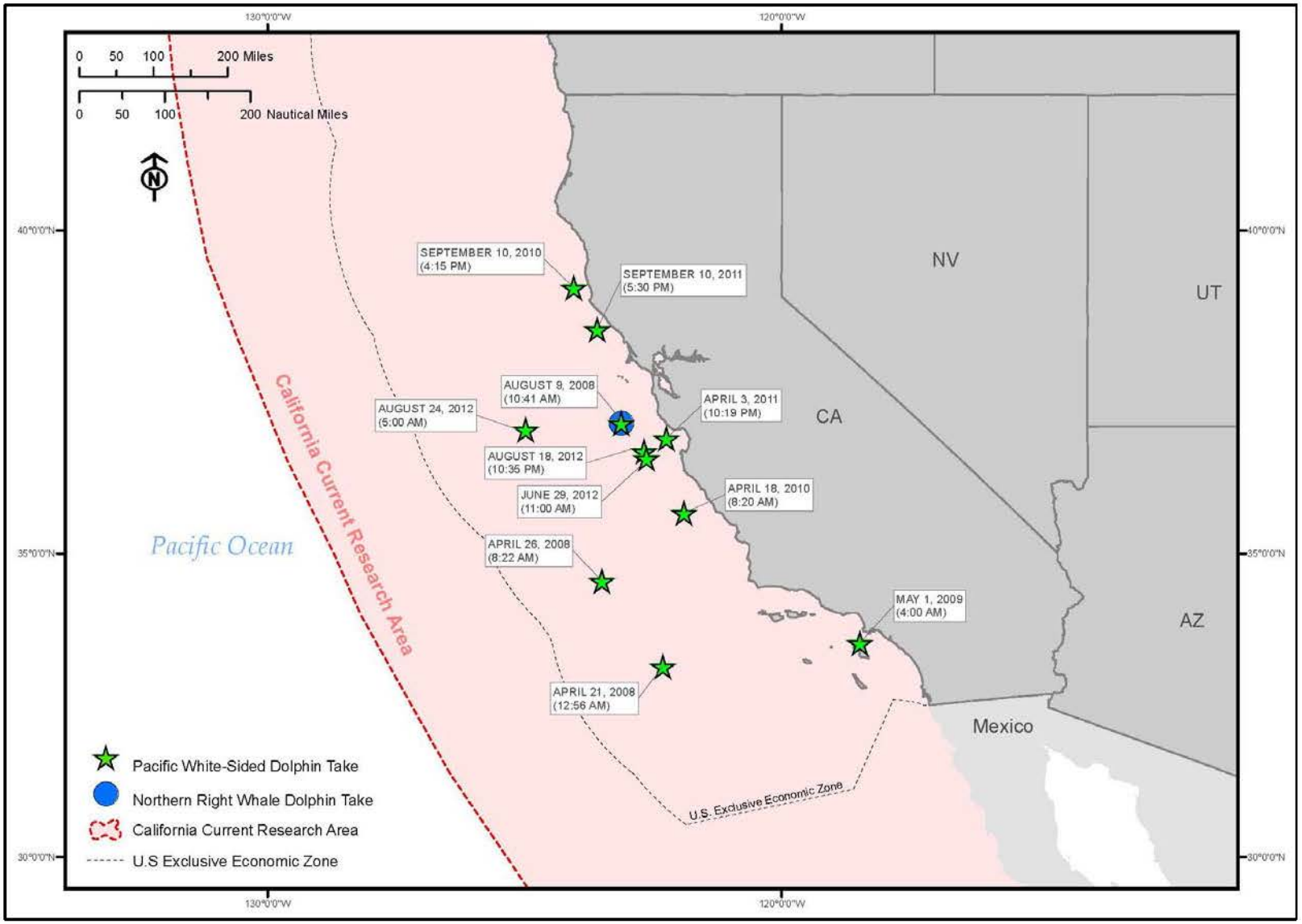


Figure 4.2-1 Location of Cetacean Takes during SWFSC Research, 2008-2012.

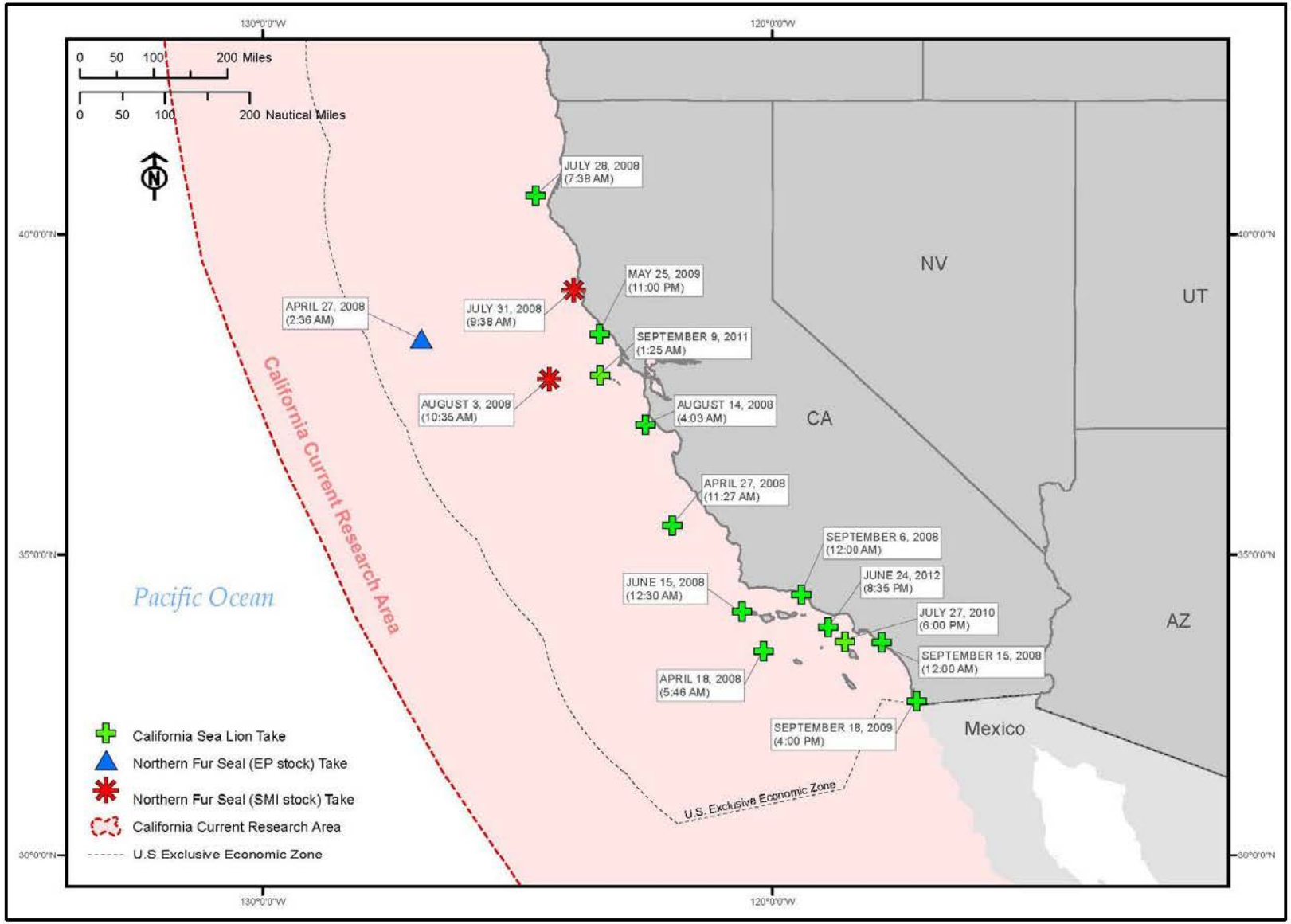


Figure 4.2-2 Location of Pinniped Takes during SWFSC Research, 2008-2012.

Changes in food availability due to research survey removal of prey and discards

Prey of marine mammals varies by species, season, and location and, for some, is not well documented. There is some overlap in prey of marine mammals in the CCRA and the species sampled and removed during SWFSC research surveys. The species of primary concern in regard to this overlap are the small, energy-rich, schooling species such as Pacific sardine, anchovies, and jack mackerel. However, the total amount of these species taken in research surveys is very small relative to their overall biomass in the area (See Section 4.2.3 for more information on fish caught during research surveys). The average annual catch of Pacific sardines in the course of all SWFSC research surveys in the past five years is about 1,565 kgs (1.565 metric tons [mt]). This research catch is a very small fraction (0.0001 percent) of the estimated biomass for Pacific sardines, 157 million mt (Hill et al. 2011), and is negligible compared to the combined commercial harvest for sardines (145,861 mt) off the coasts of British Columbia south to Baja, Mexico (2010 data, Hill et al. 2011). The average annual catch of anchovies in the course of all SWFSC research surveys in the past five years is about 1.2 mt. Biomass estimates are not available for this species but the overfishing level has been set at 139,000 mt and commercial harvests off the U.S. Pacific coast are about 2,093 mts per year (2010 data, Hill et al. 2011). For jack mackerel, average combined SWFSC research catch (0.39 mt) compares to an overfishing level of 126,000 mt and commercial harvests of about 309 mt (2010 data, Hill et al. 2011). There are other species of fish and invertebrates taken in research surveys that are used as prey by marine mammals but, as exemplified by these three species, the proportions of research catch compared to biomass and commercial harvest is very small (Section 4.2.3).

In addition to the small total biomass taken, some of the size classes of fish targeted in research surveys are very small (e.g., juvenile rockfish only centimeters long) and these small size classes are not known to be prey of marine mammals in the CCRA. Research catches are also distributed over a wide area because of the random sampling design covering large sample areas. Fish removals by research are therefore highly localized and unlikely to affect the spatial concentrations and availability of prey for any marine mammal species. This is especially true for pinnipeds in the California Current, which are opportunistic predators that consume a wide assortment of fish and squid, and judging by their increasing populations and expanding ranges in the Pacific Northwest (Caretta et al. 2011), food availability does not appear to be a limiting factor (Baraff and Loughlin 2000, Scordino 2010). The overall effect of research catches on marine mammals through competition for prey is therefore considered minor adverse for all species in the CCRA.

Under the Status Quo, SWFSC research catches in the ETP are limited to tiny amounts of plankton (about 20 kgs total) and juvenile fish (about 1 kg total) collected over vast areas of the ocean. The effects on marine mammals are therefore considered minor adverse for all species in the ETP. The addition of a few longline sets under the Preferred Alternative would likely take some species and size classes used by marine mammals but the effort would be so small and distributed over such a large area that it would not change this minor conclusion.

In the ARA, SWFSC surveys are primarily focused on Antarctic krill, which are a key component of the food web for numerous marine mammals (including southern fur seals and baleen whales) as well as penguins and other birds. Acoustic data are used to measure abundance and distribution of krill but very small amounts of krill and zooplankton are also captured in small-mesh nets (IKMT) for biometric data. Krill abundance and distribution is driven by weather and oceanographic forces and varies tremendously over space (patchy distribution) and over time. Biomass estimates are only available in the few places where research occurs (South Shetland Islands and Elephant Island). Estimates of krill biomass in each of three monitored areas have averaged between .5 and 2.5 million mts in the past few years (Van Cise 2009). The amount of krill and other zooplankton collected during research is a negligible fraction of overall biomass and would not affect the abundance or availability of prey to any marine mammals.

The SWFSC also conducts periodic bottom trawl surveys in the South Orkney Islands area to monitor the recovery of several finfish that were overfished in the 1970s and 1980s. These surveys are only conducted

every two or three years as funds and appropriate charter vessels become available. During the last survey (2008-2009 season), a total of 7.7 mt of fish were collected from 65 species (Van Cise 2009). This data has been used to estimate densities of the different species in the area, with the most common species caught having densities up to 7 mt per square nautical mile (nm^2). It is not known how important these species or size classes taken during research are to marine mammals in the area. However, given the periodic nature of the surveys and the relatively small amount of fish removed from the system over a large area, it is unlikely to affect the distribution or availability of prey for any marine mammal species.

The potential for SWFSC research to affect the availability of prey to marine mammals is considered to be negligible for all species, all three research areas, and under all of the action alternatives and it will not be discussed further.

Contamination from discharges

Discharge from vessels, whether accidental or intentional, potentially includes sewage, ballast water, fuel, oil, miscellaneous chemicals, garbage, and plastics. Impacts to marine mammals in the vicinity of the discharge range from superficial exposure to ingestion and related effects. Even at low concentrations that are not directly lethal, some contaminants can cause sub-lethal effects on sensory systems, growth, and behavior of animals, or may be bioaccumulated (DOE 2008).

All NOAA vessels and SWFSC chartered vessels are subject to the regulations of MARPOL 73/78, the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (NOAA 2010). MARPOL includes six annexes that cover discharge of oil, noxious liquid substances, harmful packaged substances, sewage, garbage, and air pollution (IMO 2010). Adherence to these regulations minimizes or negates the likelihood of discharges of potentially harmful substances into the marine environment. Annex V specifically prohibits plastic disposal anywhere at sea and severely restricts discharge of other garbage (IMO 2010). Discharge of contaminants from SWFSC vessels and SWFSC chartered vessels is possible, but unlikely, and if it occurs, would be isolated in both time and location.

Discharge of contaminants from SWFSC vessels and SWFSC chartered vessels is possible, but unlikely to occur in the next five years. If an accidental discharge does occur, it is likely to be a rare event and the potential volume of material is likely to be small and localized. The potential impacts to marine mammals would be similarly short-term, localized, and likely affect a small number of animals. The overall impact of accidental contamination of marine mammals would therefore be considered minor adverse. As the potential effects of discharges, regulations governing discharges, and the likelihood of discharges is universal across the three research areas, this will not be discussed further in this analysis.

4.2.4.1 California Current Research Area

<u>ESA-listed Species</u>

The endangered marine mammals that occur in the CCRA include blue, fin, sei, humpback, and sperm whales and the Southern resident Distinct Population Segment (DPS) of killer whales. Threatened species include Guadalupe fur seals and the Eastern DPS of Steller sea lions. All of these species are under the jurisdiction of NMFS in regard to compliance with the MMPA and ESA. In addition, the Southern subspecies of sea otters are listed as threatened under the ESA and are under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS).

Disturbance and Behavioral Responses Due to Acoustic Equipment

The LOA application (Appendix C) includes calculations of the number of marine mammals that may be exposed to sound levels above 160 dB from all acoustic devices used during SWFSC research activities. Those calculations include a number of assumptions and elements with large variables over time and space (e.g., the densities of marine mammals and the propagation of sound under different conditions).

The EA reports the results of those estimates in Table 4.2-9 below, but see Appendix C for a discussion about the derivation and concerns about the accuracy of these estimates. The likely impact on ESA-listed species from the different types of acoustic devices is discussed below.

Table 4.2-9 Estimated Level B harassment takes of marine mammals by acoustic sources during SWFSC research in the California Current Research Area.

Species (Common name)	Estimated take by acoustic sources (numbers of animals)
Harbor porpoise	682
Dall's porpoise	1365
Pacific white-sided dolphin	378
Risso's dolphin	189
Bottlenose dolphin	32
Short-beaked common dolphin	5591
Long-beaked common dolphin	348
Striped dolphin	301
Northern right whale dolphin	176
Killer whale	13
Short-finned pilot whale	12
Cuvier's beaked whale	146
Baird's beaked whale	34
Mesoplodont beaked whales	39
Pygmy sperm whale	42
Dwarf sperm whale	42
Sperm whale[1]	65
Humpback whale[1]	15
Blue whale[1]	25
Fin whale[1]	33
Sei whale[1]	2
Common minke whale	13
Gray whale	346
California sea lion	4302
Steller sea lion[1] -eastern subspecies (DPS)	1054
Guadalupe fur seal[1]	134
Northern fur seal	6083
Northern elephant seal	4744
Harbor seal	911

[1] ESA-listed species

The output frequencies of Category 1 active acoustic sources (short range echosounders, Acoustic Doppler Current Profilers) are >300 kHz and are generally short duration signals with high signal directivity (Appendix C, Section 6.2). The functional hearing range of baleen whales is 7 Hz-22 kHz, with highest sensitivity generally below 10 kHz, which is well below the frequency range of Category 1 sources so they are less likely to be detected by blue, fin, sei, or humpback whales (Figure 4.2-3). Sperm and killer whales are in the mid-frequency hearing group with a range of 150 Hz-160 kHz, with highest sensitivity from 10-120 kHz. The functional underwater hearing range of pinnipeds is 75 Hz-75 kHz, with highest sensitivity from 1-30 kHz. The functional hearing ranges of these species also fall below the output frequency of Category 1 acoustic sources; effects are expected to be temporary, if they occur, and are considered minor adverse.

Category 2 active acoustic sources (various single, dual, and multi-beam echosounders, devices used to determine trawl net orientation, and several current profilers) have frequencies of 12-200 kHz, short ping durations, and are usually highly directional. These are unlikely to be heard by most baleen whales, but are within the range of hearing for sperm and killer whales. Most Category 2 acoustic sources are also not likely to be audible to most pinnipeds. If detected, short term avoidance is the most likely response, which would tend to reduce the exposure of animals to high sound levels (Appendix C, Section 7.2).

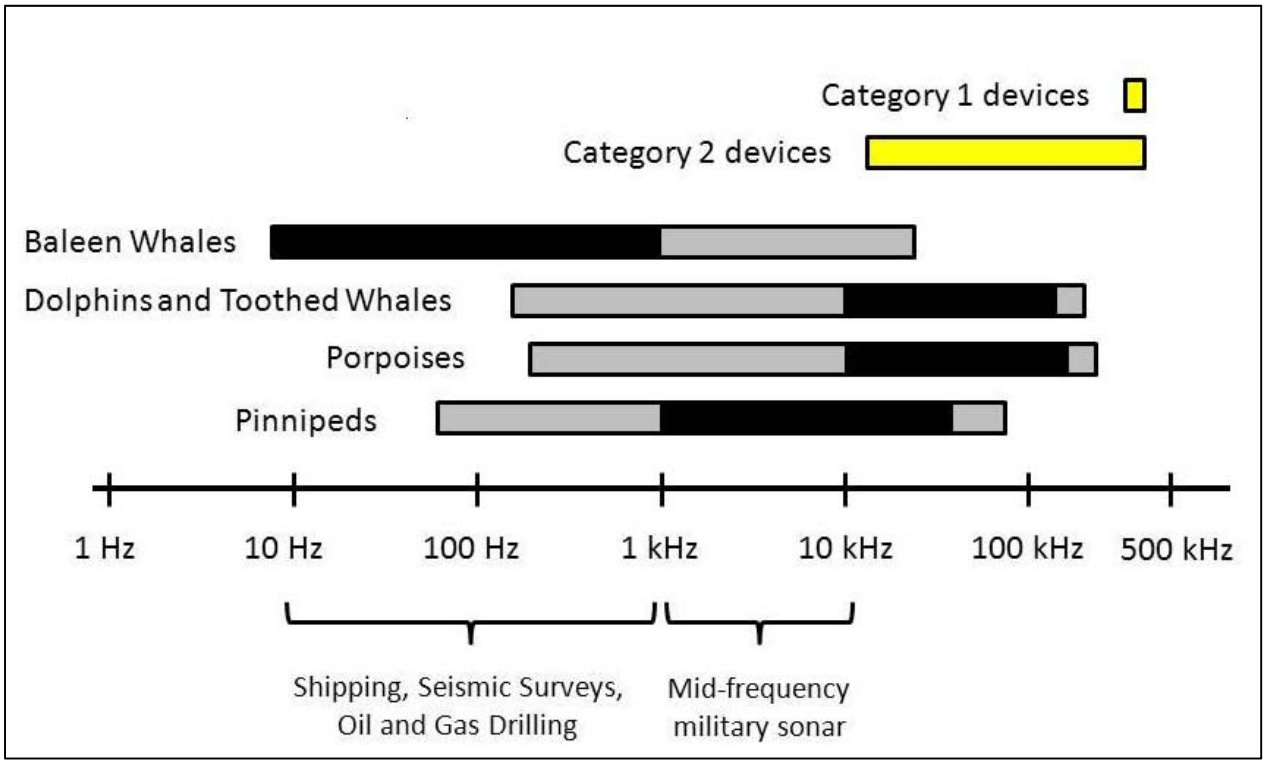


Figure 4.2-3 Typical frequency ranges of hearing in marine mammals.

This figure shows hearing range relative to the frequency outputs of the two categories of acoustic devices used in SWFSC research, as identified in Appendix C, Section 6.2. Black bars indicate the most sensitive hearing ranges of different marine mammals. Data on hearing ranges is from Southall et al. (2007) and modified from DON (2008b). The functional hearing range of sea otters in water has not been determined.

The anticipated effects of active acoustic sources used during SWFSC fisheries research on threatened and endangered marine mammals are likely to occur infrequently, although they may occur over a large geographic area. Most of the frequencies are well above detection ranges for ESA-listed whales, although some category 2 sound sources are within the range of hearing for sperm whales, killer whales, and pinnipeds. However, the sounds most likely to be audible are of short duration and restricted to areas close to the research vessel (i.e., 10s of meters to a few 100s of meters). To date, there have been no reports or anecdotal observations of sounds from SWFSC research activities disturbing or causing behavioral changes in threatened or endangered species.

Sounds originating from vessels may affect large whales through masking of biologically important sounds, particularly for low frequency baleen whales (Clark et al. 2009). The biological significance of masking from vessel noise is not known for any species but presumably the effects could include a decreased ability to detect sounds used in communication, predator avoidance, and orientation. However, the relatively small number of SWFSC research vessels in the CCRA is likely to only result in temporary and minimal effects from acoustic masking as vessels pass through an area (Appendix C, Section 7.2).

The potential effects from the use of active acoustic devices during research activities would be small in magnitude and short-term in duration, although they would be dispersed over a wide geographic area and be likely to occur under the Status Quo Alternative. The overall impacts of acoustic disturbance to ESA-listed marine mammals throughout the CCRA are therefore considered to be minor adverse.

Injury and Mortality due to Entanglement in Fishing Gear

Tables 4.2-5 and 4.2-6 indicate the history of marine mammal takes by all SWFSC research activities in the CCRA. There have been no entanglements or takes of ESA-listed marine mammals in SWFSC fisheries research from NOAA vessels or NOAA chartered vessels. Table 4.2-10 includes estimates of the number of marine mammals that may be caught in research gear with resulting Level A harassment takes and serious injury or mortality takes. For species that have not been taken historically, the LOA application estimates future takes based on an assessment of whether similar species have been taken by SWFSC research or by commercial fisheries using gear similar to gear used in research.

Given the lack of historical takes in the CCRA, the relatively small number of longline sets used during SWFSC research, and the mitigation measures described in Section 2.2, the SWFSC considers the risk of taking ESA-listed cetaceans to be very low (i.e., a rare event unlikely to occur in the next five years). None of the ESA-listed cetaceans are expected to experience any adverse interactions with SWFSC research surveys in the CCRA that result in injury, serious injury, or mortality. The overall impacts on these species through gear interactions would therefore be considered minor adverse under the criteria described in Table 4.1-1.

Steller sea lions

Based on historical takes of a similar species (California sea lions) under the status quo conditions, the SWFSC estimates that Steller sea lions from the threatened Eastern DPS could be captured in the future using both status quo trawl gear and longline gear. The LOA application uses a conservative approach to estimate nine takes of Steller sea lions in pelagic trawl gear and one take on longline gear during the five-year LOA period. In addition, the LOA application requests takes for one “undetermined pinniped” in trawl gear and one in longline gear for the five-year LOA period. This request is made to account for animals that may be caught or entangled in gear but free themselves or are released before they can be identified or photographed by research personnel. In its LOA application, the SWFSC analyzes the potential impact of these “undetermined” takes by adding them to each of the pinniped species for which it estimates Level A harassment, serious injury, and mortality takes. When applied to Steller sea lions, adding one take in trawl gear and one take in longline gear per five-year period brings the total estimated take to ten Steller sea lions in pelagic trawl gear and two takes on longline gear during the five-year LOA

period. The corresponding average annual takes would be two Steller sea lions per year in trawl gear and less than one animal per year on longline gear.

Although this estimate represents the best available information, the SWFSC does not think this many Steller sea lions will actually be taken in the next five years for two reasons. First, the estimated take in trawl gear is derived from one trawl set that had an unusually high number of takes of a similar species (all but one other record of California sea lion takes in research trawls involved only one animal). Second, the majority of the California sea lions were caught in 2008, before several new mitigation measures were implemented, including installation of MMEDs on all Nordic 264 trawl nets. One California sea lion has since been taken in a Nordic 264 using the current status quo mitigation equipment and procedures, so the risk of take has not been eliminated but the SWFSC considers the projected takes of Steller sea lions to be conservative in the sense that actual future takes would likely be less than the estimate. However, the EA analysis will assume the projected number of Level A and serious injury/mortality takes will occur under the Status Quo Alternative.

The Eastern Steller sea lion DPS has been growing by over 3 percent per year for almost 30 years and NMFS has recently proposed to delist the DPS (NMFS 2012, 77 FR 23209). The most recent minimum population estimate is about 53,000 animals with a PBR of 2,378 (Allen and Angliss 2011). An average of 2.4 lethal takes of Steller sea lions per year due to SWFSC research (trawl and longline gear combined) would be much less than 10 percent of PBR (238 animals) and would be considered minor in magnitude according to the criteria in Table 4.1-1. In addition to the magnitude of effects, impact assessments in NEPA documents must also consider their frequency or duration, geographic scope, and likelihood of occurrence. Given the lack of historical takes of this species during past SWFSC research activities in the CCRA, the relatively small number of longline sets used during SWFSC research, and the mitigation measures described in Section 2.2, the SWFSC considers the risk of taking Steller sea lions to be low (i.e., a rare event unlikely to occur in the next five years). The geographic scope element is difficult to interpret because any actual take would occur in a localized area, but Steller sea lions travel through large geographic areas so the potential loss of a sea lion would affect more than a localized population. Given the frequency and likelihood components of the analysis, the overall impact of the Status Quo Alternative on Steller sea lions would be considered minor adverse under the criteria described in Table 4.1-1.

Other ESA-listed species

The LOA application does not include any projected takes of Guadalupe fur seals in the CCRA based on a lack of historical takes in fishing gear and other characteristics of this species (Appendix C). For similar reasons, the SWFSC also does not anticipate any future takes of southern sea otters, which are under the jurisdiction of the USFWS and are not covered in the LOA application to NMFS. The potential risk of injury or mortality to these ESA-listed species is considered very low and the overall impacts are considered minor adverse under the Status Quo Alternative.

Other Cetaceans

The Common minke whale and the gray whale are the only baleen whales included in this section that are not ESA-listed. The remaining cetaceans are toothed whale species (i.e., odontocetes), including two species of porpoises, seven species of dolphins, non-ESA-listed killer whales, short-finned pilot whale, three or more species of beaked whales, and Pygmy and Dwarf sperm whales (Table 3.2-4).

Disturbance and Behavioral Responses Due to Acoustic Equipment

The analysis of acoustic effects on these species is similar to that discussed for ESA-listed killer whales and sperm whales above. Table 4.2-9 provides summaries of the numbers of each species that could be taken by acoustic disturbance during SWFSC research activities in the CCRA. See Appendix C for a discussion about the derivation and concerns about the accuracy of these estimates. The likely impact on cetaceans from the different types of acoustic devices is discussed below.

The mid-frequency odontocetes have a functional hearing range of 150 Hz to 160 kHz, with highest sensitivity from 10-120 kHz. The high-frequency odontocetes have a functional hearing range of 200 Hz to 180 kHz, with highest sensitivity from 10-150 kHz. The output frequencies of Category 1 active acoustic sources (>300 kHz) are above the functional hearing range of baleen whales and cetaceans in the mid- and high-frequency hearing groups (Figure 4.2-3). Because they would not be able to hear them, cetaceans are not expected to be affected by Category 1 sound sources (Appendix C, Section 6.2).

Category 2 active acoustic sources are unlikely to be heard by most baleen whales, but are within the range of hearing for various odontocetes, especially high frequency hearing harbor and Dall's porpoise. Some of these devices are used on trawl nets during fishing so their use is intermittent, localized and directional, and they are deployed on moving sources. The sounds could be loud to cetaceans in close proximity to the sound source but physical damage is unlikely, although Temporary Threshold Shift could occur if animals remained close to the source (tens to a few hundred meters) for prolonged periods (Appendix C, Section 6.2). The short duration of most research tows (< 30 minutes) should minimize that likelihood. If detected, short term avoidance is the most likely response (Appendix C, Section 6.2).

Potential disturbance from active acoustic equipment used during research would not have any measurable effect on the population of any cetacean and would therefore be considered minor in magnitude. Such disturbance is likely to occur wherever survey vessels use the equipment, but cetaceans would only be close enough to a vessel to be affected on a rare or intermittent basis and any behavioral changes would be temporary. The overall impact of active acoustic sound sources on non ESA-listed cetaceans throughout the CCRA is therefore considered to be minor adverse according to the criteria in Table 4.1-1.

Injury or Mortality Due To Entanglement in Gear

Table 4.2-7 shows the history of marine mammal takes by all SWFSC research activities in the CCRA, including two species of cetaceans, Pacific white-sided dolphin and northern right whale dolphin. Measures to mitigate the risk of entanglements are described in Section 2.2.1. The SWFSC LOA application (Appendix C) includes estimates of the potential number of other cetaceans that may interact with research gear based on their similarity to these two species and historical takes in commercial fisheries operating in similar areas and using similar gear types (Table 4.2-10). Note that the LOA application does not request authorization to take all species of marine mammals that occur in the CCRA; only those species listed in Table 4.2-10 are considered to have a reasonable risk of adverse interactions with gear used for SWFSC research. As described earlier, the LOA application has used conservative procedures to estimate potential future takes of marine mammals. The SWFSC considers these estimates to be greater than what is likely to occur in the future, especially for species that have never been taken in the past and that are infrequently encountered during research surveys.

Table 4.2-10 Potential number of non ESA-listed marine mammal takes in the California Current Research Area.

This table summarizes information presented in the LOA application (Appendix C) on the potential takes by Mortality and Serious Injury (M&SI) and Level A harassment in the CCRA over the next five years (2013-2018) using trawl and longline gear types. Some stocks have been combined. All population estimates, Potential Biological Removal (PBR) values, and total annual mortality and serious injury data are from the most recent stock assessment report (Carretta et al. 2011). The average annual mortality and serious injury data includes known interactions with commercial fisheries and ship strikes and, for Pacific white-sided dolphins and Northern right-whale dolphins, includes the contribution of SWFSC and NWFSC incidental takes due to fisheries research. Note that PBR is an annual measure of mortality. The LOA application estimates potential takes for the five-year period and these have been averaged for an annual take estimate that can be compared with PBR.

Species	Minimum Population Estimate	PBR (animals per year)	Average Annual M&SI from all sources	Total Historical SWFSC Takes (2008-2012)	Potential M&SI and Level A Take average per year (total for five-year period)	
					Trawl	Longline
Harbor porpoise	37,535 (four stocks)	669	8.6		**1** (5)	
Dall's porpoise	32,106	257	0.4		**1** (5)	
Pacific white-sided dolphin	21,406	193	15.1	32 (trawl)	**7** (35)	
Risso's dolphin	4,913	39	1.6		**2.2** (11)	**0.2** (1)
Bottlenose dolphin	684 (CA/OR/WA offshore stock)	5.5	0.2		**1.6** (8)	
	290 (California coastal stock)	2.4	0.2		**0.6** (3)	
	974 (All stocks combined)	7.9				**0.2** (1)
Striped dolphin	8,231	82	0		**2.2** (11)	**0.2** (1)
Short-beaked common dolphin	343,990	3,440	64		**2.2** (11)	**0.2** (1)
Long-beaked common dolphin	76,224	610	13.8		**2.2** (11)	**0.2** (1)
Northern right-whale dolphin	6,019	48	4.8	6 (trawl)	**2** (10)	
Undetermined delphinid species					**0.2** (1)	
Short-finned pilot whale	465	5	0			**0.2** (1)
Pygmy sperm whale and Dwarf sperm whale	271	3	0			**0.2** (1)
	No estimate	NA	0			
California sea lion	153,337	9,200	431	17 (trawl) 5 (longline)	**4** (20)	**1** (5)
Northern fur seal	Eastern Pacific stock 642,265	13,809	500[1]	1 from EP stock(trawl) 2 from SMI stock (trawl)	**1** (5)	
	San Miguel Is. stock 5,395	324	1.2			
Harbor seal	26,667 (CA stock) No current estimate for WA stocks	1,600	47.8		**1.8** (9)	
Northern elephant seal	74,913	4,382	10.4		**1** (5)	
Undetermined pinniped species					**0.2** (1)	**0.2** (1)

[1] Data on mortality and serious injury rate of northern fur seal, EP stock, is from the Alaska Stock Assessment Report (Allen and Angliss 2011) and primarily involves subsistence harvest by Alaska Natives.

No non-ESA-listed baleen whales are anticipated to be taken in SWFSC research activities under the Status Quo Alternative in the next five years. The LOA application requests takes for one "undetermined delphinid species" in trawl gear for the five-year LOA period. This request is made to account for similar looking dolphin and porpoise species that may be caught or entangled in gear but free themselves or are released before they can be identified or photographed by research personnel. In its LOA application, the SWFSC analyzes the potential impact of these "undetermined" takes by adding them to each of the delphinid species for which it estimates Level A harassment, serious injury, and mortality takes. When applied to the nine dolphin and porpoise species listed in Table 4.2-10, the total estimated average annual take in the next five years is less than 10 percent of PBR (Table 4.2-10**)** for all but one species (the exception is for bottlenose dolphins, see below) and this level of mortality, if it occurred, would be considered minor in magnitude. For the other non-delphinid cetaceans, the estimated average annual take in the next five years is also less than 10 percent of PBR (Table 4.2-10**)** and this level of mortality, if it occurred, would be considered minor in magnitude. These potential mortalities would be rare or infrequent events and most would be unlikely to actually occur in the next five years. Any actual take would occur in a localized area, but as explained for Steller sea lions, cetaceans generally travel through large geographic areas so the potential loss of an animal would affect more than a localized population. The overall impact of the potential takes of these species, if they occurred, would be considered minor adverse according to the criteria described in Table 4.1-1.

Bottlenose dolphin

The estimated potential take of bottlenose dolphins is divided between two stocks for trawl gear based on the relative frequency of trawl sets in nearshore waters and sets made further offshore. The coastal stock of bottlenose dolphin (PBR = 2.4) is generally only found within 1 km of shore (Carretta et al. 2011). The CA/OR/WA offshore stock is larger and has a PBR of 5.5. The LOA application estimates that less than two bottlenose dolphins from the CA/OR/WA offshore stock could be taken each year in trawl gear (1.6 average, eight takes per five-year period). In addition, less than one bottlenose dolphin from the coastal stock could be taken each year in trawl gear (0.6 average, three takes per five-year period). To account for the "undetermined delphinid species" take requested by the SWFSC, the LOA application applies one take per five-year period in trawl gear to each of these bottlenose stocks; the total estimated take would be nine takes per five-year period for the CA/OR/WA offshore stock (1.8 takes per year average) and four takes per five-year period for the coastal stock (0. 8 takes per year average). Takes of real animals occur to whole animals, of course, not fractions of animals. However, for the purpose of determining the potential magnitude of effect in this NEPA analysis, we compare the average annual take estimates to PBR, which is also an annual metric. For both of these stocks, this level of take in trawl gear, if it occurred, would be greater than 10 percent and less than 50 percent of PBR and would be considered moderate in magnitude according to the criteria described in Table 4.1-1. The LOA application also estimates that one bottlenose dolphin from "all stocks" could be taken in longline gear in a five-year period (0.2 takes per year average). The LOA application assumes that this estimated take on longline gear would occur from the CA/OR/WA offshore stock based on the location of most longline sampling efforts. When added to the estimated takes from trawl gear, the combined take from the CA/OR/WA offshore stock from both trawl and longline gear would be 2.0 dolphins per year, which would be greater than 10 percent and less than 50 percent of PBR for the stock and would be considered moderate in magnitude according to the criteria described in Table 4.1-1.

The estimated takes of bottlenose dolphins are based on their similarity with Pacific white-sided dolphins, specifically one interaction in 2008 that involved the entanglement and death of 11 Pacific white-sided dolphins in a Nordic 264 trawl (Table 4.2-7). Since that time, additional mitigation measures have been implemented, including incorporation of a MMED in the Nordic 264, and the risk of taking this species in such numbers should be reduced. The estimated take on longline gear is based on infrequent takes of dolphins in commercial fisheries; none have been taken during SWFSC research. Given the implementation of mitigation measures since 2008 and the fact that the SWFSC has never taken

bottlenose dolphins in the past, the SWFSC considers the risk of taking bottlenose dolphins to be very low (i.e., a rare event unlikely to occur in the next five years), although there is a chance that more than one animal could be taken in any one interaction. Given the frequency and likelihood components of the NEPA analysis, the overall impact of the Status Quo Alternative on bottlenose dolphins would be considered minor adverse according to the criteria described in Table 4.1-1.

Pinnipeds

There are four species of non-ESA-listed pinnipeds commonly found in the CCRA that may interact with SWFSC research: California sea lion, Northern fur seal (two stocks), harbor seal (several stocks), and Northern elephant seal (Table 3.2-4).

Disturbance and Behavioral Responses Due to Acoustic Equipment

The analysis of acoustic effects on these species is similar to that discussed for ESA-listed Steller sea lions and Guadalupe fur seals above. Table 4.2-9 provides summaries of the numbers of each species that could be taken by acoustic disturbance during SWFSC research activities in the CCRA.

The anticipated effects of active acoustic sources used during SWFSC fisheries research on pinnipeds are likely to occur over a large geographic area under the Status Quo Alternative. However, most of the frequencies are well above detection ranges for pinnipeds, although some category 2 sound sources are within the hearing range of pinnipeds. The sounds most likely to be audible are of short duration and restricted to areas very close to the research vessel so potential interactions are likely to be intermittent and infrequent. To date, there have been no reports or anecdotal observations of sounds from SWFSC research activities disturbing or causing behavioral changes in pinnipeds or other marine mammal species. The overall impacts of acoustic disturbance to pinnipeds throughout the CCRA are therefore considered to be minor adverse according to the criteria described in Table 4.1-1.

Injury and Mortality Due to Entanglement in Fishing Gear

Table 4.2-7 shows the history of pinniped takes by all SWFSC research activities in the CCRA, including California sea lions and northern fur seals from both the San Miguel Island and Eastern Pacific stocks. Measures to mitigate the risk of entanglements are described in Section 2.2.1. The SWFSC LOA application (Appendix C) includes calculations of the number of these and other pinnipeds that may interact with research gear based on their similarity to these two species and historical takes in commercial fisheries operating in similar areas and using similar gear types (Table 4.2-10). As described in the ESA-listed species section above, the SWFSC does not think this many pinnipeds will actually be taken in the next five years but has chosen to use a conservative estimation procedure to ensure accounting for the maximum amount of potential take.

California sea lions

A total of 17 California sea lions have been caught in trawl gear during SWFSC surveys from 2008-2012, with 14 mortalities and three animals being released without apparent injury. The majority of these takes (nine sea lions) occurred during one set during a CPS survey in 2008. Most of the mortalities occurred during the CPS survey but one occurred during a Juvenile Salmon survey and another occurred during a Juvenile Rockfish survey. All of the mortalities occurred using the Nordic 264 trawl except the one mortality in the Juvenile Rockfish survey, which uses the modified Cobb trawl. The LOA application uses the historical record to estimate an average of four takes per year in trawl gear for the next five years (2013-2018) under the status quo conditions (20 serious injury/mortality or Level A harassment takes in trawl gear in the five-year period). Additional mitigation measures have been implemented since 2008, including development and incorporation of a marine mammal excluder device for the Nordic 264 trawl and use of acoustic pingers on all trawls. These new procedures and equipment are expected to minimize the risk of sea lions being taken in trawl gear at the rates they were in 2008. However, the SWFSC is

taking a conservative approach to the LOA application estimates and, because this EA supports that LOA application, the following analysis is based on these estimated take numbers.

In addition to the animals caught in trawl gear, five California sea lions have been caught on longline gear in the 2008-2012 period. Two of these animals were injured but released while the other three were released without apparent injury. There have been no documented mortalities on longline gear during SWFSC research but these historical takes have been used to estimate future takes on longline gear in the LOA application. Based on these historical records, the LOA application estimates an average of one take of California sea lions per year (five total for the five-year period) by either serious injury/mortality or Level A harassment from longline gear.

The LOA application requests takes for one "undetermined pinniped" in trawl gear and one in longline gear for the five-year LOA period. This request is made to account for animals that may be caught or entangled in gear but free themselves or are released before they can be identified or photographed by research personnel. In its LOA application, the SWFSC analyzes the potential impact of these "undetermined" takes by adding them to each of the pinniped species for which it estimates Level A harassment, serious injury, and mortality takes. When applied to California sea lions, the total estimated takes of 5.4 California sea lions per year (4.2 takes per year average in trawl gear and 1.2 takes per year average in longline gear), if they occurred, would be much less than 10 percent of PBR (PBR = 8,511) and would therefore be considered minor in magnitude. Given the implementation of new mitigation measures, including a MMED for the Nordic 264 trawl, future mortalities of California sea lions would be considered rare or infrequent events and would be unlikely to actually occur at this estimated rate in the next five years. Any actual take would occur in a localized area, but these animals travel over large geographic areas so the potential loss of an animal would affect more than a localized population. The overall impact of potential takes of this species in SWFSC research gear, if they occurred, would be considered minor adverse according to the criteria described in Table 4.1-1.

Northern fur seals

A total of three Northern fur seals have been caught and killed in trawl gear during SWFSC surveys from 2008-2012. Two of these animals were from the San Miguel Island stock and one was from the Eastern Pacific stock. All of the mortalities occurred during the CPS survey using the Nordic 264 trawl. The LOA application uses this historical record to estimate an average of one take per year in trawl gear for the next five years (2013-2018) under the status quo conditions (five serious injury/mortality or Level A harassment takes in the five-year period). To account for the "undetermined pinniped species" takes requested by the SWFSC, the LOA application applies one take per five-year period in trawl gear to Northern fur seals. The total estimated take of this species would therefore be six takes per five-year period in trawl gear (1.2 takes per year average). This level of mortality, if it occurred, would be much less than 10 percent of PBR even if all of them came from the smaller San Miguel Island stock (PBR = 324) and would therefore be considered to be minor in magnitude. Given the implementation of new mitigation measures, including a MMED for the Nordic 264 trawl, future mortalities of fur seals would be considered rare or infrequent events and would be unlikely to actually occur at this estimated rate in the next five years. Given the historical record and geographic overlap with the majority of SWFSC research activities, most of these potential takes would likely involve the more geographically restricted San Miguel Island stock. The overall impact of potential takes of this species in SWFSC research trawl gear, if they occurred, would be considered minor adverse according to the criteria described in Table 4.1-1.

Other pinnipeds

There have been no historical takes of either harbor seals or Northern elephant seals in SWFSC research. The LOA application estimates the potential number of harbor seal takes based on their similarity in distribution and behavior to California sea lions. For Northern elephant seals, the estimated takes are based on historical takes in commercial fisheries operating in similar areas and using similar gear types. The estimated take of harbor seals is two animals per year in trawl gear (10 animals in the five-year LOA

period, including one take in trawl gear to account for the "undetermined pinniped species" in the LOA application take request) compared to a PBR of 1,600. The estimated take of Northern elephant seals is 1.2 animals per year in trawl gear (six animals in the five-year LOA period, including one take in trawl gear to account for the "undetermined pinniped species") compared to a PBR of 4,382. For both of these species, the estimated annual take, if it occurred, would be much less than 10 percent of PBR and would therefore be considered minor in magnitude. Considering the fact that neither of these species has been taken in research trawls in the past, these potential mortalities would be considered rare events and would be unlikely to actually occur in the next five years. The overall impact of potential takes of these species in SWFSC research trawl gear, if they occurred, would be considered minor adverse according to the criteria described in Table 4.1-1.

Sea Otters

There are two subspecies of Northern sea otter in the CCRA. The ESA-listed Southern subspecies is discussed above. The Washington subspecies is discussed in this section. This population inhabits nearshore waters along the coast of Washington and Puget Sound. These areas are either not covered by SWFSC research activities (Puget Sound) or are much closer to shore than research vessels typically travel or sample. The SWFSC does not anticipate any future Level B or Level A takes of sea otters from this population based on a lack of historical takes and very little spatial overlap between sea otter habitat and SWFSC research activities under the Status Quo Alternative.

4.2.4.2 Eastern Tropical Pacific Research Area

The SWFSC research activities in the ETP have no history of taking marine mammals. Under the Status Quo Alternative there is very little fishing gear deployed in the ETP, with efforts focused more on conducting visual transects for marine mammals and birds. The only nets deployed are very small (< 2 m^2 openings), fine meshed, and designed to capture plankton, or larval fish and invertebrates. These sampling methods have no record of previous adverse interactions with marine mammals and are not likely to do so in the future. The risk of injury or mortality due to entanglement is therefore considered minor adverse under the status quo conditions for all species. The potential effects due to use of active acoustic equipment are discussed below.

ESA-listed Species

The endangered marine mammals that occur in the ETP include blue, fin, sei, humpback, and sperm whales (Table 3.2-4). The only threatened species in the ETP is the Guadalupe fur seal. The LOA application calculates the numbers of each species that may be exposed to sound levels of >160 dB from active acoustics used in ETP research based on status quo conditions (Table 4.2-11).

The analysis of potential disturbance effects from acoustic sources is the same as described for these species in the CCRA above. The potential effects of disturbance due to research activities would be minor in magnitude, temporary in duration, likely to occur throughout the ETPRA, and would have overall minor adverse effects on all ESA-listed marine mammals throughout the ETP under the Status Quo Alternative.

Table 4.2-11 Estimated Level B harassment takes of marine mammals by acoustic sources during SWFSC research in the Eastern Tropical Pacific Research Area.

Species (Common name)	Estimated take by acoustic sources (numbers of animals)	Species (Common name)	Estimated take by acoustic sources (numbers of animals)
Dusky dolphin	19	**Short-finned pilot whale**	723
Fraser's dolphin	120	**Melon-headed whale**	19
Risso's dolphin	46	**Cuvier's beaked whale**	25
Bottlenosed dolphin	140	**Longman's beaked whale**	1
Short-beaked common dolphin	1300	**Mesoplodont beaked whales**	31
Long-beaked common dolphin	173	**Dwarf sperm whale**	14
Rough-toothed dolphin	45	**Sperm whale**	5
Striped dolphin	401	**Humpback whale**	1
Spinner dolphin	442	**Blue whale**	2
Pantropical spotted dolphin	1088	**Fin whale**	0
Killer whale	4	**Sei whale**	0
Pygmy killer whale	16	**Bryde's whale**	4
False killer whale	17	**Common minke whale**	0

Other Cetaceans

In addition to the ESA-listed species, there are two other species of baleen whales and at least 23 other odontocetes in the ETP. Table 4.2-11 shows the estimated Level B harassment takes by acoustic sources of these species under the status quo conditions. The analysis of potential disturbance effects from acoustic sources is the same as described for other cetacean species in the CCRA above. The potential effects of disturbance due to research activities would be minor in magnitude, temporary in duration, likely to occur throughout the ETPRA, and would have overall minor adverse effects on all cetaceans throughout the ETP under the Status Quo Alternative.

Pinnipeds

In addition to the ESA-listed Guadalupe fur seal, there are three other species of pinnipeds in the ETP, including California sea lion, South American sea lion, and Northern elephant seal. Table 4.2-11 shows the estimated Level B harassment takes by acoustic sources of these species under the status quo conditions. The analysis of potential disturbance effects from acoustic sources is the same as described for pinniped species in the CCRA above. The potential effects of disturbance due to research activities would be minor in magnitude, temporary in duration, likely to occur throughout the ETPRA, and would have overall minor adverse effects on all pinnipeds throughout the ETP under the Status Quo Alternative.

4.2.4.3 Antarctic Research Area

The SWFSC conducts a variety of directed research projects on marine mammals in the Scotia Sea and Antarctic islands but there have been no incidental takes of marine mammals in fishing gear during fisheries research surveys under the Status Quo scope of research.

ESA-listed Species

The ESA-listed marine mammals that occur in the ARA are the same endangered whale species listed in the ETP: blue, fin, sei, humpback whales, and sperm whales (Table 3.2-4). There are no ESA-listed pinniped species in the ARA.

Disturbance and Behavioral Responses Due to Acoustic Equipment

The LOA application calculates the numbers of each species that may be exposed to sound levels of >160 dB from active acoustics used in ARA research based on status quo conditions (Table 4.2-12). The analysis of potential disturbance effects from acoustic sources is the same as described for these species in the CCRA above. The potential effects of disturbance due to research activities would be minor in magnitude, temporary in duration, likely to occur throughout the ARA, and would have overall minor adverse effects on all ESA-listed marine mammals throughout the ARA under the Status Quo Alternative.

Table 4.2-12 Estimated Level B harassment takes of marine mammals during SWFSC research in the Antarctic Research Area.

Species (Common name)	Estimated take by acoustic sources (numbers of animals)	Estimated incidental take due to the presence of the vessel[1]
Spectacled porpoise	2	
Hourglass dolphin	2	
Killer whale	2	
Long-finned pilot whale	43	
Arnoux's beaked whale	3	
Southern bottlenose whale	3	
Sperm whale[2]	4	
Humpback whale[2]	49	
Blue whale[2]	0	
Fin whale[2]	114	
Antarctic minke whale	2	
Southern right whale	1	
Antarctic fur seal	136	417
Southern elephant seal	2	2
Leopard Seal	22	68
Weddell Seal	74	226
Crabeater Seal	884	2705

[1] Behavioral disturbance of pinnipeds hauled out on ice by AMLR survey vessel activities.

[2] ESA-listed species.

Injury or Mortality Due To Entanglement in Gear

There have been no records of ESA-listed species being taken by entanglement in any gear types used during SWFSC research in the ARA and no serious injuries or mortalities are expected to occur under the status quo conditions.

Other Cetaceans

In addition to the ESA-listed whales, there is one other species of baleen whale and at least 16 other odontocetes in the ARA.

Disturbance and Behavioral Responses Due to Acoustic Equipment

Table 4.2-12 shows the estimated Level B harassment takes by acoustic sources of these species under the status quo conditions. The analysis of potential disturbance effects from acoustic sources is the same as described for other cetacean species in the CCRA above. The potential effects of disturbance due to research activities would be minor in magnitude, temporary in duration, likely to occur throughout the ARA, and would have overall minor adverse effects on all cetaceans throughout the ARA under the Status Quo Alternative.

Injury or Mortality Due To Entanglement in Gear

There have been no records of non ESA-listed cetaceans being taken by entanglement in any gear types used during SWFSC research in the ARA and no injuries, serious injuries, or mortalities are expected to occur under the status quo conditions.

Pinnipeds

There are nine species of pinnipeds in the ARA (Table 3.2-4).

Disturbance and Behavioral Responses Due to Acoustic Equipment and Vessels

Table 4.2-12 shows the estimated Level B harassment takes by acoustic sources of these species under the status quo conditions. The analysis of potential disturbance effects from acoustic sources is the same as described for pinniped species in the CCRA above. In addition, the LOA application estimates the number of pinnipeds hauled out on ice that may be disturbed by the passing of SWFSC research vessels (Level B harassment). Behavioral disturbance may include visible reactions of hauled out animals to the ship, such as some animals leaving haulout locations and entering the water. The LOA application estimates the number of each pinniped species that may be disturbed based on their density estimates, the length of transits through Antarctic waters by research vessels, and an assumed "disturbance zone" of 100 m on either side of the vessel. These estimated Level B harassment takes are included in Table 4.2-12. The potential effects of disturbance due to research activities would be minor in magnitude, temporary in duration, likely to occur throughout the ARA, and would have overall minor adverse effects on all pinnipeds throughout the ARA under the Status Quo Alternative.

Injury or Mortality Due To Entanglement in Gear

There have been no records of pinnipeds being taken by entanglement in any gear types used during SWFSC research in the ARA and no injuries, serious injuries, or mortalities are expected to occur under the status quo conditions.

4.2.4.4 Conclusion

The potential direct and indirect effects of SWFSC research activities on marine mammals have been considered for each of the three SWFSC research areas (CCRA, ETPRA, and ARA) and for all gear types used in research under the Status Quo Alternative. Every species in these research areas may be exposed to sounds from active acoustic equipment used in SWFSC research. However, many of the acoustic sources are likely not audible to many species and the others would likely cause temporary and minor changes in behavior for nearby animals as the ships pass through any given area. The potential for temporary threshold shifts in hearing is low for high frequency cetaceans (porpoises) and very low to zero for other species. The potential for hearing loss or injury to any marine mammal is essentially zero. Because of the minor magnitude of effects and the short-term duration of acoustic disturbance, the overall effects of acoustic disturbance are considered minor adverse for all species and in all three research areas.

There have been two species of cetaceans (Pacific white-sided dolphin and Northern right whale dolphin) and two species of pinnipeds (California sea lion and Northern fur seal) that have been caught in research gear in the past five years, all in the CCRA. These historic data and other data on mortalities in similar commercial fisheries have been used to estimate the potential for mortalities in the next five years under the status quo conditions, which include a suite of mitigation measures that have been implemented for SWFSC surveys using pelagic trawl and longline gear. Future takes, if they occur, would likely not be as high as the estimates because they are based on a conservative approach to ensure accounting for the maximum amount of potential take. The estimated potential takes in the CCRA for these species are still below 10 percent of PBR for most species and would be considered to have minor magnitudes of effect on the population level. For two species in the CCRA (Risso's dolphin and bottlenose dolphin), estimated takes would be greater than 10 percent and less than 50 percent of PBR and would be considered to have moderate magnitudes of effect on the population level. However, given the lack of historical takes of these species, the relatively small number of research trawls and longline sets used during SWFSC research, and the mitigation measures described in Section 2.2, the SWFSC considers the risk of taking these species at the estimated rate to be very low. Marine mammals generally travel through large geographic areas so the potential loss of one animal would not likely have localized effects. The overall impact of the potential takes of these species in the CCRA, if they occurred, would be considered minor adverse according to the criteria described in Table 4.1-1. Given the type of research gear and protocols used in the ETPRA and ARA under the status quo conditions, no marine mammals are expected to be caught in those research areas.

Given the very small amounts of fish and invertebrates removed from the ecosystem during scientific sampling, the dispersal of those sampling efforts over large geographic areas, and the short duration of sampling efforts, the overall risk of causing changes in food availability for marine mammals is considered minor adverse for all three research areas. Also, given the crew training, required emergency equipment, and adherence to environmental safety protocols on NOAA research vessels and NOAA chartered vessels, the risk of altering marine mammal habitat through contamination from accidental discharges into the marine environment is considered minor adverse for all three research areas.

4.2.5 Effects on Birds

This section describes the effects of the status quo SWFSC research activities on seabirds. The potential effects of research vessels, survey gear, and other associated equipment on seabirds include:

- Injury or mortality due to ship strikes and entanglement in gear
- Changes in food availability due to survey removal of prey and discards
- Contamination or degradation of habitat

Injury and Mortality Due to Ship Strikes and Entanglement in Fishing Gear

There are several potential mechanisms for SWFSC research activities to cause injury or mortality to seabirds. Many seabirds are attracted to fishing vessels in order to forage on bait, offal, discards, and natural prey disturbed by the fishing operation. This attraction to fishing vessels creates the opportunity for birds to inadvertently collide with cables or lines and other structures on the vessel as well as being caught in the fishing gear. Bird strikes are probably most numerous during the night and during storms or foggy conditions when bright deck lights are on, which can cause the birds to become disoriented (NMFS 2004). However, such collisions with gear or vessels are hard to detect, especially without a dedicated research effort to monitor bird interactions.

In some parts of the world, mortality of seabirds in commercial fishing gear, especially longlines and gillnets, is a major conservation concern for albatross, gulls, and other species that follow commercial fishing vessels. Diving birds are vulnerable to getting caught in gill nets and other fishing gear near the surface as it is being set or hauled in. In the California Current, commercial fisheries using set and drift

gillnets and longline gear have the worst records of taking seabirds and a number of species are considered to have population-level effects as a result (Mills et al. 2005). In the Southern Ocean and many areas of the ETP, longline fisheries for various species have had severe effects on several species of albatross and other tubenoses (Brothers at al. 1999).

Changes in Food Availability

Fishing activities can have potentially adverse effects on seabirds through changing the abundance or distribution of their prey species. A recent study (Cury et al. 2011) examined data from the past 450 years and all of the world's oceans and found that when prey abundance (small fish and invertebrates) dropped below one third of maximum documented biomass, seabird reproductive success declined significantly. This held true for species all over the world. Many factors influence the abundance and distribution of seabird prey, including strong roles for oceanographic and weather fluctuations, but commercial fisheries are also a factor. Although it is very difficult to demonstrate the indirect effects of fishing for other species and size classes on the availability of prey for seabirds, directed fishing on small schooling fish (e.g., sardines and anchovies) and invertebrates (e.g., krill) have played major roles in driving seabird prey populations below the "one third" limit in many areas (Cury et al. 2011).

Fishing activities may also have beneficial effects on seabirds through the provisioning of offal and discards that would otherwise be unavailable to birds. In some areas with intensive fishing efforts, offal may provide a substantial portion of the total food consumed by scavenging species such as gulls (Tasker and Furness 1996). However, while scavenging may benefit individual birds, it also places them in danger from entanglement and incidental mortalities in fishing gear.

Contamination or Degradation of Habitat

Contamination from spills and discharges can accumulate in the seafloor and marine life and have a toxic effect on the plants, animals and humans through the food chain (NOAA 2010d). While there are no intentional discharges of pollutants from SWFSC or any other fisheries research vessels, there is the potential for accidental spills to occur. Discharge from vessels, whether accidental or intentional, may include sewage, ballast water, fuel, oil, miscellaneous chemicals, garbage, and plastics.

All NOAA and ocean-going vessels are subject to the regulations of MARPOL 73/78, the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (NOAA 2010 b). MARPOL includes six annexes that cover discharge of oil, noxious liquid substances, harmful packaged substances, sewage, garbage, and air pollution (IMO 2010). Adherence to these regulations minimizes or negates the likelihood of discharges of potentially harmful substances into the marine environment. Annex V specifically prohibits plastic disposal anywhere at sea and severely restricts discharge of other garbage (IMO 2010).

NOAA vessels are operated by the NOAA Commissioned Officer Corps, one of the seven uniformed services of the United States (U.S.). All NOAA vessels are fully equipped to respond to emergencies, including fuel spills, and crew receive extensive safety and emergency response training. These precautionary measures help reduce the likelihood of fuel spills occurring and increase the chance that they will be responded to and contained quickly. Oil spill prevention training and equipment may be more variable on commercial fishing vessels that are chartered for research purposes but all vessels are required to comply with USCG regulations on spills. Discharge of contaminants from vessels used during research surveys is possible, but unlikely, and if it occurs, would be isolated in both time and location and likely small in volume.

4.2.5.1 California Current Research Area

Seabirds occur throughout the year in all areas of the California Current concurrent with SWFSC research activities. Fisheries research surveys use several gear types that have been demonstrated to result in seabird mortality in commercial fisheries of the Pacific, including longlines and pelagic trawls (Mills et

al. 2005). However, there are no records of any bird mortalities due to interactions with fishing gear or ship strikes during SWFSC fisheries and ecological research activities. The lack of seabird mortalities during pelagic trawl research may be due in part to the short tow times for research surveys relative to typical commercial fishing efforts and also to the much smaller number of vessels and gear sets involved in research. On NOAA vessels or chartered vessels, any seabird mortalities during survey efforts would be recorded. As stated earlier, it is usually very difficult to detect seabird collisions with gear or vessels but there are no records of any bird mortalities due to ship strikes during SWFSC conducted fisheries research activities. There is still a potential for mortality to occur from gear interaction or ship strikes but they are likely to be rare events that would not affect seabird populations.

The short duration of fisheries research tows, the dispersal of research effort over wide areas of sea, and the relatively small number of research surveys over time makes it very unlikely that the abundance or distribution of seabird prey would be affected by research activities. This is especially true for the small size classes of fish and pelagic invertebrates favored by most seabirds because of their large biomass and the minimal amounts taken in research samples (Sections 4.1.3 and 4.1.7). For the same reasons, the amount of food made available through research activities is unlikely to have more than temporary and highly localized beneficial effects on seabirds. The potential effects of research on seabirds through changes in food availability are therefore considered minor adverse.

The potential for research vessels to cause degradation of seabird habitat and prey through contamination would only be through accidental spills and discharges. Given the crew training previously discussed and the small number of fisheries research vessels, these would likely be limited in scope, infrequent, and localized and would therefore considered minor adverse.

4.2.5.2 Eastern Tropical Pacific Research Area

The SWFSC research activities in the ETP have no history of taking seabirds. Under the Status Quo scope of research there is very little actual fishing activity in the ETP, with efforts focused more on conducting visual transects for marine mammals and birds. This means there is very little or no offal or bait to attract birds and a relatively small risk of birds inadvertently striking the vessels or gear. The risk of injury or mortality is therefore considered minor adverse. Given the minimal amount of biomass removed by research and the fact that these surveys are conducted from only one or two NOAA vessels, the potential effects from changes in prey availability or contamination in the ETP are also considered minor adverse.

4.2.5.3 Antarctic Research Area

The SWFSC research activities in the ARA have not resulted in any seabird mortalities.. The gear types that have been used in these surveys (small plankton nets, similar nets to sample krill and juvenile fish, and bottom snapper trawls) have not been implicated in seabird mortalities in commercial fisheries as has longline gear and gill nets. Given the minimal amount of biomass removed by research, the potential effects on seabirds from changes in prey availability are considered minor adverse. These surveys are conducted on large charter vessels that must pass health, safety, and emergency preparedness requirements similar to those on NOAA vessels. With only one or two vessels being used in any given year, the risk of contamination in the Antarctic is also considered minor adverse.

4.2.5.4 Conclusion

The overall effects on seabirds from SWFSC research activities under the Status Quo Alternative are expected to be short-term and rare in frequency and duration, localized in geographic extent, and would not result in any measurable changes to seabird populations; effects are therefore considered minor adverse according to the criteria in Table 4.1-1. This conclusion holds for each of the three SWFSC research areas and for all gear types used in research.

4.2.6 Effects on Sea Turtles

Section 3.6 describes the populations of sea turtles that are likely to overlap with SWFSC fishery research activities in the CCRA and ETPRA. This section describes the potential effects of SWFSC research activities on sea turtles under the Status Quo Alternative, including mitigation measures that have been implemented to reduce adverse effects.

Five species of sea turtles can be found within the CCRA and ETPRA: leatherback, olive ridley, green, loggerhead, and hawksbill sea turtles. All five species of sea turtles are listed as endangered under the ESA. Direct and indirect effects of SWFSC research activities on sea turtles may include:

- Disturbances and changes in sea turtle behavior due to physical movements and sounds
- Injury or mortality due to ship strikes and gear interaction
- Changes in food availability due to survey removal of prey
- Contamination or degradation of sea turtle habitat

Mitigation measures implemented under the Status Quo Alternative are intended to reduce the potential for adverse interactions with sea turtles, and are described in Section 2.2.1.

Disturbance and Changes in Behavior Due to Physical Movements and Sound Sources

Impact producing factors that could potentially disturb sea turtles and cause changes in behavior include the physical presence of marine vessels and fishing gear, operational sounds from engines and hydraulic equipment, and active acoustic devices used for navigation and research.

There are no experimental or systematic observational data on auditory or behavioral responses of sea turtles to high frequency sound sources typically used for acoustic fisheries research and navigation (Appendix C, Section 6.2). Based on the auditory capabilities of sea turtles at low frequencies, active acoustic sources used in SWFSC fisheries research operations are unlikely to be audible to sea turtles and therefore are unlikely to have adverse effects on sea turtles (Appendix C, Section 6.2). Sea turtles may be disturbed or displaced from their normal behavior or movements by passing vessels or fishing gear in the water. Given the small number of research vessels and their dispersal over a wide area, behavioral disturbances resulting from SWFSC research activities proposed under Alternative 1 would be isolated in geographic extent and short-term in nature, lasting only a few minutes as the research vessel passes. Such disturbances would not result in measureable changes to sea turtle foraging success or survival at the population level. Therefore, the effects would be minor adverse using gear types and mitigation measures similar to those currently in use.

Injury or Mortality Due to Ship Strikes and Entanglement in Gear

The two main mechanisms for research activities to cause injury or mortality to sea turtles are ship strikes and entanglement in fishing gear. Sea turtles come to the surface to breathe, and also to rest, making them susceptible to ship strikes. However, there are no reported incidents of collisions with sea turtles by NMFS research vessels in the CCRA or ETPRA. As described in Section 2.2.1, vessel speeds are restricted on research cruises in part to reduce the risk of ship strikes with marine mammals and sea turtles. Transit speeds vary from 6-14 kts, but average 10 kts. The vessel's speed during active sampling is typically 2-4 kts due to sampling design, and these slower speeds are assumed to minimize the risk of collisions with sea turtles. Given the relatively slow speeds of research vessels, the presence of dedicated watches during survey activities, and the small number of research cruises, collisions with sea turtles resulting from the research activities considered under the Status Quo Alternative are considered unlikely. Therefore, the effects of collisions with sea turtles are considered minor adverse throughout the CCRA and ETPRA using vessel types and mitigation measures similar to those currently in use.

In the CCRA, there has been one incident of sea turtle entanglement resulting from SWFSC research using a standard Nordic 264 trawl configured for surface fishing. During the 2011 SWFSC Juvenile Salmon Survey, a Pacific leatherback sea turtle was incidentally caught due west of Pigeon Point, San Mateo County, California. Once the net was pulled onto the deck of the research vessel, it became apparent that the leatherback sea turtle had been caught, along with a large haul of jellyfish. The crew immediately loosened the net around the turtle's head to allow breathing during extraction from the net. The turtle was breathing while in the net, and the crew opened the net and extracted the turtle within three minutes. Once out of the net, the turtle showed no signs of severe injuries, and was released alive. The turtle was subsequently observed swimming and breathing normally at the surface behind the vessel. Mitigation measures in use at the time of the sea turtle interaction included a sea turtle watch (3-4 observers) before and during the trawl.

Sea turtle interactions with longline gear include entanglement in lines and being caught by hooks as a result of depredation by sea turtles on the bait or caught fish. These types of adverse interactions may result in serious injuries or even mortalities to the sea turtle species involved. Loggerhead and leatherback sea turtles have been identified as being at particular risk of population decline as a result of incidental take by longline pelagic fisheries (Lewison et al. 2004) However, there have been no recorded incidents of sea turtle interactions with SWFSC research longline gear in the CCRA. Under Alternative 1, the SWFSC would continue to use circle hooks and finfish bait to minimize the risk of catching sea turtles. In addition, the SWFSC would continue to use shallow pelagic sets to sample sharks with gangions long enough to allow a hooked turtle to reach the surface. Longline gear for Highly Migratory Species surveys would be set at depths greater than 50 ft. Given the lack of historical interactions under the same conditions, the potential for future interactions is considered small and unlikely to affect any populations of sea turtles. The effects of longline surveys on sea turtle populations are therefore considered minor adverse based on the criteria in Table 4.1-1.

Mitigation measures implemented under the Status Quo Alternative would be intended to reduce the potential for adverse interactions with sea turtles. Operational procedures and monitoring methods described in Section 2.1.1 would include visual scans for sea turtles, and would preclude trawl and longline surveys in areas where turtles are observed. However, the efficacy of these mitigation measures may be limited by the fact that turtles in the water may be difficult to see. Mitigation measures limiting tow duration to 30 minutes would decrease the potential for turtle mortality to result from interaction with trawl gear. Short tow durations would ensure that any turtles captured in trawl nets would be removed from the net in a timely manner, thereby decreasing the potential for drowning. In addition, MMEDs similar to those required under Alternative 1 have been shown to be effective for reducing adverse interactions between sea turtles and trawl gear (http://www.nmfs.noaa.gov/pr/species/turtles/teds.htm). In summary, there has been one recorded incident of sea turtle entanglement resulting from SWFSC research activities. In that instance, the turtle was released alive. There have been no reported interactions resulting in sea turtle mortality. Based on this information, minor adverse effects are expected to occur using gear types and mitigation measures similar to those currently in use; these effects would be rare and short-term in frequency and duration, and would not result in measurable changes to sea turtle population levels in any of the SWFSC research areas.

Changes in food availability due to survey removal of prey

Western Pacific leatherback turtles (*Dermochelys coriacea*) forage seasonally on dense aggregations of jellyfish off the west coast of the United States (Graham 2009). All life stages consume gelatinous organisms such as jellyfish and tunicates (USFWS Biological Technical Publication, BTP-R4015-2012). Several species of jellyfish, including the two common large jellyfish species, *Chrysaora fuscescens* and *Aurelia labiata*, are frequently caught as a result of SWFSC fisheries research activities in the CCRA. Regurgitated stomach contents and observations of actively foraging individuals in the study area indicate *Chrysaora fuscescens* is more frequently consumed by leatherbacks than other scyphozoan species (Graham 2009).

The average annual catch of *Chrysaora fuscescens* in the course of all SWFSC research surveys over the past five years is about 18,473 kg, and the estimated total average annual catch of *Aurelia labiata* is 2,623 kg (Table 4.2-13). Catches of jellyfish from the Juvenile Salmon Surveys far exceed those from other SWFSC surveys. An average of 17,866 kg of *Chrysaora fuscescens* are caught annually during Juvenile Salmon Surveys, 99 percent of which are caught from within designated critical habitat for leatherback sea turtles. These surveys also catch an average of 2,529 kg of *Aurelia labiata* each year, of which 62 percent (1,575 kg) are caught from within designated critical habitat for leatherback sea turtles (See section 3.2.4). Although the total biomass of jellyfish species in SWFSC research areas is difficult to estimate, a mean areal density of 251,522 ± 57,504 jellyfish per square nautical mile (jellies / nm^2), has been calculated in the central California foraging area of leatherback turtles based on acoustic backscatter survey data (Graham 2009). Thus, due to the extremely high densities of jellyfish encountered in leatherback foraging areas, the amount of jellyfish removed as a result of SWFSC surveys would have only minor adverse effects on the availability of jellyfish as a food source for leatherback sea turtles.

Contamination or Degradation of Habitat

The only potential mechanisms for SWFSC research activities to cause contamination or degradation of sea turtle habitat would involve accidental spills and discharges. All NOAA vessels are subject to the regulations of MARPOL 73/78, the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (NOAA 2010b). MARPOL includes six annexes that cover discharge of oil, noxious liquid substances, harmful packaged substances, sewage, garbage, and air pollution (IMO 2010). Adherence to these regulations would avoid or minimize the likelihood of discharges of potentially harmful substances into the marine environment. Annex V specifically prohibits plastic disposal anywhere at sea and severely restricts discharge of other garbage (IMO 2010). Discharge of contaminants from SWFSC vessels and SWFSC chartered vessels is unlikely. Any contamination or degradation of sea turtle habitat resulting from SWFSC research activities proposed under Alternative 1 would be isolated in both time and location, and would not result in measureable changes to sea turtle populations in the CCRA or ETPRA. No measureable changes in contamination or degradation of sea turtle habitat are expected to result from SWFSC research activities. Such effects are unlikely and are therefore considered to be minor adverse based on the criteria in Table 4.1-1.

4.2.7 Effects on Invertebrates

This section describes the potential effects of SWFSC research activities on invertebrates under the Status Quo Alternative. The potential effects of research vessels, survey gear, and other associated equipment on invertebrates would include:

- Targeted and incidental capture of invertebrates resulting from surveys
- Physical damage to infauna and epifauna
- Contamination or degradation of habitat

In all instances, the numbers and biomass of invertebrates captured as a result of SWFSC surveys would be minor in magnitude. Because SWFSC surveys do not utilize bottom-contact trawl gear in the CCRA or ETPRA, physical damage to infaunal and epifaunal communities would not occur in those areas. The SWFSC periodically uses bottom-contact trawl equipment to sample benthic invertebrates and fish in the ARA. Contamination or degradation of invertebrate habitat are unlikely to occur in any of the SWFSC research areas due to standard operating procedures and mitigation measures intended to eliminate adverse impacts to invertebrate habitat. Potential effects are discussed below for each of the SWFSC research areas.

4.2.7.1 California Current Research Area

SWFSC research activities would result in the targeted and incidental capture of several invertebrate species in the CCRA, including Market Squid, Humboldt Squid, euphausids, and several species of jellyfish. The equipment used for research in the CCRA includes near-surface and midwater trawl gear, as well as various plankton nets, water sampling devices and acoustic survey equipment. Because SWFSC surveys do not utilize bottom-contact trawl gear in the CCRA, adverse effects on benthic invertebrates are considered unlikely.

Table 4.2-13 shows the mean annual catch of marine invertebrates in the CCRA for species with a mean annual catch in excess of 20 kg. The amounts of invertebrates caught in research samples are very low relative to both their biomass and the amounts of these species that are harvested in commercial fisheries. For example, the California market squid FMP sets a seasonal catch limit of 107,048 mt (118,000 mt) to prevent the market squid fishery from over-expanding (CDFG 2005b). In contrast, the mean annual catch of market squid resulting from all SWFSC research activities in the CCRA is 470 kg, equivalent to less than one one-thousandth of one percent (0.00001) of the seasonal catch limit for commercial fisheries.

Commercial fisheries do not currently exist for the other invertebrates listed in Table 4.2-13, so comparisons to commercial catch limits are unavailable. Several species of jellyfish, including the two common large jellyfish species, *Chrysaora fuscescens* and *Aurelia labiata*, occur in samples from the surveys shown in Table 4.2-13. Catches of jellyfish from the Juvenile Salmon Surveys far exceed those from other survey types due to the locations of the surveys, gear characteristics, and survey techniques. Juvenile Salmon Surveys extend from central Oregon (Newport) to central California (Pillar Point), and in general they catch large numbers of jellyfish only south of Fort Ross, California. Jellyfish are consistently abundant in the Gulf of the Farallones and just north of Point Reyes near Tomales Bay, and mostly within 5 miles of shore or less. In this region, jellyfish catch occasionally exceeds 5,000 kg in only a few minutes of trawling with a 264 Nordic rope trawl. Not all jellyfish catches are weighed, but the weights given in Table 4.2-13 include estimates for the large hauls. Jellyfish are also encountered in the Juvenile Rockfish Surveys but have not been routinely weighed. Overall, the amounts of invertebrates removed as a result of the SWFSC research activities proposed under Alternative 1 would be small relative to invertebrate population sizes, and this removal would not result in measureable changes to invertebrate populations within the CCRA. Effects to invertebrate populations resulting from SWFSC research activities under Alternative 1 would be minor in magnitude and intensity, localized in small sample areas, and short-term in duration. The effect of these activities on invertebrate populations would be minor adverse according to the criteria in Table 4.1-1.

Table 4.2-13 Mean annual catch of marine invertebrates in the California Current Research Area.

Table shows estimated mean annual catch for species with a mean annual catch in excess of 20 kg from all SWFSC research surveys combined.

Species	Scientific Name	Survey name	Mean Annual Catch (kg)
Market Squid	*Doryteuthis opalescens*	CalCOFI CPS Survey Juvenile Rockfish Survey Juvenile Salmon Survey	470
Humboldt squid	*Dosidicus gigas*	CalCOFI	80
Euphausiid	Euphausiacea	CPS Survey Juvenile Rockfish Survey	991
Sea nettle jellyfish	*Chrysaora fuscescens*	CalCOFI CPS Survey Juvenile Rockfish Survey	18,473

Species	Scientific Name	Survey name	Mean Annual Catch (kg)
		Juvenile Salmon Survey Habitat Survey	
Moon jellyfish	*Aurelia labiate*	CalCOFI CPS Survey Juvenile Rockfish Survey Juvenile Salmon Survey Habitat Survey	2,623
Fried-egg jellyfish	*Phacellophora camtschatica*	CalCOFI Juvenile Salmon Survey Juvenile Rockfish Survey	33
Unidentified salp	unknown	CalCOFI Juvenile Salmon Survey	24

4.2.7.2 Eastern Tropical Pacific Research Area

Under Alternative 1, SWFSC research activities would result in removal of very small amounts of invertebrates from the ETPRA. Zooplankton and phytoplankton would be removed from the ETPRA as a result of surveys using various small, towed, fine-mesh nets designed to sample larval and juvenile fish and small pelagic invertebrates as part of the Stenella Abundance Research (STAR) surveys (See Appendix A for descriptions of Oozeki, IKMT, MOCNESS, and Tucker nets). The total biomass of invertebrates removed as a result of these surveys was 19.80 kg during the 2006 STAR survey, and similar amounts of invertebrates would be expected to be removed from the ETPRA annually under Alternative 1. The effects of this removal on populations of invertebrates in the ETPRA would be minor in magnitude. Because the SWFSC does not employ bottom-contact gear in the ETPRA, no direct impacts to benthic invertebrates are expected. The effects of other activities, such as the use of active acoustic devices, water sampling devices, and expendable bathythermographs would also be minor with regard to invertebrate populations in the ETPRA. Research activities in the ETPRA would likewise have minor adverse impacts upon invertebrate habitat. Overall, SWFSC research activities in the ETPRA do not involve any mechanism for effects on invertebrates at the population level; the effects on populations of invertebrates in the ETPRA resulting from SWFSC survey activities would therefore be minor adverse based on the criteria in Table 4.1-1.

4.2.7.3 Antarctic Research Area

In the ARA, SWFSC surveys are primarily focused on Antarctic krill, which are a key component of the Antarctic food web. Acoustic data are the principal source of information used to measure the abundance and distribution of krill. In addition, very small amounts (10s of kgs) of krill and zooplankton are captured in small-mesh nets to facilitate physiological studies and collection of biometric data. Estimates of krill abundance in the ARA are only available in the few places where research occurs. Estimates of krill biomass in the Elephant Island, West, and South Areas around the Shetland Islands, Antarctica are shown in Figure 4.2-4 (AMLR 2010). In comparison to the data presented in Figure 4.2-4, the amounts of krill and other zooplankton collected during the course of SWFSC research activities are minor fractions of overall biomass and would not affect Antarctic krill or other zooplankton at the population level.

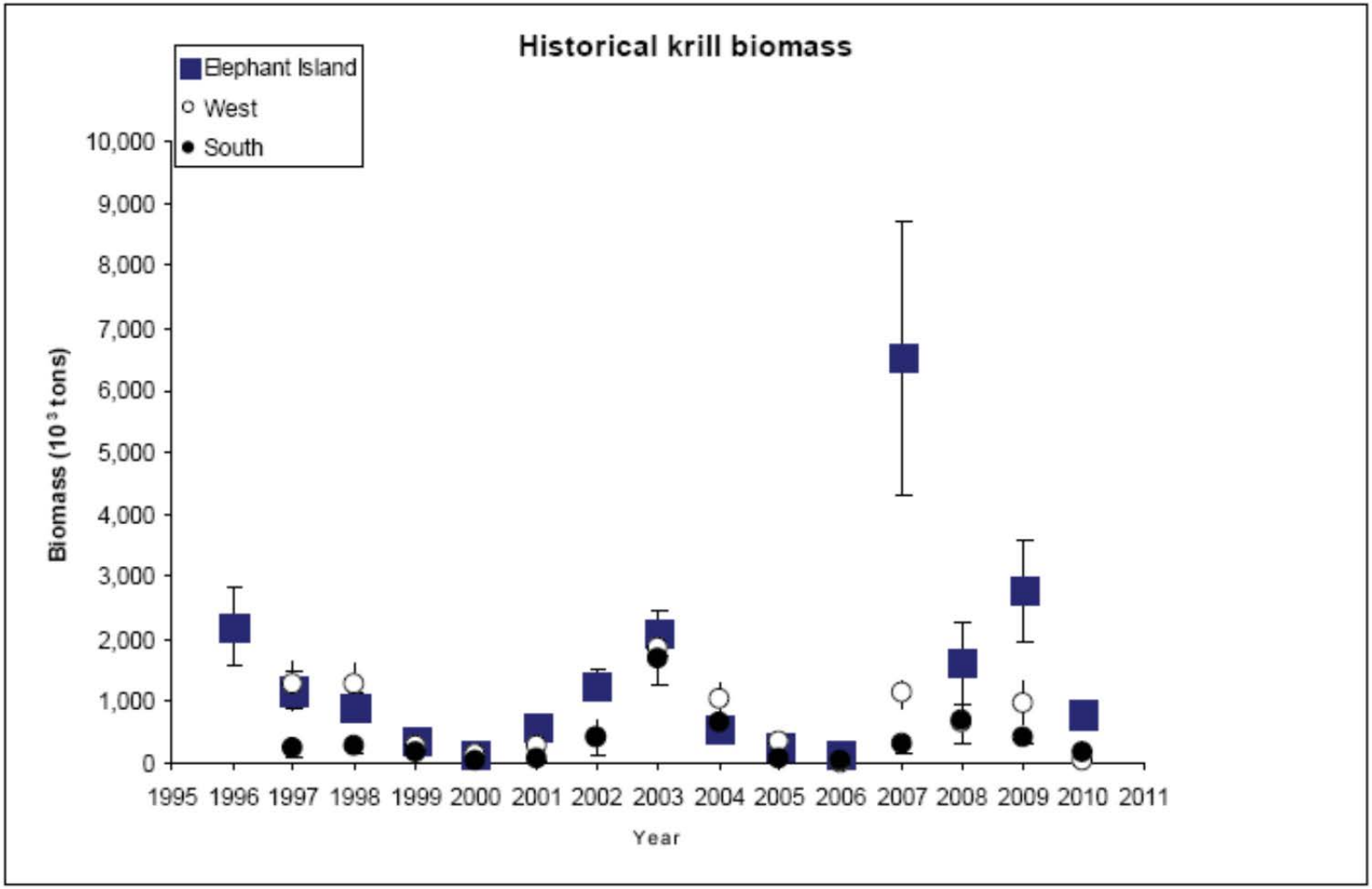


Figure 4.2-4 Historical krill biomass values around the Shetland Islands, Antarctica.

Data for the Elephant Island area and the west and south areas around the Shetland Islands from 1996-2010; biomass values in 10^3 metric tons (from Cossio and Reiss 2011; 2009-2010 AMLR Field Season Report).

SWFSC Antarctic survey data are occasionally augmented with information from bottom trawl surveys used to quantify benthic invertebrates and fish (see Table 2.2-1). Such surveys would occur once every three years and have historically involved 75 bottom trawl hauls per survey. Under Alternative 1, it is assumed that a similar amount of survey effort would continue in the future. The effects of SWFSC bottom trawl surveys on benthic invertebrates in the ARA may include removal of infauna and epifauna from sand, silt, or gravel substrates. Bottom contact fishing gear can break or disrupt corals and other benthic invertebrates, thereby reducing structural complexity, which may reduce species diversity of the corals and other animals that utilize the habitat (Freiwald et al. 2004). Cold-water corals such as *Flabellum thouarsii* and *Flabellum curvatum* are known to occur in the SWFSC ARA, although their exact distribution and abundance are poorly understood (Cairns 1982; Waller et al. 2008). Cold water corals are generally slow growing, fragile, and long lived, which makes them particularly vulnerable to damage. The disturbance of these organisms may only be reversible through natural recovery that may occur over hundreds of years (Freiwald et al. 2004). Thus, the duration of impacts to benthic invertebrates resulting from bottom trawl survey activities in the ARA could be long-term. However, under Alternative 1, SWFSC would implement as standard operating procedure numerous measures to reduce the likelihood, magnitude, and geographic extent of such impacts. Bottom-contact trawl gear would be deployed only after initial acoustic reconnaissance is conducted to verify bottom conditions suitable for trawling. Bottom trawl surveys would only be conducted on suitable benthic substrates, e.g., sand, silt or gravel bottoms. Rocky areas that are more likely to support corals would be avoided by using sonar to examine the bottom contours before surveys are conducted. Given the selection for bottom substrates and avoidance of coral areas, impacts to slow-growing corals in the ARA would be possible but unlikely, and such impacts would not affect Antarctic corals at the population level. The effects of SWFSC research activities on benthic invertebrates in the ARA may also include impacts to non-coral infauna and epifauna from sand, silt, or gravel substrates. These effects would be minor in magnitude due to the small areal extent and intermittent nature of surveys using bottom trawl and other bottom contact equipment.

Information collected from the SWFSC Antarctic survey program provide the only datasets available for quantification of abundance and distribution of demersal finfish, their prey, and habitat characteristics, and represent the only comprehensive dataset of composition and spatial distribution of benthic invertebrate megafauna communities in the in the Southern Scotia Arc (Subarea 48.1 & 48.2). In addition, SWFSC activities represent the only scientific survey conducted along the Antarctic Peninsula, and fulfill U.S. commitments to CCAMLR and obligations under the Antarctic Treaty. The scientific information gleaned from SWFSC survey activities is used to inform Antarctic conservation measures which are implemented to protect and conserve biological resources, including invertebrates in the ARA. Under Alternative 1, the beneficial effects of science-based management supported by SWFSC research would at least partially countervail adverse effects resulting from the survey activities. Although impacts of SWFSC research activities on slow growing corals could be long term, the overall magnitude and geographic extent of impacts to invertebrates within the ARA would be minor adverse due to the infrequent nature of the survey activities, and the localized areal extent of the impacts.

4.2.8 Effects on the Social and Economic Environment

Section 3.3 describes the interaction of the SWFSC with the social and economic environment of the CCRA, ETPRA, and the ARA. This section describes the effects of the fishery research alternatives on socioeconomic resources. Major factors that could be influenced by changes to the SWFSC program include:

- Collection of scientific data used in sustainable fisheries management
- Economic support for fishing communities
- Collaborations between the fishing industry and fisheries management
- Fulfillment of obligations to communities specified by laws and treaties

Collection of scientific data used in sustainable fisheries management

Long-term standardized resource surveys conducted by NOAA fishery research vessels are fundamental elements of stock assessments in the Southwest research regions. The extended time-series of data helps identify trends that inform fisheries management planning. This information is essential to establishing species-specific sustainable harvest limits on an annual basis. Harvest limits that are set too high may lead to overfishing of specific stocks and more restrictive management measures in the future to rebuild those stocks. Harvest limits that are set too low do not allow a maximum sustainable harvest that benefits commercial and recreational fisheries and the communities and services that support them. In addition, the predictability and reliability of long term data sets and the harvest limits they support is essential for economic stability in the fisheries over time.

Economic support for fishing communities

The SWFSC's roughly $50 million in annual operations costs (J. Rusin 2011, pers. comm.) have a primary and secondary economic influence on the communities and ports in which they operate. These funds are distributed among U.S. research stations located in LaJolla, Santa Cruz, Pacific Grove, Arcata, Granite Canyon, and Piedras Blancas, California. The operating budget directly supports employees and operations of facilities. Approximately $22 million is spent annually on the collection of at-sea survey data, extending from Oregon to Antarctica (J. Rusin 2011, pers. comm.). This includes ship and aircraft time, equipment and logistics costs, contracts, crew wages, and taxes and fees. NOAA ships, charters, and research vessels operate from several home ports, and are serviced in many others. The SWFSC also leases vessels and equipment from local suppliers. Some commercial fishing operations are compensated for participation in cooperative research projects through grants or shares in fishing quotas that they sell on the market.

Collaborations between the fishing industry and fisheries management

Cooperative research is an important element in establishing communication, trust, and information exchanges between scientists, fisheries managers, and the fishing industry. Cooperative research is used to: a) increase the precision and expand the scope of resource surveys; b) provide supplemental information about fishing operations; c) incorporate fishing expertise into the design and implementation of research; and d) build mutual understanding and respect among scientists and people in the fishing industry. Collaboration in the development of new gear and techniques encourages participation in developing sustainable fishing practices and contributes to a broader understanding of management for marine resources.

Fulfillment of obligations to communities specified by laws and treaties

A list of applicable laws is shown in Chapter 6. These obligations include the 1996 amendment to the MSA, which requires assessment, specification, and description of the effects of conservation and management measures on participants in fisheries, and on fishing communities (NMFS 2007b); and Executive Order (EO) 12898 on environmental justice, which directs agencies to assess actions that may disproportionately affect low income and minority populations. The fisheries research programs conducted in the CCRA, ETPRA, and ARA help fulfill these obligations under the MSA.

4.2.8.1 California Current Research Area

Under the Status Quo Alternative, the SWFSC would continue current research operations, at current levels, with current research methods. Data collected and analyzed would continue to contribute to fisheries management. While difficult to quantify, the direct effect of fisheries research would be to inform forecasting the future productivity and sustainability of fisheries and setting harvest limits. Collaboration with other agencies, and the commercial fishing industry would continue, comprising a coordinated approach to fisheries management.

Community and port spending would continue at current levels, which would have primary and secondary beneficial economic effects in communities. The majority of SWFSC spending occurs in support of facilities and employees in California, and in research in California Current waters. About $5 million is dedicated to at-sea survey expenditures in the CCRA (J. Rusin 2011, pers. comm.).

NMFS conducts community studies and develops statistical methodologies and economic models for identifying and describing communities substantially engaged in fishing. This information is ultimately utilized by fishery managers, whose decisions balance the needs of a variety of fisheries communities and users. This supports responsibilities outlined in the MSA (NMFS 2007b) and EO 12898 on environmental justice.

The Status Quo Alternative assumes the continued direct effects of SWFSC spending, research activity, collaboration with fisheries managers, and sustained evaluation of the economic health of fishing communities. The direct effects are noticeable in the economy, affect a large geographic area, and have been continued over a long period. Indirect effects include the effects of the data on sustainable fisheries management decisions, which are difficult to quantify. The Status Quo Alternative would continue to have, overall, moderate beneficial direct and indirect effects on the social and economic environment of communities associated with the CCRA.

4.2.8.2 Eastern Tropical Pacific Research Area

The total budget for ship, crew support, and equipment is approximately $1 million per year for SWFSC research in the ETPRA (J. Rusin 2011, pers. comm.). The majority of these funds are spent on crew, vessel operation and maintenance, and providing supplies and services associated with research cruises, and accrue in the home port. Voyages supporting data collection have a minimal influence on the economies of ports of call in Mexico and South America. The SWFSC does not have economic obligations to non-U.S. communities, but research contributes to an understanding of factors important to global marine resources, and collaboration with researchers in other countries. Several international treaties govern research in the ETP, as well, as described in Chapter 6. SWFSC ETP activity could indirectly benefit the productivity of U.S. fisheries. In Alternative 1, research would continue for the long-term, and effects would be expected to occur as before, and affect a large geographical area. The overall direct and indirect effect of the Status Quo Alternative on communities associated with the ETPRA would be beneficial and minor.

4.2.8.3 Antarctic Research Area

On the Antarctic Peninsula, the SWFSC's Antarctic Ecosystem Research Division (AERD) maintains two field stations located at Cape Shirreff on Livingston Island and at Copacabana in Admiralty Bay on King George Island. Research surveys account for approximately $3 million in expenditures annually (J. Rusin 2011, pers. comm.). As with the ETPRA, the majority of these funds are spent on crew, vessel operation and maintenance, and providing supplies and services associated with research cruises, and accrue in the home port. SWFSC vessels make few visits to other ports of call, but occasionally stop in Punta Arenas, Argentina, for example, so this activity has a minor influence on the economies of ports of call. The SWFSC does not have economic obligations to non-U.S. communities, but research contributes to an understanding of factors important to global marine resources, and collaboration with researchers in other countries. Several international treaties govern research in the ETP, as well, as described in Chapter 6. SWFSC Antarctic activity could indirectly benefit the productivity of U.S. fisheries. The research would continue for the long-term, and effects would be expected to occur as before, and affect a large geographical area. The overall direct and indirect effect of the Status Quo Alternative for the Antarctic region would be beneficial and minor.

4.2.8.4 Conclusion

Overall direct and indirect effects of SWFSC operations would be beneficial and moderate for the CCRA because of contributions to local economies, collaboration with other researchers, contributions to fisheries management, and fulfillment of obligations to communities under U.S. laws. Direct and indirect contributions to the productivity of fisheries are not easily measurable. Overall direct and indirect effects of the ETPRA and ARA would be beneficial and minor because of lower expenditures and infrequent interaction with U.S. and foreign port and fishing communities.

4.3 DIRECT AND INDIRECT EFFECTS OF ALTERNATIVE 2 – PREFERRED ALTERNATIVE.

This section presents an analysis of the potential direct and indirect effects of Alternative 2 – Preferred Alternative on the physical, biological, and social environment. Under this Alternative, the SWFSC would conduct a new suite of research activities and implement new mitigation measures in addition to the Status Quo program to comply with the MMPA and ESA compliance process. The new suite of research activities is a combination of past research and additional, new research. Potential direct and indirect effects were evaluated according to the criteria described in Table 4.1-1. A summary of the impact rating determinations for all topics evaluated under Alternative 2 is presented below in Table 4.3-1.

Table 4.3-1 Alternative 2 Summary of Effects

All conclusions refer to adverse effects unless noted.

RESOURCE	Physical Environment	Special Resource Areas	Fish	Marine Mammals	Birds	Sea Turtles	Invertebrates	Social &Economic
SECTION #	***4.3.1***	***4.3.2***	***4.3.3***	***4.3.4***	***4.3.5***	***4.3.6***	***4.3.7***	***4.3.8***
Research Area								
California Current	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Moderate-*beneficial*
Eastern Tropical Pacific	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor-*beneficial*
Antarctic	Minor	Minor	Minor	Minor	Minor	N/A	Minor	Minor-*beneficial*

4.3.1 Effects on the Physical Environment

The effects of the Preferred Alternative (Alternative 2) on the physical environment would be substantially similar to those of the Status Quo Alternative (Alternative 1- see Section 4.2.1). Mitigation measures for protected species required under Alternative 2, such as the use of MMEDs, video sampling with an open cod end, and retrospective analysis of factors influencing incidental take of protected species, would not measurably influence the effects of the research activities on physical properties of the environment. Likewise, the implementation of procedures for handling of incidentally captured marine mammals would not influence the impacts of the activities on physical properties of the environment. The addition of a new survey in the ETPRA to monitor the abundance and distribution of HMS is included in Alternative 2 (see Table 2.3-1). This survey would involve deployment of pelagic longline gear, bongo plankton nets, CTD sensors, and water sampling equipment, as well as collection of acoustic data. These survey activities would result in minor effects on physical properties of the environment in addition to the effects described under Alternative 1. Therefore, the overall effects of Alternative 2 on the physical environment would be substantially similar to those described for Alternative 1; due to their minor

intensity and localized areal extent, the overall impacts to the physical environment would be minor adverse in each of the SWFSC research areas.

4.3.2 Effects on Special Resource Areas

4.3.2.1 California Current Research Area

Special resource areas within the CCRA include EFH and HAPC areas, closed areas, and MPAs, including National Marine Sanctuaries. Mitigation measures for protected species required under Alternative 2, such as the use of MMEDs, video sampling with an open codend, and retrospective analysis of factors influencing incidental take of protected species, would decrease the potential for adverse effects to special resource areas within the CCRA relative to Alternative 1. The mitigation measures included under Alternative 2 include the use of new equipment and techniques designed to reduce potentially adverse impacts on protected species. These mitigation measures could decrease the potential for adverse impacts to biological resources within special resource areas, but would not result in substantial differences in the impacts to non-biological resources in special resource areas relative to Alternative 1. Direct effects of SWFSC research activities on biological resources within special-fishery related areas are most accurately captured in the assessments of species groups, which are evaluated in Sections 4.3.3-4.3.7. Although some reduction in potential for adverse interactions with protected species within special resource areas relative to Alternative 1 may result from the mitigation measures described under Alternative 2, the overall magnitude and nature of the impacts of Alternative 2 on special resource areas in the CCRA would be substantially similar to those described for Alternative 1 (see Section 4.2.2). Impacts to EFH, HAPC, and closed areas would be minor and adverse.

Adverse effects to MPAs resulting from SWFSC research activities would be minor in magnitude, localized in geographic extent, and short-term in duration. It is important to note that sound science-based management practices are partially dependent upon the data generated from SWFSC research surveys. MPAs are, by definition, managed more carefully than other special resource areas, and therefore MPAs depend more heavily on the data collected during SWFSC surveys to sustain the habitats and resources that they are designed to protect through the implementation of sound science-based management practices.

The overall effects of SWFSC survey activities on MPAs, including National Marine Sanctuaries, would be minor adverse using the gear types, survey techniques, and mitigation measures described under Alternative 2.

4.3.2.2 Eastern Tropical Pacific Research Area

Special resource areas within the ETPRA include reserves, marine parks, and World Heritage Sites established by foreign governments. For the purposes of this EA, these areas are considered MPAs, and the impacts of SWFSC survey activities on these areas resulting from the actions described under Alternative 2 would be substantially similar to those described under Alternative 1 in Section 4.2.2.2. In general, the impacts to each of the MPAs are a subset of the impacts to specific physical, biological, and socioeconomic resources that are addressed in the resource specific sections of this EA. An additional survey proposed under Alternative 2 to monitor the abundance and distribution of HMS could result in increased potential for adverse impacts to biological resources within ETP special resource areas relative to Alternative 1(see Section 4.2.6- Effects on Sea Turtles). The magnitude and likelihood of such effects would depend largely upon the proximity of the new HMS survey to special-fishery related areas. However, implementation of mitigation measures, such as the use of circle-hooks to minimize adverse interactions with sea turtles, would mitigate impacts to biological resources. Other mitigation measures for protected species required under Alternative 2, such as the use of MMEDs, video sampling with an open codend, and retrospective analysis of factors influencing incidental take of protected species, would decrease the potential for adverse effects to special resource areas within the ETPRA relative to

Alternative 1. These mitigation measures could decrease the potential for adverse impacts to biological resources within special resource areas, but would not result in substantial differences in the impacts to non-biological resources in special resource areas relative to Alternative 1. Adverse effects on MPAs resulting from SWFSC research activities would be minor in magnitude, localized in geographic extent, and short-term in duration and frequency.

It is important to note that sound science-based management practices are partially dependent upon the data generated from SWFSC research surveys. MPAs are, by definition, managed more carefully than other special resource areas; and, therefore, MPAs depend more heavily on the data collected during SWFSC surveys to sustain the habitats and resources that they are designed to protect.

The overall effects of SWFSC survey activities on MPAs in the ETPRA would be minor adverse using the gear types and mitigation measures described under Alternative 2.

4.3.2.3 Antarctic Research Area

Closed areas within the ARA include those established by CCAMLR conservation measures, as discussed in the *Schedule of Conservation Measures in Force 2010/11 Season* (CCAMLR 2010). An additional series of closed areas have been proposed as a management tool to determine the efficacy of small scale management units in the Antarctic krill fishery (Constable et al. 2000; Hill et al. 2009). Under Alternative 2, the impacts of SWFSC research activities on Antarctic special resource areas would be substantially the same as those described under Alternative 1 (see Section 4.2.2.3). Although mitigation measures required under Alternative 2 could theoretically decrease the likelihood of adverse impacts to protected species within Antarctic closed areas, historically there have been no adverse interactions between protected species and SWFSC research activities in those areas. Therefore, in practice the mitigation measures described under Alternative 2 are not expected to have a measureable influence on the effects of SWFSC research activities on protected species in the ARA, and effects would be substantially similar to those resulting from the actions described under Alternative 1. Under Alternative 2, the adverse impacts of SWFSC research activities on closed areas within the ARA would be minor adverse due to the short-term and infrequent nature of the survey activities, and the localized areal extent of the impacts.

4.3.3 Effects on Fish

Under the Preferred Alternative, the SWFSC would conduct a new longline survey in the ETPRA and implement new mitigation measures to reduce potential effects on protected species in addition to the research activities and mitigation measures included in the Status Quo program. The effects of the Preferred Alternative on fish would be similar to those described for the Status Quo Alternative in the CCRA and ARA, Section 4.2.3. The proposed longline survey in the ETPRA would be used by the SWFSC to monitor the abundance and distribution of HMS in the ETPRA. Given the small amount of effort during the new longline survey (60 sets) over a very large area, the resulting fish mortality would likely be very small and not result in any measurable changes to fish populations. The effects of the new longline survey would be both localized at a small number of sample sites and temporary in any one location (2-4 hr soak times); the effects to fish in the ETPRA would be minor adverse.

4.3.4 Effects on Marine Mammals

The direct and indirect effects of the Preferred Alternative on marine mammals are very similar to those described for the Status Quo (Section 4.2.4). The differences involve:

- The development of new equipment, techniques, and analyses that may become additional mitigation measures if development efforts are successful
- The implementation of a new training program regarding appropriate responses to protected species interactions, and

- The addition of a longline survey in the ETPRA

The following analysis draws heavily on the analysis provided under the Status Quo Alternative (Section 4.2.4) but focuses on the difference that may result from the new research elements and mitigation measures added under the Preferred Alternative.

The Preferred Alternative is the SWFSC research program and suite of mitigation measures that are being proposed in the MMPA LOA application (Appendix C). The analysis of effects in the LOA application was based primarily on the history of past environmental effects under the status quo conditions, which cover the years 2008-2012. However, especially with regard to mitigation measures for marine mammal interactions, the status quo reflects a dynamic situation in that the SWFSC is continually monitoring their effects and exploring ways to effectively reduce and document those adverse interactions while fulfilling their mission to collect scientific information for fisheries and natural resource management. The Status Quo Alternative therefore reflects the mitigation equipment and procedures as they were implemented at the end of 2012 while the Preferred Alternative includes several ongoing efforts to develop new mitigation measures.

The potential effects of the Preferred Alternative on marine mammals involve adverse interactions with research vessels, survey gear, sonar and other active acoustic devices, and other associated equipment, including:

- Disturbance and behavioral responses due to acoustic equipment
- Injury or mortality due to ship strikes and entanglement in gear
- Changes in food availability due to research survey removal of prey and discards
- Contamination from discharges

These mechanisms of potential effects are discussed in the Status Quo Alternative (Section 4.2.4), most of which will not be repeated here. The mechanism in the first bullet, acoustic disturbance, would be the same for the Preferred Alternative as it is for the Status Quo Alternative because there are no new acoustic sound sources that would be introduced (the new longline survey in the ETPRA would be conducted in conjunction with existing cruises that already use acoustic equipment), and no new mitigation measures are being proposed that would address potential effects due to acoustic disturbance. Although every species of marine mammal in the three research areas may be exposed to sounds from active acoustic equipment used in SWFSC research, many of the acoustic sources are likely not audible to many species and the others would likely cause temporary and minor changes in behavior for nearby animals as the ships pass through any given area. The overall effects from acoustic disturbance are considered minor adverse for all species and in all three research areas. The potential effects from changes in food availability and contamination were also considered to be minor adverse for all species of marine mammals in all three research areas in which the SWFSC operates and will not be discussed further. The following discussion will therefore focus on the potential effects from entanglement or incidental capture in fishing gear used in SWFSC research, especially with regard to incremental changes between the Status Quo Alternative and the Preferred Alternative.

4.3.4.1 California Current Research Area

ESA-listed Species

The endangered marine mammals that occur in the CCRA include blue, fin, sei, humpback, and sperm whales and the Southern resident DPS of killer whales. Threatened species include Guadalupe fur seals and the Eastern DPS of Steller sea lions. All of these species are under the jurisdiction of NMFS in regard to compliance with the MMPA and ESA. In addition, the Southern subspecies of sea otters are listed as threatened under the ESA and are under the jurisdiction of USFWS.

There have been no entanglements or takes of ESA-listed marine mammals in SWFSC fisheries research from NOAA vessels or NOAA chartered vessels (Table 4.2-5) and the LOA application does not include any estimated takes of these species. Given the relatively small amount of SWFSC research using trawl gear, the mitigation measures in place, and the lack of historical takes, the SWFSC does not expect to have any adverse interactions with ESA-listed cetaceans during research surveys in the CCRA under the Preferred Alternative.

The LOA application does not include any projected takes of ESA-listed Guadalupe fur seals and southern sea otters based on a lack of historical takes and other characteristics of these species that are not similar to species that have a history of takes (Appendix C). Based on that analysis, the potential risk of injury or mortality to these ESA-listed species is considered minor adverse.

However, based on historical takes of a similar species (California sea lion) under the status quo conditions, the SWFSC estimates that Steller sea lions from the threatened Eastern DPS could have adverse interactions with both trawl gear and longline gear in the future. The LOA application estimates an average take of 1.8 Steller sea lions per year in trawl gear (nine total for the five-year LOA period) and an average take of 0.2 Steller sea lions in longline gear (one total for the five-year LOA period).

For several reasons, the SWFSC does not think this many Steller sea lions will actually be taken in the next five years. First, the estimated take is based on one incident of an unusually high number of takes (nine) of a similar species in one trawl set (all other records of takes involved only one sea lion). Second, the nine California sea lions were caught in 2008, before several new mitigation measures were implemented, including installation of MMEDs on all Nordic 264 trawl nets. One California sea lion has since been taken in a Nordic 264 using the current status quo mitigation equipment and procedures. The risk of take has not been eliminated but the SWFSC considers the estimated takes of Steller sea lions to be very conservative, especially since Steller sea lions have never been taken in the past and they are much less common than California sea lions off the California coast, where most SWFSC research effort occurs.

In addition to the mitigation measures that have been implemented in recent years under the Status Quo Alternative, the Preferred Alternative includes several new measures that may further reduce the risk of future marine mammal takes, including those of Steller sea lions. First, the SWFSC will continue to design and develop MMEDs for use on Modified Cobb trawl gear. Most takes of California sea lions have occurred in surveys using Nordic 264 trawl gear, which already have been outfitted with MMEDs, but there are two historical records of sea lions being caught during the Juvenile Rockfish Survey in Modified Cobb trawl gear. One incident (in 2009) involved a single sea lion that was released alive and apparently uninjured. The other incident occurred in 2008 and involved three sea lions caught in one set. Two animals were released alive and apparently uninjured but one animal was killed. It is not clear how effective any new excluder devices may be in reducing potential mortalities but the SWFSC is committed to pursuing further development and testing of such devices on the premise that they have a reasonable chance of reducing mortalities in the future. If all development concerns can be addressed, the new excluder devices will be installed on Modified Cobb trawl gear as soon as practicable.

The second new element in the Preferred Alternative involves a retrospective analysis of factors influencing incidental take of protected species. The SWFSC will commit its scientists to provide a thorough scientific exploration of past marine mammal bycatch in its fisheries research surveys. The goal will be to better understand what factors might increase the likelihood of take and then focus future research on reducing or eliminating "high-risk" factors, if they exist, in a way that enables scientifically important surveys to continue with minimized risk to protected species.

The third new element in the Preferred Alternative that is intended to help mitigate adverse interactions with marine mammals (and other protected species) is the development of a formal information exchange

program for Chief Scientists and research crews to share their experiences with protected species encounters during research work and to improve decision-making regarding avoidance of adverse interactions. As described in Section 2.2.1, there are many situations where professional judgment is used to decide the best course of action for avoiding marine mammal interactions when research gear is in the water. The intent of this mitigation measure would be to draw on the collective experience of people who have been making those decisions, provide a forum for the exchange of information about what went right and what went wrong, and try to determine if there are any "rules-of-thumb" or key factors to consider that would help in future decisions regarding avoidance practices. The SWFSC would coordinate not only among its staff and vessel captains but also with those from other Fisheries Science Centers with similar experience.

In addition, Chief Scientists and appropriate members of SWFSC research crews would participate in the Protected Species training program offered by the regional commercial fisheries Observer Program. The Observer Program provides this training for NMFS-certified observers placed on board commercial fishing vessels and the SWFSC research crews will be trained using the same monitoring, data collection, and reporting protocols. All SWFSC research crew members that may be assigned to monitor for the presence of marine mammals during future surveys will be required to attend an initial training course and refresher courses annually or as necessary. The existing Observer Program training includes topics such as crew responsibilities, monitoring and sighting protocols, species identification, decision-making factors for avoiding take, procedures for handling and documenting protected species caught in fishing gear, and reporting requirements. The implementation of this training program would formalize and standardize the information provided to all crew that might experience protected species interactions during research activities. Although the potential effectiveness of this measure to reduce future takes of protected species cannot be quantified at this time, the SWFSC will implement this training program on the assumption it will provide tangible conservation benefits.

Given the mitigation measures already implemented under the status quo and the additional measures described above, the SWFSC expects that the risk of taking Steller sea lions in the future will be less under the Preferred Alternative than it is under the Status Quo Alternative. However, the LOA application (Appendix C) takes a conservative approach and estimates the potential average take of two Steller sea lions per year in trawl and longline gear combined. The LOA application and this EA must therefore use this estimated level of take in the analysis of effects.

The Eastern Steller sea lion population has been growing by over 3 percent per year for almost 30 years and NMFS has recently proposed to delist this DPS (77 FR 23209). The most recent minimum population estimate is about 53,000 animals with a Potential Biological Removal (PBR) of 2,378 (Allen and Angliss 2011). Two lethal takes of Steller sea lions per year due to SWFSC research, if they occurred, would be much less than 10 percent of PBR (238 animals) and would be considered minor in magnitude according to the impact criteria in Table 4.1-1. Given the fact that this species has never been caught during past SWFSC research activities, it is unlikely that this level of take would actually occur in the future and it would be a rare event. The overall impact of this level of incidental mortality, if it occurred, would be considered minor adverse under the criteria described in Table 4.1-1.

Other Cetaceans

No baleen whales have had adverse interactions with SWFSC research activities in the past, and none are anticipated to be taken in SWFSC research activities under the Preferred Alternative in the next five years. For all but one species of odontocetes (see bottlenose dolphin below) that are considered to have a reasonable risk of adverse interactions with research gear (i.e., those that have requested takes in the LOA application), the estimated average annual take in the next five years is less than 10 percent of PBR (Table 4.2-10) and this level of mortality, if it occurred, would be considered minor in magnitude. These potential mortalities would be rare or infrequent events and most would be unlikely to actually occur in the next five years. Any actual take would occur in a localized area but cetaceans generally travel through

large geographic areas so the potential loss of an animal would affect more than a localized population. The overall impact of the potential takes of these species, if they occurred, would be considered minor adverse according to the criteria described in Table 4.1-1.

Bottlenose dolphin

The estimated potential take of bottlenose dolphins is divided between two stocks for trawl gear based on the relative frequency of trawl sets in nearshore waters and sets made further offshore. The coastal stock of bottlenose dolphin (PBR = 2.4) is generally only found within 1 km of shore (Carretta et al. 2011). The CA/OR/WA offshore stock is larger and has a PBR of 5.5. The LOA application estimates that less than two bottlenose dolphins from the CA/OR/WA offshore stock could be taken each year in trawl gear (1.6 average, 8 takes per five-year period). In addition, less than one bottlenose dolphin from the coastal stock could be taken each year in trawl gear (0.6 average, 3 takes per five-year period). Takes of real animals occur to whole animals, of course, not fractions of animals. However, for the purpose of determining the potential magnitude of effect in this NEPA analysis, we compare the average annual take estimates to PBR, which is also an annual metric. For both of these stocks, this level of take in trawl gear, if it occurred, would be greater than 10 percent and less than 50 percent of PBR and would be considered moderate in magnitude according to the criteria described in Table 4.1-1. The LOA application also estimates that one bottlenose dolphin from either stock could be taken in longline gear in a five-year period (0.2 per year). The LOA application does not specify from which stock the estimated take on longline gear would occur. If this potential take occurred to an animal from the smaller coastal stock, the combined take of this stock from both trawl and longline gear would be 0.8 per year, which would still be greater than 10 percent and less than 50 percent of PBR for the stock and would be considered moderate in magnitude. If the potential longline take occurred to an animal from the CA/OR/WA offshore stock, the combined take of this stock from both trawl and longline gear would be 1.8 per year, which would also be greater than 10 percent and less than 50 percent of PBR for the stock and would be considered moderate in magnitude according to the criteria described in Table 4.1-1.

These estimated takes are based on similarities with Pacific white-sided dolphins, specifically one interaction in 2008 that involved the entanglement of 11 Pacific white-sided dolphins in a Nordic 264 trawl (Table 4.2-7). Since that time, additional mitigation measures have been implemented, including incorporation of a MMED in the Nordic 264, and the risk of taking this species in numbers should be reduced. The estimated take on longline gear is based on infrequent takes of dolphins in commercial fisheries; none have been taken during SWFSC research. Given the implementation of mitigation measures, and the fact that the SWFSC has never taken bottlenose dolphins in the past, the SWFSC considers the risk of taking bottlenose dolphins to be very low (i.e., a rare event unlikely to occur in the next five years), although there is a chance that more than one animal could be taken in any one interaction. Given the frequency and likelihood components of the NEPA analysis, the overall impact of the Preferred Alternative on bottlenose dolphins would be considered minor adverse according to the criteria described in Table 4.1-1.

<u>Pinnipeds</u>

There are four species of non ESA-listed pinnipeds commonly found in the CCRA that may interact with SWFSC research: California sea lion, Northern fur seal (two stocks), harbor seal (several stocks), and Northern elephant seal (Table 4.2-9).

The analysis of historical takes and estimated takes for pinnipeds in the LOA application is the same as presented in the Status Quo Alternative (Section 4.2.4). As described for cetaceans, the SWFSC expects each of the new research and training programs included in the Preferred Alternative (described above for Steller sea lions) to further reduce the risk of adverse pinniped interactions with research activities but the EA bases the analysis of effects on the estimated takes of these species in the LOA application (Appendix C).

Based on historical takes during SWFSC research surveys, the LOA application estimates an average total take of five California sea lions per year (20 in trawl gear and five in longline gear over the five-year period) under the Preferred Alternative. If this level of mortality or serious injury occurred it would be much less than 10 percent of PBR (8,511) and would therefore be considered minor in magnitude. Given the implementation of new mitigation measures, including a MMED for the Nordic 264 trawl, future mortalities of California sea lions would be considered rare or infrequent events and would be unlikely to actually occur at this estimated rate in the next five years. Any actual take would occur in a localized area, but these animals travel over large geographic areas so the potential loss of an animal would affect more than a localized population. The overall impact of potential takes of this species in SWFSC research gear, if they occurred, would be considered minor adverse according to the criteria described in Table 4.1-1.

The LOA application estimates an average of one Northern fur seal take per year (five takes in a five-year period) based on historical records of SWFSC takes during past research activities. This level of mortality would be much less than 10 percent of PBR even if all of them came from the smaller San Miguel Island stock (PBR = 324) and would therefore be considered minor in magnitude. Given the implementation of new mitigation measures, including a MMED for the Nordic 264 trawl, future mortalities of fur seals would be considered rare or infrequent events and would be unlikely to actually occur at this estimated rate in the next five years. Given the historical record and geographic overlap with the majority of SWFSC research activities, most of these potential takes would likely involve the more geographically restricted San Miguel Island stock. The overall impact of potential takes of this species in SWFSC research trawl gear, if they occurred, would be considered minor adverse according to the criteria described in Table 4.1-1.

There have been no historical takes of either harbor seals or Northern elephant seals in SWFSC research. The LOA application estimates the potential number of harbor seal takes based on their similarity in distribution and behavior to California sea lions. For Northern elephant seals, the estimated takes are based on historical takes in commercial fisheries operating in similar areas and using similar gear types. The estimated take of harbor seals is 1.8 animals per year in trawl gear (nine animals in the five-year LOA period) compared to a PBR of 1,600. The estimated take of Northern elephant seals is one animal per year in trawl gear compared to a PBR of 4,382. For both of these species, the estimated annual take, if it occurred, would be much less than 10 percent of PBR and would therefore be considered minor in magnitude. Considering the fact that neither of these species has been taken in research trawls in the past, these potential mortalities would be considered rare events and would be unlikely to actually occur in the next five years. The overall impact of potential takes of these species in SWFSC research trawl gear, if they occurred, would be considered minor adverse according to the criteria described in Table 4.1-1.

Sea Otters

There are two subspecies of Northern sea otter in the CCRA. The Southern subspecies is discussed in the ESA-listed species section above. The Washington subspecies is discussed in this section. This population inhabits nearshore waters along the coast of Washington and Puget Sound. These areas are either not covered by SWFSC research activities (Puget Sound) or are much closer to shore than research vessels typically travel or sample. The SWFSC does not anticipate any future Level B or Level A takes of sea otters from this population based on a lack of historical takes and very little spatial overlap between sea otter habitat and SWFSC research activities under the Preferred Alternative.

4.3.4.2 Eastern Tropical Pacific Research Area

The SWFSC research activities in the ETPRA have no history of taking marine mammals under the status quo scope of research, which includes only very small nets and other oceanographic instruments that have essentially no risk of taking marine mammals. However, the Preferred Alternative would add a new pelagic longline component to sample highly migratory fish (e.g., tuna and swordfish). Because there has been no history of SWFSC marine mammal takes in the ETPRA, the LOA application used data from

commercial longline fisheries in the ETPRA to estimate which species may be vulnerable to take in future SWFSC research using longline gear. Under the Preferred Alternative, the SWFSC would implement all of the mitigation measures designed to reduce adverse interactions with longline gear as they currently use in longline surveys in the CCRA (see Section 2.2.1). In addition, the new information exchange and training programs proposed for the Preferred Alternative would be applied to longline efforts in the ETPRA, applying lessons learned in other areas on similar surveys to reduce the risk of adverse interactions with marine mammals in the ETPRA.

ESA-listed Species

The endangered marine mammals that occur in the ETPRA include blue, fin, sei, humpback, and sperm whales (Table 3.2-4). The only threatened species in the ETPRA is the Guadalupe fur seal. Given the rarity of these species in the research area, the small number of research longline sets that will be made under the Preferred Alternative, and the mitigation measures that will be implemented, the SWFSC does not anticipate any takes of ESA-listed species in the ETPRA and the LOA application (Appendix C) does not include estimates takes for any of these species under the Preferred Alternative.

Other Cetaceans

In addition to the ESA-listed species, there are two other species of baleen whales and at least 23 other odontocetes in the ETPRA. Table 4.3-2 shows the estimated number of cetaceans that may be taken in the ETPRA under the Preferred Alternative based on historical takes in analogous commercial fisheries. Considering the small number of longline sets that are being proposed in the area and the mitigation measures included in the Preferred Alternative, the risk of taking any marine mammals is considered very small and the LOA application includes only one take per five-year period (average of 0.2 takes per year) for those species that are considered susceptible to entanglement in longline gear. The PBR metric is not required to be calculated for species outside the U.S. EEZ but the SWFSC calculated PBR for these species for the purposes of this analysis using accepted calculations for minimum population estimates (Nmin) and PBR (NMFS 2005). For all of these cetacean species, , the loss of one animal per five-year period would be much less than 10 percent of PBR (Table 4.3-2) and this level of mortality, if it occurred, would be considered minor in magnitude. Given the relatively small number of research longline sets proposed under the Preferred Alternative and the mitigation measures described in Section 2.2, the SWFSC considers the risk of taking these cetacean species to be very low (i.e., a rare event unlikely to occur in the next five years). The overall impact of these potential takes on these species, if they occurred, would be considered minor adverse according to the criteria described in Table 4.1-1.

Table 4.3-2 Potential takes of non-ESA-listed marine mammals in the ETPRA.

This table shows the potential number of non ESA-listed marine mammals that could be taken by M&SI and Level A harassment in the ETPRA over the next five years (2013-2018) using longline gear. There have been no historical takes from SWFSC research in the ETPRA. The SWFSC has calculated PBR for these species for the purposes of this analysis using accepted calculations for minimum population estimates (Nmin) and PBR (NMFS 2005).

Species	Population Estimates (from ETPRA surveys in 2006[1] unless noted)	PBR (animals per year)	Potential M&SI and Level A Take in Longline Gear Average per year (total for five year period)
Risso's dolphin	110,457	831	**0.2** (1)
Short-beaked common dolphin	3,127,203	25,133	**0.2** (1)
Long-beaked common dolphin	55,000 (off Mexico, NA for other areas)	2,787	**0.2** (1)
Striped dolphin	964,362	8,116	**0.2** (1)
Pantropical spotted dolphin	>1.7 million (all stocks)	14,558	**0.2** (1)
Bottlenose dolphin	335,834	2,850	**0.2** (1)
False killer whale	39,800 [2]	244	**0.2** (1)
Short-finned pilot whale	589,315 [3]	4,751	**0.2** (1)
Dwarf sperm whale	11,200 [2]	88	**0.2** (1)
California sea lion	105,000	1,050	**1** (5)
South American sea lion	150,000	1,500	**1** (5)
Unidentified pinniped species			**0.2** (1)

[1] data from 2006 (Gerrodette et al. 2008)
[2] data from 1986 to 1990 (Wade and Gerrodette 1993)
[3] data from 2000 (Gerrodette and Forcada 2002)

Pinnipeds

In addition to the ESA-listed Guadalupe fur seal, there are three other species of pinnipeds in the ETPRA: California sea lion, South American sea lion, and Northern elephant seal. (Table 4.3-2) shows the estimated number of pinnipeds that may be taken in the ETPRA under the Preferred Alternative based on takes in analogous commercial fisheries. Considering the small number of longline sets that are being proposed in the area and the mitigation measures included in the Preferred Alternative, the risk of taking pinnipeds on longline gear is considered very small and the LOA application includes only one take per year (five takes per five-year period) for each of the two sea lion species plus one take per five-year period for "undetermined pinniped species" (average 0.2 animals per year). The request for undetermined species takes is made to account for animals that may be caught or entangled in gear but free themselves or are released before they can be identified or photographed by research personnel. Adding one take per five-year period to each sea lion species to account for these undetermined takes, the total estimated average annual take for each species would be much less than 10 percent of PBR (Table 4.3-2) and this

level of mortality, if it occurred, would be considered minor in magnitude. The SWFSC considers the risk of taking these species to be very low (i.e., a rare event unlikely to occur in the next five years). The overall impact of these potential takes on these species, if they occurred, would be considered minor adverse according to the criteria described in Table 4.1-1.

4.3.4.3 Antarctic Research Area

The Preferred Alternative includes the same scope of research and mitigation measures in the ARA as described for the Status Quo (Section 4.2.4.3), with the addition of the new information exchange and training programs for minimizing adverse interactions with marine mammals. The direct and indirect effects on marine mammals would therefore be very similar to those described for the Status Quo Alternative, which were minor adverse for all species.

4.3.5 Effects on Birds

The effects of the Preferred Alternative on birds are very similar to those described for the Status Quo (Section 4.2.5), especially for the CCRA and ARA. The only difference concerns the addition of a longline survey in the ETP. The Preferred Alternative also includes a number of mitigation measures and research projects intended to help reduce adverse interactions with marine mammals and other protected species. Although these measures would likely raise awareness about potential interactions with ESA-listed seabird species, they are unlikely to change the actual effects of SWFSC research activities on seabirds, which are minor.

In the ETP, the addition of a longline survey adds to the risk of incidentally capturing seabirds, especially species accustomed to following fishing boats such as albatross and gulls. However, given the relatively small amount of effort (60 sets per year) and standard best practices of sinking baited hooks as fast as possible, the risk of seabird mortality in this new survey is considered very small. If mortalities do occur, they would likely be rare occurrences and unlikely to have any measurable effect on the populations of seabirds in the ETP.

The overall effects of SWFSC research activities on birds under the Preferred Alternative are considered minor adverse according to the criteria in Table 4.1-1. This conclusion holds for each of the three SWFSC research areas and for all gear types used in research.

4.3.6 Effects on Sea Turtles

The effects of the Preferred Alternative (Alternative 2) on sea turtles would be similar in nature and magnitude to those of the Status Quo Alternative (Alternative 1- see Section 4.2.6). Direct and indirect effects of SWFSC research activities on sea turtles may include: disturbances or changes in sea turtle behavior due to physical movements and sounds, injury or mortality due to ship strikes, gear interaction, and contamination or degradation of sea turtle habitat. These mechanisms are described in Section 4.2.6.

Mitigation measures for protected species required under Alternative 2, such as the use of MMEDs for Modified Cobb trawl gear and retrospective analysis of factors influencing incidental take of protected species, could potentially decrease the likelihood of adverse impacts to sea turtles. Although no adverse interactions have occurred in the past between sea turtles and SWFSC surveys using Modified Cobb trawl gear, MMEDs required as a mitigation measure under Alternative 2 are also likely to be effective for excluding turtles from mid-water trawl equipment. Likewise, retrospective analysis of factors influencing incidental take of protected species would theoretically reduce the potential for adverse interactions between sea turtles and trawl gear. In addition, the implementation of procedures for handling of incidentally captured protected species could decrease the potential for adverse impacts to sea turtles. However, considering that there have been no reported instances of SWFSC survey activities resulting in sea turtle mortality, the mitigation measures described under Alternative 2 would not result in substantial changes to the overall level of impact on sea turtles.

The addition of a new survey in the ETPRA to monitor the abundance and distribution of HMS would involve deployment of pelagic longline gear, bongo plankton nets, CTD sensors, and water sampling equipment, as well as collection of additional acoustic data. This survey would involve approximately 60 longline sets annually in the ETPRA with a soak time of approx. 2-4 hours per set, and would pose a small additional risk of adverse effects to turtles. However, there have been no reported adverse interactions between sea turtles and SWFSC longline survey activities, due in part to the fishing depth at which SWFSC research longline sets are deployed and where the survey activities are conducted. Sets targeting HMS would be deployed at depths greater than 50 ft. The use of circle hooks and finfish bait (instead of squid) would be standard operating procedures for SWFSC longline surveys, and would minimize the risk of sea turtle bycatch or entanglement.

The additional longline survey activity described under Alternative 2 would result in negligible impacts to sea turtles in addition to those described under Alternative 1. Therefore, the overall effects of Alternative 2 on sea turtles would be substantially the same as those resulting from Alternative 1; minor adverse effects are expected to occur using the gear types and mitigation measures described under Alternative 2; these effects would be isolated and infrequent, and would not impact sea turtles at the population level in any of the SWFSC research areas.

4.3.7 Effects on Invertebrates

The effects of the Preferred Alternative (Alternative 2) on invertebrates would be substantially similar to those of the Status Quo Alternative (see Section 4.2.7). Mitigation measures for protected species required under Alternative 2, such as the use of MMEDs, video sampling with an open codend, and retrospective analysis of factors influencing incidental take of protected species, would not measurably influence the effects of the research activities on invertebrates. Likewise, the implementation of procedures for handling of incidentally captured marine mammals would not influence the impacts of the activities on invertebrates. The addition of a new survey in the ETPRA to monitor the abundance and distribution of HMS would involve deployment of pelagic longline gear, bongo plankton nets, CTD sensors, and water sampling equipment, as well as collection of additional acoustic data. This survey activity would result in negligible effects on invertebrates in addition to the effects described under Alternative 1. Therefore, the overall effects of Alternative 2 on invertebrates would be substantially the same as those resulting from Alternative 1; the effects would be minor adverse in the ARA, CCRA and ETPRA.

4.3.8 Effects on the Social and Economic Environment

The effects of the Alternative 2, the Preferred Alternative, on social and economic conditions of the study area are very similar to that of Alternative 1 (see Section 4.2.8). The addition of a survey in the ETPRA would not be expected to measurably increase effects above the status quo for social and economic conditions. The overall direct and indirect effects of Alternative 2 would be beneficial and minor for the ETPRA and ARA, and remain moderate for the CCRA.

4.4 DIRECT AND INDIRECT EFFECTS OF ALTERNATIVE 3 – MODIFIED RESEARCH ALTERNATIVE.

This section presents an analysis of the potential direct and indirect effects of Alternative 3 – Additional Mitigation Alternative on the physical, biological, and social environment. Under this Alternative, the SWFSC would conduct a new suite of research activities and implement new mitigation measures in addition to the Status Quo program. The new suite of research activities is a combination of past research and additional, new research, as described for the Preferred Alternative. Potential direct and indirect effects were evaluated according to the criteria described in Table 4.1-1. A summary of the impact rating determinations for all topics evaluated under Alternative 3 is presented below in Table 4.4-1.

Table 4.4-1 Alternative 3 Summary of Effects

All conclusions refer to adverse effects unless noted.

RESOURCE	Physical Environment	Special Resource Areas	Fish	Marine Mammals	Birds	Sea Turtles	Invertebrates	Social & Economic
SECTION NUMBER	***4.4.1***	***4.4.2***	***4.4.3***	***4.4.4***	***4.4.5***	***4.4.6***	***4.4.7***	***4.4.8***
Research Area								
California Current	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Moderate-*beneficial*
Eastern Tropical Pacific	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor
Antarctic	Minor	Minor	Minor	Minor	Minor	N/A	Minor	Minor

4.4.1 Effects on the Physical Environment

The continuation of federal fisheries research with scope and protocols modified to minimize risks to protected species (Alternative 3) would result in effects on the physical environment substantially similar to those of the Status Quo Alternative (see Section 4.2.1). Additional mitigation measures for protected species required under Alternative 3, such as the use of advanced monitoring methods for the detection of marine mammals, operational restrictions, and acoustic and visual deterrents for protected species would not measurably influence the effects of the research activities on physical properties of the environment. Temporal or geographic restrictions on SWFSC research activities intended to reduce adverse impacts to protected species (i.e., time /area restrictions) proposed as mitigation measures under Alternative 3 could potentially alter the spatiotemporal distribution of impacts to the physical environment; however, overall impacts to the physical environment would remain substantially similar to those described under Alternative 1. Likewise, avoidance of federal and state MPAs, proposed as a mitigation measure under Alternative 3, could potentially alter the spatiotemporal distribution of impacts to the physical environment, but would not result in substantial changes to the overall level of impacts to the physical environment compared to Alternative 1. Therefore, the overall adverse effects of Alternative 3 on the physical environment would be substantially similar to those described for Alternative 1; due to their minor intensity and limited areal extent, the overall impacts to the physical environment would be minor adverse in each of the SWFSC research areas.

Refer to Appendix A for a detailed description of the SWFSC research vessels and survey gear.

4.4.2 Effects on Special Resource Areas

4.4.2.1 California Current Research Area

Mitigation measures required under Alternative 3 include the avoidance of federal and state Marine Protected Areas (MPAs). This measure could disallow or restrict SWFSC trawl surveys in federal and/or state MPAs. An MPA is defined by EO 13158 as “any area of the marine environment that has been reserved by federal, state, tribal, territorial, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein.” In accordance with this definition, MPAs encompass a large fraction of the area where research surveys are conducted. They include: California’s State Marine Reserves (SMR), State Marine Parks (SMP), State Marine Conservation Areas (SMCA),

and State Marine Recreational Management Areas (SMRMAs); Oregon's MPA's; Washington's MPA's; Wildlife Refuges; National Parks; and National Marine Sanctuaries, as well as Marine World Heritage Sites and Marine Management Areas established outside of the U.S. EEZ, can be found on the List of National System MPAs (NOAA 2012). This list also includes Habitat Closed Areas and Closed Areas. Prohibition or restriction of SWFSC trawl surveys in MPAs would decrease the potential for direct adverse impacts to special resource areas within the CCRA relative to Alternative 1; however countervailing indirect effects resulting from this mitigation measure would potentially include major adverse impacts resulting from a lack of the data needed to support science-based management of MPAs.

Additional mitigation measures described under Alternative 3 include the use of advanced monitoring methods for the detection of marine mammals, operational restrictions, acoustic and visual deterrents for protected species, and time/area closures for research activities. These mitigation measures would potentially alter the spatiotemporal distribution of impacts to special resource areas within the CCRA and would affect the magnitude, extent, frequency, and likelihood of impacts to biological resources within special resource areas. Direct effects of SWFSC research activities on biological resources within special-fishery related areas are most accurately captured in the assessments of species groups, which are evaluated in Sections 4.4.3-4.4.7.

The direct effects of Alternative 3 on special resource areas in the CCRA would be minor in magnitude, localized in geographic extent, and short-term in duration and frequency. However, indirect effects resulting from mitigation measures prohibiting research in protected areas included under Alternative 3 would include impacts resulting from a lack of the data needed to support science-based management of MPAs. MPAs are, by definition, managed more carefully than other special resource areas; MPAs depend more heavily on the data collected during SWFSC surveys to sustain the habitats and resources that they are designed to protect through the implementation of sound science-based management practices. Overall effects of Alternative 3 on special resource areas in the CCRA are considered moderate and adverse.

4.4.2.2 Eastern Tropical Pacific Research Area

Special resource areas within the ETPRA include reserves, marine parks, and World Heritage Sites established outside of the U.S. EEZ by international agencies and foreign governments (see Section 3.1.2.4 and Table 3.1-1). These areas meet the operational definition of MPAs, as defined by EO 13158. Thus, mitigation measures required under Alternative 3 could disallow or restrict SWFSC trawl surveys in these areas. Prohibition or restriction of SWFSC trawl surveys in MPAs would decrease the potential for direct adverse effects to special resource areas within the ETPRA relative to Alternative 1.

Additional mitigation measures described under Alternative 3 include the use of advanced monitoring methods for the detection of marine mammals, operational restrictions, acoustic and visual deterrents for protected species, and time/area closures for research activities. These mitigation measures would potentially alter the spatiotemporal distribution of impacts to special resource areas within the ETPRA, and would affect the magnitude, extent, frequency, and likelihood of impacts to biological resources within special resource areas. Direct effects of SWFSC research activities on biological resources within special-fishery related areas are most accurately captured in the assessments of species groups, which are evaluated in Sections 4.4.3-4.4.7.

Overall, the direct effects of Alternative 3 on special resource areas in the ETPRA would be minor in magnitude, localized geographic extent, and short-term in duration and frequency. However, indirect effects resulting from mitigation measures prohibiting research in protected areas included under Alternative 3 would include impacts resulting from a lack of the data needed to support science-based management of MPAs. MPAs are, by definition, managed more carefully than other special resource areas; MPAs depend more heavily on the data collected during SWFSC surveys to sustain the habitats and resources that they are designed to protect through the implementation of sound science-based

management practices. Overall effects of Alternative 3 on special resource areas in the ETPRA are considered moderate and adverse.

4.4.2.3 Antarctic Research Area

Mitigation measures required under Alternative 3 include the avoidance of federal and state MPAs. In the ARA, specific mechanisms exist under the Antarctic Treaty System and CCAMLR for protection of sensitive marine areas. The entire Antarctic region is protected to some degree by the Antarctic Treaty System and CCAMLR; all marine areas south of the 60°S parallel fulfill the operational definition of MPAs. Therefore, under Alternative 3, SWFSC trawl surveys could be disallowed or restricted in the ARA. Such a restriction would eliminate minor impacts to special resource areas resulting from Antarctic trawl surveys, but would also preclude the collection of the only datasets available for quantification of temporal changes in the abundance and distribution of demersal finfish and benthic invertebrate megafauna in the Southern Scotia Arc (Subarea 48.1 & 48.2). Mitigation measures described under Alternative 3 could result in indirect effects to Antarctic special resource areas due to a lack of the scientific information needed to inform Antarctic conservation measures which are implemented to protect and conserve biological resources within special resource areas. In addition, mitigation measures described under Alternative 3 would preclude fulfillment of U.S. commitments to CCAMLR and obligations under the Antarctic Treaty. Overall effects of Alternative 3 on special resource areas in the ARA are considered moderate and adverse.

4.4.3 Effects on Fish

Under the Modified Research Alternative, the SWFSC would implement additional mitigation measures while conducting the same scope of research as described under the Preferred Alternative. Some of the additional mitigation measures for protected species that would be considered could reduce the overall research fishing effort (e.g., time/area restrictions). Such measures could restrict the ability of the SWFSC to sample at the times and places as laid out in their research plan, so fish catches and activity levels could be reduced or research vessels could extend their time at sea, in order to reach their research goals.

Temporal or geographic restrictions on SWFSC research activities intended to reduce adverse impacts to protected species could potentially alter the spatial/temporal distribution of impacts to fish; however, overall impacts to fish would remain substantially similar to those described under the Status Quo Alternative. Likewise, avoidance of federal and state MPAs, proposed as a mitigation measure under Alternative 3, could potentially alter the spatial-temporal distribution of impacts to fish, but would not result in substantial changes to the overall level of impacts as compared to the Status Quo Alternative. Therefore, the overall effects of Alternative 3 on fish would be substantially similar to those described for the Status Quo Alternative; the effects would be minor adverse in the CCRA, ETPRA, and ARA.

4.4.4 Effects on Marine Mammals

The Modified Research Alternative includes the same scope of research in all three of the SWFSC research areas (CCRA, ETPRA, and ARA) as the Preferred Alternative, including the same mitigation measures currently implemented or to be implemented, and intended to reduce potentially adverse interactions with marine mammals and other protected species. The Modified Research Alternative differs from the Preferred Alternative in that it also includes a suite of mitigation measures that the SWFSC is not proposing to implement as part of the proposed action in the SWFSC LOA application (Appendix C). The SWFSC considers the suite of mitigation measures to be implemented under the Preferred Alternative to represent the optimal mix of efficacy and practicability to reduce the risk of adverse interactions with protected species during the conduct of its research program. However, NMFS' Office of Protected Resources (OPR) must consider a broad range of mitigation measures under the MMPA authorization and ESA consultation processes, and these additional measures will be considered in this alternative. These

additional mitigation measures focus on reducing the likelihood of injury, serious injury, and mortality from interaction with fisheries research gear and are described in Section 2.4 of this EA. They involve:

- The use of additional personnel and equipment/technologies to improve detection of marine mammals, especially at night or other low-visibility conditions.
- Operational restrictions on survey activities at night or other low-visibility conditions.
- The use of additional acoustic or visual deterrents to keep marine mammals away from research gear.
- The incorporation of high-resolution, high-speed video cameras into trawl nets with open cod ends.
- Temporal or geographic restrictions to avoid known concentrations of marine mammals or federal and state MPAs.
- Use of decoy vessels to distract marine mammals away from research sets.

All of the additional mitigation measures concern trawl surveys using the Nordic 264 and modified Cobb pelagic trawl gear (CCRA only) and longline surveys (CCRA and ETPRA), as these gear types have been involved with all past adverse interactions with marine mammals and are considered the highest risk for future interactions. The analysis of effects for the ARA is therefore the same as described for the Status Quo and Preferred Alternatives and will not be discussed further.

None of the additional mitigation measures directly concern the reduction of noise from acoustic devices (Level B harassment take), reducing the numbers of fish and invertebrates caught in research samples, or reducing the risk of accidental contamination from spills. The analyses of effects through these mechanisms (disturbance or changes in habitat quality) are the same as described for the Status Quo and Preferred Alternatives and will not be discussed further. The following analysis will therefore focus on the potential for the additional mitigation measures to reduce the risk of injury, serious injury, and mortality through entanglement in fishing gear or ship strikes.

The potential direct and indirect effects of this alternative on marine mammals would be the same as described for the Preferred Alternative (Section 4.2.4) except for the potential of the additional mitigation measures to reduce those effects of injury, serious injury, and mortality through entanglement in fishing gear or ship strikes. Scientists at the SWFSC continually review their procedures to see if they can do their work more efficiently and with fewer incidental effects on the marine environment, including effects on marine mammals. Many of the additional mitigation measures included in this alternative have been discussed and considered in the past by SWFSC scientists; however, any changes to operational procedures or the equipment used during surveys must also be considered from the standpoint of how they affect the integrity of the scientific data collected, the cost of implementing equipment or operational changes, and the safety of the vessel and crew. It is not possible to quantify how much any one of these measures (or some combination of them) may reduce the risk of future takes relative to the Status Quo or Preferred Alternatives. Any revisions to the estimated takes of each species to directly compare with the Status Quo or Preferred Alternatives would be based on speculation. This analysis will therefore provide a qualitative discussion of the potential for each additional mitigation measure to reduce takes and other effects on marine mammals as well as how each measure may affect practicability, data integrity, and other aspects of the survey work.

4.4.4.1 Trawl Surveys

The surveys that use the Nordic 264 pelagic trawl gear occur only in the CCRA and include the CPS Survey, Juvenile Salmon Survey, and habitat surveys for sea turtles and adult rockfish. The only survey that uses the modified Cobb trawl gear is the Juvenile Rockfish Survey in the CCRA.

Monitoring methods

Visual observations (using bridge binoculars as needed) by the officer on watch, Chief Scientist (CS) or other designated scientist, and crew standing watch are currently the primary means of detecting protected species in order to avoid potentially adverse interactions. However, there are other detection methods that have been tested or used in commercial fisheries, naval exercises, and geotechnical exploration that could be considered. These additional types of detection methods would be intended to be used in specific circumstances, such as operating at night or in low visibility conditions.

Visual surveillance by dedicated Protected Species Observers (PSO)

This measure would require the SWFSC to use trained protected species observers whose dedicated job is to detect the presence of marine mammals and other protected species within the survey area and communicate their presence to ship operations personnel. This dedicated PSO position would be in addition to having marine mammal and/or bird biologists on board whose job is to conduct abundance and distribution surveys (not all surveys include marine mammal or bird survey components). Considerations include the use of dedicated observers for all surveys or during trawl surveys of particular concern.

Under the Preferred Alternative, at least one member of the crew is assigned to be the marine mammal observer at least 30 minutes prior to the vessel arriving on station or otherwise deploying trawl gear. This crew member does not have any other duties while assigned to be the marine mammal observer. Currently, not all crew members have received formal training in marine mammal identification or marine mammal mitigation procedures, although they are briefed on what they are looking for and may have considerable experience with the task. However, the Preferred Alternative does include a new program to refine and formalize the training and decision-making process for all Chief Scientists, bridge crew, and deck crew that may be assigned to the marine mammal observer post in the future. This new program would provide the same types of training for all appropriate crew members as PSOs trained for that specific task. This training would be provided by the commercial fisheries Observer Program staff at NMFS using the same course materials and reporting forms as used to train PSOs for applicable commercial fisheries. The difficulty in having crew members assigned only to PSO duties is that most vessels have limited carrying capacity for personnel and any berths given to PSOs would mean a reduction in personnel available to help with other research or vessel duties. This could compromise crew safety or the amount of research that could be conducted. By providing formal PSO training for crew already trained in other skills, the SWFSC believes it can provide the same quality of visual monitoring for marine mammals and other protected species as would occur with dedicated PSOs while maintaining the flexibility to fulfill all other crew duties.

Use of underwater video systems to monitor trawl gear

Underwater video technology may allow the SWFSC to determine the frequency of marine mammal interactions with the trawl gear and evaluate the effectiveness of MMEDs or other efforts to mitigate entanglement interactions. Underwater video systems have been used for these purposes in several fisheries, both in the U.S. and abroad (Northridge 2003, Lyle and Wilcox 2008, Dotson et al. 2010). Northridge (2003) describes a twin camera system used to monitor the grid and escape hole of an MMED and quantify the frequency and outcome of marine mammal interactions with trawl gear. The system used LED lighting and two Simrad SIT cameras. Video images were carried by cable from the cameras to the wheelhouse for continuous display and recording (Northridge 2003). Similarly, Lyle and Wilcox (2008) used a low-light black and white digital camera with a 90-degree wide-angle lens coupled to a commercially available hard drive unit to monitor interactions involving marine mammals and other megafauna. SWFSC scientists have successfully used underwater video gear to monitor the position of an MMED and its effect on the configuration of a Nordic 264 trawl net during research activities (Dotson et al. 2010).

Underwater video equipment may provide useful information about the efficacy of additional mitigation measures but the video equipment itself is unlikely to influence bycatch rates of protected species. In order to directly reduce takes of marine mammals, a video system to detect marine mammals underwater would have to be linked to a means of avoiding entanglement in gear. However, ships with deployed trawl nets cannot "swerve" to avoid a marine mammal for two reasons: 1) all marine mammals can swim faster than the tow speed so trying to move gear away from an animal that is likely attracted to fish in the net will be ineffective, and 2) changing the vessel direction suddenly risks tangling the gear, making it difficult and dangerous to retrieve, delaying retrieval and making the risk of marine mammal entanglement worse.

An alternative strategy would be to incorporate high-resolution, high-speed video cameras into trawl nets with open cod ends for the purpose of sampling fish without capturing them. The idea is that fish entering the trawl could be identified and counted through review of the video images but they would pass through the open cod end. This technique would potentially allow any incidentally captured marine mammals or other protected species to pass through the open cod end as well. Such an approach would be appropriate for swept area surveys designed to determine the density of fish but it would not be appropriate for surveys designed to determine the reproductive condition of adult fish (e.g., CPS surveys) or the growth rates of fish (e.g., Juvenile Salmon Surveys) as these measurements require the dissection of specimens. It would also be inappropriate for surveys targeting very small fish (e.g., Juvenile Rockfish Surveys) because species identification often requires microscopic analysis. Although this technique holds promise for reducing the risk of marine mammal interactions, the SWFSC is not proposing to conduct any surveys with trawl gear under the Modified Research Alternative that would be appropriate for an open cod end.

Use of passive acoustic monitoring

Passive acoustic monitoring involves the detection of animals by listening for the sounds that they produce (Barlow and Gisiner 2006). Use of passive acoustic monitoring may aid in the detection of marine mammals present in survey areas, and could potentially be used to inform decisions about when to implement appropriate modifications of fishing operations to prevent adverse interactions with marine mammals. Marine mammal calls can be reliably detected using hydrophones mounted on ships, autonomous underwater gliders, buoys, moorings, or bottom-founded installations. However, not all marine mammals vocalize and the vocalization rates of marine mammals may vary in a complex fashion depending upon environmental factors, including long periods of silence (Barlow and Gisiner 2006). While detection of a marine mammal call indicates the presence of a marine mammal, the absence of marine mammal calls does not necessarily indicate the absence of marine mammals. In addition, if the intent is to locate marine mammals so that they can be avoided, hydrophones in multiple locations combined with real-time processing are required to allow triangulation of the acoustic signal. This may be more practicable for planning large-scale activities at a set time and place rather than directing specific locations for research sampling, which involves continuous movement of a vessel from widely spaced sampling stations. Taking the time to set up a triangulated hydrophone system in an area prior to each 20-minute trawl would greatly lengthen the time and cost of collecting a certain amount of sample data. In summary, passive acoustic monitoring may be useful for detecting underwater marine mammals that could potentially interact with research activities but it would have substantial costs in terms of the research data collected and it would not guarantee the avoidance of all adverse interactions; passive acoustics inevitably overlooks those marine mammals that are not vocalizing and marine mammals may move into an area after trawl gear is deployed and still be at risk.

Use of aircraft or unmanned aerial or underwater gliders to expand detection of marine mammals

Currently, surveys using manned aircraft are routinely conducted to obtain unbiased estimates of marine mammal populations and their distributions. Aerial surveys provide reliable information about marine mammal populations because they are able to cover large areas over relatively short periods of time. In addition, airborne survey platforms generally do not influence the distribution or behavior of the marine

mammals being counted, whereas many species of marine mammals are either attracted to or avoid seagoing vessels (Barlow and Gisiner 2006). The usefulness of manned aerial surveys for detection of marine mammals that could interact with fisheries research activities is limited by the range that the aircraft may travel from shore, flight time constraints, weather conditions, poor visibility in rough seas, logistical difficulties in matching a fast-moving airplane with a slow-moving research vessel, and considerable expense that would likely decrease the amount of ship-based research that could be conducted. Aerial surveys may be more practicable for planning large-scale activities at a set time and place rather than directing specific locations for research sampling, which involves continuous movement of a vessel from widely spaced sampling stations. Even with this capacity, the risk of marine mammal interactions would remain because any marine mammals that are not near the surface would not be detectable by airborne observers and, as with other extended detection methods, marine mammals may move into an area after trawl gear is deployed but before it is retrieved.

Unmanned aerial vehicles have the potential to overcome many of the limitations associated with manned aerial surveys for detection of marine mammals. Unmanned aerial systems range from inexpensive lightweight radio-controlled aircraft to complex autonomous aircraft developed for military applications. Unmanned aerial systems could be launched and retrieved from the research vessel, stream video data to observers onboard or at a shore station, and provide near-real-time data of marine mammals in proximity to fisheries research activities. Several systems are commercially available that have the ability to remain airborne for up to 24 hours and can be operated up to 150 kilometers (km.) from the control station. Several tests have successfully used unmanned aerial vehicles for marine mammal detection (NOAA 2006). However, these systems can only be operated in mild to moderate wind conditions, with increasing wind speeds strongly reducing their range and making recovery difficult.

Advantages associated with the use of unmanned aerial systems include ability to operate in areas far from shore, long flight times, increased safety of observers who can monitor the data from the ship or a shore based location, and decreased expense relative to surveillance conducted from manned aircraft. Unmanned aerial technologies are rapidly evolving; over the next 5 to 10 years, increased video resolution and advanced sensors are likely to increase the utility of these systems for monitoring marine mammals. However, approval from additional regulatory agencies, including the Federal Aviation Administration, would be required for operation of unmanned aerial vehicles for marine mammal monitoring or research purposes. Federal Aviation Administration approval has been very difficult to obtain, even in areas with very little air traffic, which currently limits the potential for using these systems over large areas.

Autonomous underwater gliders are highly successful platforms for the collection of oceanographic data and environmental characterization. Gliders offer an attractive platform for marine mammal detection due to their relatively low cost, low power consumption, and the ability to cover large areas of ocean during long-term deployments (Olmstead et al. 2010). Gliders have been used to locate and identify marine mammals using passive acoustic technology, and the U.S. Navy is conducting additional research and development using autonomous underwater gliders to support efforts to mitigate impacts from marine mammal interactions (Hildebrand et al. 2009). The use of underwater gliders to provide mitigation options for research activities is limited by the same issues as described above for other passive acoustic detection systems.

Use of infrared technologies

Infrared (IR) sensors may be useful for detection of marine mammals under certain circumstances. IR sensors used for marine mammal detection generally measure the spatial distribution of mid-wavelength IR radiation (3-5 µm). IR emissivity of an object in this waveband is closely correlated to the object's surface temperature, such that IR sensor arrays can detect slight variations in temperature across relatively large areas. This technology, also known as 'thermal imaging', could be useful to augment visual detection of marine mammals, particularly in conditions with low ambient light when visual detection of

marine mammals would be difficult. IR image data also lends itself to automated image processing. With additional research and development, it is possible that an automated marine mammal detector could be designed to recognize the IR 'signatures' of certain marine mammals. However, several major drawbacks currently preclude such use of IR detection for automated marine mammal detection.

First, because emitted IR radiation is absorbed in the first few millimeters of water surrounding an object, IR technology is only able to detect animals at the surface, and only those parts that are above the surface of the water. Since water is virtually opaque to IR radiation, IR detection of marine mammals is also complicated by the thin film of water that covers the dorsal surfaces of marine mammals at the sea surface. The temperature measured by an IR sensor is the temperature of the water on the surface of the animal, which may only be a couple degrees above the surface water temperature (Cuyler et al. 1992, Kasting et al. 1989). Under ideal conditions (flat calm seas and close proximity to the IR detector), this slight temperature difference can be detected. However, waves cause the measured temperature of the sea surface to be much more variable and the thermal signature of the animal can easily be masked (Graber et al. 2011).

Second, the likelihood of detecting a temperature signature from a marine mammal falls off quickly with distance from the detector. In tests under ideal conditions, the ability of an IR system to detect killer whales, which present a large portion of their body and a tall dorsal fin above the surface of the water, was very poor beyond 100 meters (Graber et al. 2011). The ability of an IR system to detect much smaller targets like dolphins and porpoises would presumably be much less than it is for killer whales. Finally, considerable effort and time is required to process the video data so that the thermal signatures of animals can be distinguished from the surrounding water. This greatly reduces the effectiveness of the technique for real-time monitoring tied to potential mitigation. In summary, the logistical difficulties of using IR detectors in a real-life context on a research vessel would be overwhelming and currently preclude this potential tool as a practical element of mitigation.

Use of night vision devices

Like IR imaging devices, night vision devices may be used for detecting marine mammals at or above the water surface in low-light conditions. Unlike IR sensors, night vision devices operate by amplifying the signal produced when visible light interacts with a detector. Although night vision devices could potentially improve an observer's ability to detect a marine mammal under low light conditions, previous studies have shown that the effective range of detection for marine mammals using night vision devices is only about 100m (Calambokidis and Chandler 2000, Barlow and Gisner 2007). These devices work best when there is a little light on the water (from the moon or nearby land sources) but they must be directed away from deck lights because they are too bright. This means they could not be used to monitor trawl gear as it is being deployed or retrieved because of the deck lights used for crew safety. They also have a very narrow field of view, making broad area searches inefficient and unreliable, and if sea conditions are rough the many reflections off waves make it very difficult to distinguish objects in the water. Some observers found the devices disorienting and uncomfortable and all observers said it was very difficult to estimate distances while using the night vision devices (Calambokidis and Chandler 2000). Failure to detect marine mammals using such devices would not decrease the uncertainty about whether marine mammals are actually in the immediate area or not and would thus offer no help in deciding whether to deploy trawl gear or not.

Operational restrictions

This measure would require the SWFSC to suspend trawl operations at night or during periods of low visibility (including fog and high sea state) to minimize adverse interactions with marine mammals that would be difficult to detect by visual monitoring. Given the fact that many of the historical takes in SWFSC research trawls have occurred during hours of darkness, this measure has the potential to reduce the risk of adverse interactions with marine mammals. However, two of the three highest incidences of

incidental take (involving multiple animals in one trawl) and 30 out of 49 fatalities have occurred during daylight hours (Table 4.2-7), so restricting operations to only daylight hours would not eliminate the majority of risk. In addition, restrictions on trawling at night would seriously hinder the ability of the SWFSC to sample important species such as sardines that aggregate near the surface at night but are otherwise dispersed at depth. If survey vessels had to stand down when they encountered fog or rough seas, survey periods would have to be extended or fewer stations would have to be sampled to accommodate such delays. This would mean substantially higher costs and/or decreased quality of data. Although visual monitoring is a reasonable and practicable precaution to undertake for trawl surveys, it clearly does not ensure that marine mammals will be detected or that entanglement can be prevented even if they are detected.

The SWFSC would investigate the use of video cameras to identify fish and their encounter rates in lieu of a closed cod end on pelagic trawls, thereby allowing protected species (and fish) to pass through the net rather than be captured. Such an approach would be appropriate for some swept area surveys designed to determine the density of fish but it would not be appropriate for surveys designed to determine the reproductive condition of adult fish (e.g., CPS surveys) or the growth rates of fish (e.g. Juvenile Salmon Surveys) as these measurements require the dissection of specimens. As was the case with the development of excluder devices, it is not clear how effective the video camera technique would be in actually reducing marine mammal takes. The SWFSC would experiment with this technique under the assumption it could be used to reduce the number of closed cod end trawls needed for scientific purposes and therefore reduce the risk of capturing marine mammals. While it would not be the primary objective, video camera data may also provide documentation of protected species interactions with trawl gear and may thus provide insight into the efficacy of other measures intended to reduce the adverse interactions with protected species (e.g. excluder devices or acoustic pingers).

Acoustic and visual deterrents

The SWFSC currently deploys acoustic pingers on all trawl gear to deter marine mammal interactions (Section 4.2.4). This measure would require the SWFSC to use additional acoustic deterrents, such as recordings of predator vocalizations (e.g., killer whale) to deter adverse interactions with trawl gear. This measure would also require the SWFSC to use visual deterrence techniques (e.g., lights, light sticks, reflective twine/rope) to reduce marine mammal adverse interactions with the gear.

An alternative approach to using pingers for acoustic deterrence of marine mammals involves the underwater broadcasting of pre-recorded predator sounds (e.g. killer whale calls) to scare animals away from the fishing operation. Jefferson and Curry (1996) concluded that this technique was largely ineffective for reducing marine mammal interactions with commercial fisheries based on their review of multiple studies. Gilman et al. (2006) concluded that marine mammals are likely to become habituated to predator calls broadcast in the vicinity of fishing operations.

Several methods have been suggested to help protected species detect the presence of fishing gear with the expectation that these methods will help animals avoid entanglement. Dense material, such as barium sulphate, can be incorporated into the rope and twine used for construction of fishing gear in order to increase the acoustic reflectivity of the gear (Gilman et al. 2006). The increased acoustic reflectivity would make the gear more apparent to cetaceans that use echolocation in the vicinity of the fishing gear. This measure would theoretically reduce rates of interaction or entanglement for animals that have trouble detecting the fishing gear in order to avoid it (Gilman et al. 2006). Similarly, phosphorescent or luminescent material can be incorporated into fishing gear to emit light underwater at wavelengths that are visible to protected species. However, it is not clear that such measures to enhance the acoustic or visual appearance of trawl nets would have the same effect on all species. For some species that are attracted to the fish in the net or the disturbance of potential prey as the net is towed through the water, efforts to increase the “visibility” of a net may increase the potential for adverse interactions rather than decrease those risks. Tests conducted by Wang et al. (2009) in a Mexican gillnet fishery suggest that the

use of luminescent lightsticks and LEDs significantly decreased rates of green sea turtle bycatch in that fishery without impacting the catch of target species. In contrast, laboratory experiments performed by Wang et al. (2007) demonstrated that sea turtles are attracted to underwater illumination. Thus, the efficacy of such mitigation measures could be different under different conditions and for different species and should be examined on a case-by-case basis.

Temporal or geographic restrictions

Spatial-temporal restrictions can be a direct way of reducing adverse impacts to protected species if there are known overlaps in time and space of the survey's footprint with concentrations of protected species. This measure would require the SWFSC to identify areas and times that are most likely to result in adverse interactions with marine mammals (e.g., areas of peak abundance) and to avoid, postpone, or limit their research activity to minimize the risk of such interactions with marine mammals. This may include limits on specific locations, physical or oceanographic features, biologically important times, and/or gear types.

While the rationale for such restrictions is clear, the methods for identifying appropriate places and times for effective restrictions are not. The SWFSC has been conducting marine mammal surveys in all three research areas (many of which are included as part of this alternative) to monitor the changing patterns of marine mammal abundance and distribution. Although certain oceanographic conditions indicating high productivity can be remotely sensed, there is no catalog of areas with consistently "high concentrations" of animals at sea that could be used to define areas that should be "off limits" to research involving trawl gear. The abundance and distribution of marine mammals at sea are highly dynamic, varying among seasons and years, and are impacted to varying degrees by climate and oceanographic changes, so marine mammal survey information from the previous year or even the previous month may not reflect actual conditions when it is time to deploy trawl gear. It might be possible to conduct aerial surveys or passive acoustic surveys in an area prior to conducting trawls, but such surveys require time to process data before actual density information is available.

Even if recent marine mammal survey data are available, there is an open question about what standards of density should be used for limiting research. This is important to the potential effectiveness of such restrictions because it is not clear if marine mammal density is a key factor in the risk of catching animals in a research trawl. Marine mammals can all swim much faster than an active trawl tow (2-4 kts) so they can easily avoid such gear if they perceive it and choose to move. This is true no matter how many animals are in a given area. The risk of entanglement is likely much more influenced by the attraction of marine mammals to fish caught in the trawl or disturbed by it as the trawl passes by, which in turn may be influenced by the overall availability of prey and the nutritional status of the marine mammals. Even if there are only a few marine mammals in an area, the risk of entanglement could be high if they are very hungry and strongly attracted to fish in a trawl. Conversely, the risk of entanglement could be quite small even if there are many marine mammals in an area if they have been foraging successfully and are inclined to avoid the disturbance of a trawl operation.

In any case, under the Status Quo and Preferred Alternatives, the "move-on" rule is typically applied if any marine mammals are sighted from the vessel during the 30 minutes prior to deploying trawl gear and appear to be at risk of adverse interactions with the gear. If an area has a high density of marine mammals, they would likely be sighted within that 30 minute period and the station would be moved away or abandoned to avoid the marine mammals. In addition, under the Preferred Alternative, the SWFSC will undertake an extensive analysis of the factors that may have influenced past takes of marine mammals in research trawl gear with the intent of trying to identify conditions that may pose higher risk of entanglements in trawls, including spatial/temporal factors. If any such causal factors are identified, the SWFSC will use that analysis to make modifications to its sampling efforts as appropriate, potentially involving spatial/temporal restrictions similar to what is called for in this additional mitigation measure.

A special case of spatial/temporal restrictions would be for the SWFSC to avoid trawl survey work within federal and state MPAs (see Section 3.1.2). While the SWFSC has conducted survey work within some MPAs under the authority of special use permits, these permits primarily provide authority to scientifically sample fish in areas that are otherwise closed to fishing and do not concern the incidental take of marine mammals. The only areas that are protected specifically for marine mammals are coastal areas and islands used by pinnipeds for rookeries and haulouts (e.g., Steller sea lion critical habitat areas) and SWFSC surveys using trawl gear do not go close to shore. The SWFSC will continue to apply for special use permits to sample in MPAs as necessary to meet the scientific needs of their surveys and, if the managing agencies of any MPAs prohibit such sampling, the SWFSC will avoid those areas. However, as described above, the same concerns about the effectiveness of spatial/temporal restrictions as a mitigation measure would apply to MPAs. They may or may not have high concentrations of marine mammals relative to the surrounding areas but, given the uncertainty about what factors contribute to high risk of entanglement in trawl gear and the imposition of the "move-on" rule, the potential for actually reducing incidental take by avoiding certain areas is not clear. Such avoidance also comes at the cost of not sampling in areas that are important to different fish species or that were established to promote recovery of depleted stocks. Scientific sampling is often the only reliable way to track the status of these stocks and the effectiveness of the MPA in fulfilling its established goals.

4.4.4.2 Longline Gear

The surveys that use longline gear occur in the CCRA (HMS, Thresher Shark, and Habitat surveys) and the ETPRA (new HMS survey). The following additional mitigation measures could be applied to one or more of these longline surveys.

Monitoring methods

As is the case with surveys using trawl gear, longline surveys conducted under the Preferred Alternative use crew to visually monitor for marine mammals (using 7x bridge binoculars as needed) at least 30 minutes prior to setting longline gear. Whoever is assigned to the marine mammal observer post is dedicated to that task until the gear is deployed and does not have any other duties during the observation period. Under the Additional Mitigation Alternative, one mitigation measure would require the SWFSC to use trained PSOs whose dedicated job would be to monitor for the presence of marine mammals during all fishing operations. Considerations include the use of dedicated PSOs for all surveys or during longline surveys of particular concern.

As was described for trawl surveys, not all current crew members have received formal training in marine mammal identification or marine mammal mitigation procedures, although they are briefed on what they are looking for and may have considerable experience with the task. However, the customized protected species training program included in the Preferred Alternative would provide the same types of training for all appropriate crew members as PSOs trained for that specific task for commercial fisheries. The difficulty in having crew members assigned only to PSO duties is that all vessels used for longline surveys have limited carrying capacity for personnel and any berths given to PSOs would mean a reduction in personnel available to help with other research or vessel duties. This could compromise crew safety or the amount of research that could be conducted. By providing formal PSO training for crew already trained in other skills, the SWFSC believes it can provide the same quality of visual monitoring for marine mammals and other protected species as would occur with dedicated PSOs while maintaining the flexibility to fulfill all other crew duties.

Operational procedures

This measure would require use of a decoy research vessel playing pre-recorded longline fishing sounds to distract marine mammals away from research longline sets. There have been no attempts to test the effectiveness of this method but it is very likely that cetaceans would quickly learn to tell the difference

between decoys and actual fishing operations (Gilman et al. 2006). Although the potential effectiveness is not clear, the additional cost of chartering another vessel to serve as a decoy would certainly compromise the research budget and restrict the amount of data that could be collected. In addition, a second vessel and broadcast fishing sounds would add to the amount of noise introduced to the marine environment, potentially increasing the number of animals taken by disturbance (Level B harassment takes) everywhere the survey was conducted.

Acoustic deterrents

This measure would require the SWFSC to use deterrents such as acoustic pingers or recordings of predator vocalizations (e.g., killer whales) to deter adverse interactions with longline gear. These methods have not been tested for use with longline gear (Gilman et al. 2006). The intent of pingers is to alert the animals to the presence of the fishing gear so they do not get entangled inadvertently. However, past takes of marine mammals in SWFSC longline surveys (all California sea lions) have involved animals hooked while depredating fish caught on the gear. Adding pingers to the longline may serve to attract animals rather than deter them (the "dinner bell" effect). As with trawl gear, attempts to scare animals off by playing killer whale recordings are likely to prove ineffective as animals learned they could safely ignore the hoax.

Visual deterrents

This measure would require the SWFSC to use visual deterrence techniques (e.g., lights, light sticks, reflective twine/rope, or marked lines) to make the longline gear more detectable thereby reducing the likelihood of hooking or entangling a marine mammal. This measure would theoretically reduce rates of interaction or entanglement for animals that have trouble detecting the fishing gear in order to avoid it (Gilman et al. 2006). Similarly, phosphorescent or luminescent material can be incorporated into fishing gear to emit light underwater at wavelengths that are visible to protected species. However, it is not clear that such measures to enhance the acoustic or visual appearance of longline gear would have the same effect on all species. For some species that are attracted to the fish caught on the longline, efforts to increase the "visibility" of a longline set may increase the potential for adverse interactions rather than decrease those risks. As mentioned above, the historical takes of sea lions in SWFSC longline surveys have all involved depredation rather than inadvertent entanglement in the ground mainline or gangions.

4.4.4.3 Summary and Conclusion

Of the potential techniques and procedures considered under this alternative to improve monitoring of trawl gear, three techniques appear to offer some promise in helping to detect marine mammals in conjunction with the current visual monitoring protocol. These include the use of underwater video technology, passive acoustic monitoring, and unmanned aerial or underwater surveillance vehicles. However, all three of these techniques have substantial limitations in terms of the conditions under which they may be useful (e.g., weather and sea state), the logistics of incorporating them into sampling procedures (e.g., timing of deployment, crew responsibilities, data processing, etc.), and how they might be incorporated into actual marine mammal take-avoidance decisions like the "move-on" rule. These three techniques deserve further examination to explore these limitations and to see how they may be applied under actual survey conditions, especially as technology changes and is improved. The other technological approaches considered, infra-red imaging and use of night vision devices, have severe limitations to their usefulness in a real-world situation and therefore offer no advantages for actual mitigation. The use of dedicated PSOs for monitoring is essentially what will occur under the Preferred Alternative once the crew and scientists of research surveys complete the new protected species training program. Whatever crew person is assigned to monitor for protected species before and during the time fishing gear is deployed will be dedicated only to that task, even if they have other duties while fishing gear is not being deployed.

Operational restrictions such as not allowing trawls to be set at night or in poor visibility conditions would certainly reduce the risk of taking marine mammals. However, such restrictions would have a serious impact on the ability of the SWFSC to collect certain kinds of research data and would have impacts to the cost and scope of research that could be conducted. The spatial/temporal restrictions that were considered to avoid high densities of marine mammals are similar in that they would reduce risk of take but also strongly impact the ability of the SWFSC to pursue certain scientific goals. Under the Preferred Alternative, the SWFSC will be examining the conditions under which marine mammals are more likely to be caught in trawl gear and will make practicable adjustments to their sampling procedures to accommodate any high risk factors they discover, if any.

The use of additional acoustic and visual deterrents is worth exploring further, especially as new devices enter the market and are tried in other fisheries. However, the effectiveness of the devices considered in this alternative appears to be species specific; mitigation advantages for some species may lead to higher risk for other species. The effectiveness of these techniques is also likely to decrease with time as animals habituate to various devices and techniques.

The analysis of additional measures considered to decrease the risk of marine mammal takes in longline gear is similar to trawl gear. The use of PSOs would impose logistical difficulties on small longline vessels with limited crew quarters and, given the use of trained survey crew who are dedicated to the observation task before and during gear deployment, would offer no advantages for mitigation once the survey crew complete the new protected species training program. Decoy vessels, acoustic deterrents, and visual deterrents are all unlikely to provide consistent mitigation value and may increase the risk for certain species. New variations on these techniques may be developed in the future that address some of these concerns.

In conclusion, some elements of the Modified Research Alternative (trained PSOs, examining spatial/temporal risk factors) would offer mitigation advantages compared to the Status Quo Alternative. However, many of the additional mitigation measures considered in this alternative would compromise the ability of the SWFSC to conduct research important to its mission, and the SWFSC currently considers them to be impracticable to implement. Some concepts and technologies considered in the Modified Research Alternative are promising, and NMFS will continue to evaluate the potential for implementation if they become more practicable.

4.4.5 Effects on Birds

The effects of the Modified Research Alternative on birds are very similar to those described for the Status Quo (Section 4.2.5) and essentially the same as the Preferred Alternative (Section 4.3.5). The only major difference is regarding longline surveys, where SWFSC could potentially deploy streamer lines on each side of the baited longline to discourage seabirds from diving on baited hooks. This measure has proven to be effective in reducing seabird bycatch in other Pacific fisheries (Melvin et al. 2001).

The overall effects of SWFSC research activities on birds under the Modified Research Alternative are considered minor adverse for mortality or any alterations to their habitat. This conclusion holds for each of the three SWFSC research areas and for all gear types used in research.

4.4.6 Effects on Sea Turtles

Additional mitigation measures described under Alternative 3 are unlikely to decrease the potential for adverse impacts to sea turtles relative to Alternative 1. Under Alternative 3, the SWFSC would implement video sampling with an open codend as an additional mitigation measure. Underwater video technology may allow the SWFSC to determine the frequency of sea turtle interactions with trawl gear and evaluate the effectiveness of MMEDs or other devices intended to reduce entanglement or bycatch of protected species. This technology may provide useful information about the efficacy of some mitigation measures;

however, the use of video equipment is unlikely to influence the impact of SWFSC research activities on sea turtles.

Passive acoustic monitoring involves the detection of animals by listening for the sounds that they produce (Barlow and Gisiner 2006). This technology is not expected to be effective for detection or avoidance of sea turtles because sea turtles vocalize only during copulation and nesting, and are the least vocal of living reptiles (Cook and Forrest 2005). Likewise, IR detection is unlikely to improve the ability to detect and avoid sea turtles in the water because water is effectively opaque to IR radiation. Although turtles come to the surface to breathe, only a very small area of a turtle is exposed above the sea surface. In addition, because turtles are ectothermic (cold-blooded) reptiles, temperature differences between the turtle and the surrounding water would be minimal and difficult to detect using IR-sensing devices. Similarly, sea turtles in the water would be extremely difficult to detect using night-vision technology.

Operational restrictions proposed under Alternative 3 would require the SWFSC to suspend trawl operations at night or during periods of low visibility (including fog and high sea state) to minimize adverse interactions with protected species including sea turtles, which would be difficult to detect by visual monitoring under low-visibility conditions. As discussed in Section 4.3.4, visual monitoring is a reasonable and prudent precaution to undertake for trawl surveys, but would not ensure detection of sea turtles, nor would it necessarily decrease the potential for adverse interactions between sea turtles and SWFSC research activities. Thus, the suspension of trawl activities during low-visibility conditions is not expected to influence overall effects of SWFSC research activities on sea turtles in the CCRA and ETPRA.

The effectiveness of visual deterrents for mitigation of sea turtle interactions with fishing gear is uncertain. Some data suggest that the use of luminescent lightsticks and LEDs may decrease rates of green sea turtle bycatch in longline gear (Wang et al. 2009). However, results from other studies demonstrate that sea turtles are attracted to underwater illumination (Wang et al. 2007).

The uses of aircraft or unmanned aerial or underwater gliders to detect sea turtles in the vicinity of SWFSC research operations are untested. While this mitigation could potentially be effective for detecting and subsequently avoiding sea turtles, the overall influence of the mitigation measure on the impacts to sea turtles is expected to be trivial.

Spatial-temporal restrictions are one of the most direct means of reducing adverse impacts to protected species. Where and when the gear is deployed and retrieved are critical variables for reducing the potential for adverse interactions with sea turtles. The implementation of time-area closures to restrict fishing activities at times and places turtles are most likely to be present in the highest numbers have been shown to be effective for reducing impacts to sea turtles in the Pacific Islands region (Kobayashi and Polovina 2005). Time-area restrictions proposed as mitigation measures under Alternative 3 could potentially alter the spatiotemporal distribution and overall level of impacts to sea turtles resulting from SWFSC research activities; if the species of interest has a predictable distribution in time and space, this would facilitate the designing of an effective time-area closure. However, the identification of specific sea turtle migratory pathways or high-residence areas and times is essential for the establishment of effective spatial-temporal restrictions to reduce adverse interactions with sea turtles.

Thus, additional mitigation measures described under Alternative 3 are unlikely to substantially decrease the potential for adverse impacts to sea turtles relative to Alternative 1. Time-area restrictions included as mitigation measures under Alternative 3 could result in decreased potential for adverse interactions with sea turtles relative to the Status Quo Alternative provided that the restrictions accurately address the spatiotemporal distribution of sea turtles in SWFSC research areas. However, considering that SWFSC research activities historically have not resulted in any sea turtle mortality, the implementation of such mitigation measures would not be expected to result in any substantial reduction in impacts to sea turtles. Thus, the overall level of effects on sea turtles resulting from the actions proposed under Alternative 3 would be substantially similar to those of the Status Quo Alternative. Minor adverse effects would occur

using gear types and mitigation measures described under Alternative 3; these effects would be isolated and infrequent, and would not result in any measurable changes to sea turtles at the population level in any of the SWFSC research areas.

4.4.7 Effects on Invertebrates

The continuation of federal Fisheries Research with Additional Mitigation Measures for Protected Species (Alternative 3) would result in effects on invertebrates substantially similar to those of the Status Quo Alternative (see Section 4.2.7). Additional mitigation measures for protected species required under Alternative 3, such as the use of advanced monitoring methods for the detection of marine mammals, operational restrictions, and acoustic and visual deterrents for protected species would not measurably influence the effects of the research activities on invertebrates. Temporal or geographic restrictions on SWFSC research activities intended to reduce adverse impacts to protected species (i.e., time/area restrictions) proposed as mitigation measures under Alternative 3 could potentially alter the spatiotemporal distribution of impacts to invertebrates; however, overall impacts to invertebrates would remain substantially similar to those described under Alternative 1. Likewise, avoidance of federal and state MPAs, proposed as a mitigation measure under Alternative 3, could potentially alter the spatiotemporal distribution of impacts to invertebrates, but would not result in substantial changes to the overall level of impacts to invertebrates compared to Alternative 1. Therefore, the overall effects of Alternative 3 on invertebrates would be substantially similar to those described for Alternative 1; the effects would be minor adverse in the CCRA and ETPRA, and the ARA.

4.4.8 Effects on the Social and Economic Environment

The effects of Alternative 3 on social and economic factors depends on the extent that additional mitigation measures would be implemented. Some of the mitigation measures require additional equipment than is currently used, and additional trained observers, which could increase spending on wages, rentals, and equipment. Other measures could curtail research operations, for example, time/area closures, which may reduce some operation expenditures if surveys are reduced in scope but may also increase survey expenses if surveys need to be extended in time to compensate for restricted data collection opportunities. The consistency of data collected with changes in methodology has not been evaluated, so it is uncertain if contributions to fisheries management would be comparable to that at present. If the SWFSC could incorporate the additional mitigations measures to be compatible with their current program, the direct and indirect effects on social and economic conditions would continue to be beneficial and moderate in the CCRA and minor adverse in the ETPRA and ARA, as in the Status Quo Alternative.

4.5 DIRECT AND INDIRECT EFFECTS OF ALTERNATIVE 4 – NO RESEARCH ALTERNATIVE

This section presents an analysis of the potential direct and indirect effects of Alternative 4 – the No Research Alternative – on the physical, biological, and social environment. Under the No Research Alternative, SWFSC would no longer conduct or fund fieldwork for the fisheries and ecosystem research considered in the scope of this EA in marine waters of the CCRA, ETPRA, or ARA. This moratorium on fieldwork would not extend to research that is not in scope of this EA, such as directed research on marine mammals and ESA-listed species covered under separate research permits and NEPA documents. NMFS would need to rely on other data sources, such as fishery-dependent data (i.e., harvest data), and state or privately supported data collection programs to fulfill its responsibility to manage, conserve, and protect living marine resources in the U.S.

The potential direct and indirect effects of implementing Alternative 4 were evaluated according to the criteria described in Table 4.1-1. A summary of the impact rating determinations for all topics evaluated under this Alternative are presented below in Table 4.5-1.

Table 4.5-1 Alternative 4 Summary of Effects

All conclusions refer to adverse effects.

Resource	Physical Environment	Special Resource Areas	Fish	Marine Mammals	Birds	Sea Turtles	Invertebrates	Social & Economic
SECTION NUMBER	***4.5.1***	***4.5.2***	***4.5.3***	***4.5.4***	***4.5.5***	***4.5.6***	***4.5.7***	***4.5.8***
Research Area								
California Current	Moderate	Moderate	Moderate	Minor - Moderate	Minor	Moderate	Moderate	Moderate
Eastern Tropical Pacific	Minor	Minor	Minor	Minor - Moderate	Minor	Moderate	Minor	Minor
Antarctic	Minor	Minor	Minor	Minor - Moderate	Minor	N/A	Minor	Minor

4.5.1 Effects on the Physical Environment

Currently, the research conducted by SWFSC includes assessments of fisheries and marine habitat that are used to inform a wide range of plans, policies, and resource management decisions. Many of the plans, polices and decisions that are partially based upon SWFSC data are concerned with conservation of ecological properties of the environment and maintenance of the habitat that sustains living resources in the SWFSC research areas. For instance, SWFSC data on the physical environment are used to support the establishment and ongoing management of special resource areas, including closed areas, conservation areas, and MPAs, both inside and outside the U.S. EEZ. FMPs developed for the region are partially based on scientific advice derived from SWFSC data. These special resource areas and management plans strategically limit impacts to physical habitat such as disturbance of benthic habitat and removal of organisms that produce seafloor structure. Without a relatively continuous input of SWFSC data, management authorities would lose some of the information necessary to establish management measures in a meaningful fashion. The No Research Alternative (Alternative 4) is expected to result in certain adverse effects due to the loss of scientific information used to support informed decision making and establish physical resource conservation measures. Currently, SWFSC directs a robust information stream which is used, at least partially, to manage and conserve the physical environment and habitat that sustains living marine resources in the CCRA, ETPRA, and ARA. In addition, SWFSC is the primary source of scientific advice to the U.S. Commissioner and delegation to CCAMLR, and research conducted by the SWFSC has been instrumental in the development and successful implementation of ecosystem-based management in Antarctica. The loss of information on physical resources under Alternative 4 would affect a number of different federal and state resource management agencies to various degrees. The SWFSC research program is not the only source of information available to these resource managers but Alternative 4 could lead to changes in some management scenarios based on greater uncertainty. Given the potential for resource management agencies to compensate for this loss of information to some extent, and the preference to avoid rapid, major changes in management strategies, the potential magnitude of effects on the physical environment would likely vary from minor to moderate and be limited in geographic extent over the next five years. Under Alternative 4, the overall impact of these indirect effects on physical resources would be considered adverse and moderate for the CCRA and minor adverse for the ETPRA and ARA according to the criteria in Table 4.1-1.

4.5.2 Effects on Special Resource Areas

The No Research Alternative (Alternative 4) would result in elimination of the minor adverse direct impacts to special resource areas described in Section 4.2.2 for the Status Quo Alternative. The potential

adverse impacts to the benthic environment of special resource areas resulting from SWFSC research activities would likewise be eliminated under the No Research Alternative. However, the loss of scientific information currently provided by SWFSC survey activities under the Status Quo Alternative would make it increasingly difficult for fisheries managers to assess the efficacy of special resource areas in fulfilling the ecosystem functions for which they were designated. Furthermore, a loss of input from SWFSC research would handicap the maintenance and effective management of existing EFH, HAPC, and closed areas, and would encumber the designation of additional special resource areas in the future. The loss of information about special resource areas under Alternative 4 would have various implications for different federal and state resource management agencies. The SWFSC research program is not the only source of information available to these resource managers but it could lead to changes in some management scenarios based on greater uncertainty (e.g., greater restrictions on commercial fisheries in MPAs). If the SWFSC discontinued collecting information on special resource areas, management authorities would lose important information needed to establish management measures in a meaningful fashion, and current conservation measures in place to protect ecological properties of the environment would become less effective. The indirect effects of these potential management implications would likely vary among research areas and the many special resource areas considered. Given the potential for resource management agencies to compensate for this loss of information to some extent and the tendency to avoid rapid, major changes in management strategies, the potential magnitude of effects on special resource areas would likely vary from minor to moderate and be limited to a few local areas within the CCRA over the next five years. Under Alternative 4, the overall impact of these indirect effects on special resource areas would be considered adverse and moderate for the CCRA and minor adverse for the ETPRA and ARA according to the effect levels criteria described in Table 4.1-1.

4.5.3 Effects on Fish

Under the No Research Alternative, the SWFSC would no longer conduct or fund fieldwork for the fisheries and ecosystem research considered in the scope of this EA. Currently, the SWFSC collects data which are used to manage and conserve marine resources, including fish, their habitats, and the ecosystems that sustain the fish populations of the CCRP, ETRP, and ARA. Alternative 4 proposes no at-sea SWFSC research activities, so there would be no direct effects on fish. The lack of at-sea research activities would eliminate the risk of mortality from surveys and fish tagging activities, disturbance and changes in behavior due to sound sources, and potential contamination from vessel discharges. However, the loss of scientific information about these species is expected to make it increasingly difficult for fisheries managers to effectively monitor their status, set commercial harvest limits, or develop fishery regulations to protect vulnerable stocks, especially as information used in stock assessments gets older and less reliable.

The conservation and management of fishery resources is a core mission for NMFS and is listed among the ten National Standards set forth in the MSA. In carrying out Congress's mandate under the MSA, NMFS is responsible for ensuring that management decisions involving fishery resources are based on the highest quality, best available scientific information on the biological, social, and economic status of the fisheries. In the Southwest, this is achieved through the work of the SWFSC, which provides supporting scientific information with which NMFS uses for the basis of their fisheries management actions.

As acknowledged by Congress through legislation, in order to achieve the goal of optimal yield in U.S. fisheries, it is necessary to end overfishing, rebuild overfished stocks, minimize bycatch, and protect EFH. In 2006, Congress amended the MSA to include, among other things, strengthened requirements to end overfishing by developing annual catch limits and accountability measures.

In carrying out Congress's mandate under the MSA, NMFS is responsible for ensuring that management decisions involving fishery resources are based on the highest quality, best available scientific information on the biological, social, and economic status of the fisheries. In the Southwest, this is

achieved through the work of the SWFSC, which provides the knowledge with which NMFS uses for the basis of their fisheries management actions.

The information provided by the SWFSC is not solely intended to support current management decisions, but also to conserve resources and anticipate future trends, ensure future utilization opportunities, and assess the effectiveness of the agency's ongoing management efforts. In addition to assessing the status of stocks and examining potential effects of commercial fishing activities, NMFS uses SWFSC research data to support the development and implementation of FMPs. In NMFS' view, the ability to acquire scientific information is essential to the agency's responsibility to manage our nation's fishery resources in support of and in cooperation with international treaty organizations and other nations.

Under Alternative 4, the loss of scientific data would make it increasingly difficult for fisheries managers to effectively monitor the status of stocks, develop meaningful fishery regulations, and rebuild overfished stocks, particularly in the CCRA. Federal and state resource management agencies would be affected to various extents. Although resource management agencies have other available data sources to support resource management decisions, the No Research Alternative is expected to result in increased uncertainty and changes in some management scenarios. If the SWFSC discontinued collecting information on fish stocks, management authorities would lose important information needed to establish management measures in a meaningful fashion, and current conservation measures in place to protect ecological properties of the environment would become less effective. The indirect effects of these potential management implications would likely vary among research areas and the different fish stocks assessed by the SWFSC. There are too many unknown variables to estimate what the indirect effects of this loss of information would mean to any particular fish stock. Given the potential for resource management agencies to compensate for this loss of scientific information to some extent and the tendency to avoid accelerated, major changes in management strategies, the potential magnitude of effects on fish stocks would likely vary from minor to moderate and be limited in geographic scope. Through these indirect effects on future management decisions, the overall impact on fish stocks would be adverse and moderate for the CCRA and minor adverse for the ETPRA and ARA.

4.5.4 Effects on Marine Mammals

Under the No Research Alternative, the SWFSC would no longer conduct or fund fisheries and ecosystem research involving fieldwork in marine waters of the CCRA, ETPRA, or ARA. This would eliminate the potential for direct effects on marine mammals through disturbance, entanglement in gear, changes to prey fields, and contamination of the marine environment in all three research areas and for all species of marine mammals.

However, many of the SWFSC projects that would be eliminated under this alternative include observations made from the deck of the vessels (transects while vessels are underway) which provide scientific data on the abundance and distribution of marine mammals in these three areas. Oceanographic and fisheries data collected by the SWFSC is also important for monitoring the ecological status of the environment important to marine mammals. While there would be no direct effects on marine mammals due to adverse interactions with ships and scientific gear, the loss of observational and ecological information important to marine mammals would indirectly affect resource management decisions concerning the conservation of marine mammals. The discontinuation of observational research on marine mammal abundance and distribution would greatly limit the ability of NMFS to update marine mammal stock assessments, which are key documents for recovery plans and other conservation efforts but also affect fishery management decisions in U.S. waters and in international waters. Because of the lack of updated information on marine mammals, fisheries that interact with stocks that are ESA-listed or considered depleted under the MMPA may be managed more conservatively, i.e., with more restrictions or smaller fishing quotas, based on increasing uncertainty about the recovery of the species. Another possibility is that a marine mammal stock may decline for various reasons (e.g., climate change effects on prey, anthropogenic noise in the environment, or fisheries-related interactions) and the negative

population trend would not be detected until the stock was in serious condition. If the SWFSC discontinued collecting information on marine mammals, the ability of state and federal agencies as well as international treaty organizations to make informed decisions about the marine environment would be adversely compromised, especially as time went on and uncertainty about the status of marine mammals increased. There are too many unknown variables to estimate the magnitude of effects this lack of information would mean to any particular stock of marine mammal but they would likely vary from minor to moderate over the next five years. However, the indirect effects could result in long-term effects and have impacts over a large geographic range, depending on which species are affected. Through these indirect effects on future management decisions, the overall impact on marine mammals would be adverse and minor to moderate for all three SWFSC research areas.

4.5.5 Effects on Birds

Under the No Research Alternative, the SWFSC would no longer conduct or fund fisheries and ecosystem research involving fieldwork in marine waters of the CCRA, ETPRA, or ARA. This would eliminate the potential for direct effects on birds through disturbance, entanglement in gear, changes to prey fields, and contamination of the marine environment in all three research areas and for all species of birds. However, many of the SWFSC projects that would be eliminated under this alternative include observations made from the deck of the vessels (transects while vessels are underway) which provide scientific data on the abundance and distribution of seabirds in these three areas. Oceanographic and fisheries data collected by the SWFSC is also important for monitoring the ecological status of the environment important to seabirds. While there would be no direct effects on seabirds, the loss of observational and ecological information important to seabirds would adversely affect resource management decisions concerning the conservation of seabirds. Although NMFS does not have regulatory jurisdiction over birds, the scientific contribution from the SWFSC observational research on seabirds is used, at least partially, to support fishery management decisions, USFWS conservation efforts, and international treaties such as CCAMLR. If the SWFSC discontinued collecting observational information on seabirds, the ability of state and federal agencies as well as international treaty organizations to make informed decisions about the marine environment would be adversely affected, especially as time went on and uncertainty about the status of various populations of birds increased. Resource management authorities would lose important information needed to establish management measures in a meaningful fashion, and current conservation measures in place to protect ecological properties of the environment would become less effective. Given the fact that the SWFSC is not the only source of information available to federal and state resource managers, and the potential for resource managers to compensate for this loss of information, Alternative 4 is expected to have an adverse and minor indirect effect on seabirds for all of the SWFSC research areas. There are too many unknown variables to estimate what the indirect effects of this loss of information would mean to any particular species.

4.5.6 Effects on Sea Turtles

Under the No Research Alternative, the SWFSC would no longer conduct or fund fisheries and ecosystem research involving fieldwork in marine waters of the CCRA and ETPRA. This would eliminate the potential for direct impacts to sea turtles through disturbance, entanglement in gear, or contamination associated with SWFSC research activities. The No Research Alternative would result in elimination of the direct adverse impacts to all species of sea turtles in the CCRA and ETPRA described in Section 4.2.6 for the Status Quo Alternative.

However, several of the SWFSC projects that would be eliminated under this alternative include observations made from the deck of the vessels which provide scientific data on the distribution of sea turtles in the CCRA and ETPRA Research Areas. Oceanographic and fisheries data collected by the SWFSC is also important for monitoring the ecological status of the environment important to sea turtles. These data support the management and conservation of sea turtle populations and the habitats and

ecosystems that sustain them. Many of the plans, polices and decisions that are based upon SWFSC data are used to support the conservation and ongoing management of sea turtle populations, both inside and outside the U.S. EEZ. FMPs that are developed based, at least partially, on scientific advice derived from SWFSC data include management measures such as time area closures and gear type restrictions for commercial fisheries specifically intended to reduce adverse interactions with sea turtles. These management measures strategically limit impacts to sea turtles, and are partially dependent on periodic input of SWFSC data. Without these data, management authorities would lack some of the information needed to establish management measures in a meaningful fashion, and current conservation measures in place to protect sea turtles would become obsolete. The loss of scientific information important to understanding sea turtle ecology under Alternative 4 would affect federal and state resource management agencies to various degrees. Without the input of SWFSC data relevant to sea turtle ecology, management authorities would lose important information needed to establish management measures in a meaningful fashion, and current conservation measures in place to protect ecological properties of the environment would become less effective. Since the SWFSC is not the sole provider of scientific information on sea turtles or their habitats, resource management agencies would be forced to adequately compensate for this loss of information through changes in management scenarios. There are too many unknown variables to estimate what the indirect effects of this loss of information and associated management implications would mean to any particular sea turtle species. Under the No Research Alternative, the loss of information currently provided by SWFSC research activities is expected to have adverse and moderate indirect effects on sea turtles in the CCRA and ETPRA.

4.5.7 Effects on Invertebrates

The No Research Alternative would result in no direct impacts to invertebrates. However, increased adverse effects could result indirectly from a loss of information necessary for informed decision making and conservation of invertebrates and their habitats. Currently, SWFSC collects data which are used to manage and conserve marine resources, including invertebrates such as market squid in the CCRA and krill in the ARA, their habitats, and the ecosystems that sustain invertebrate populations in the CCRA, ETPRA, and ARA. Under Alternative 4, discontinuation of SWFSC research activity would affect federal, state, and international resource management agencies to various degrees. Without the input of SWFSC data, management authorities would lose important information needed to establish management measures in a meaningful fashion, and current conservation measures in place to protect ecological properties of the environment would become less effective. Resource management agencies would have to adequately compensate for this loss of information through changes in management scenarios based on greater uncertainty. Given the fact that the SWFSC is not the only source of information available to federal and state resource managers, and the potential for resource managers to compensate for this loss of information, the overall indirect effects of Alternative 4 on invertebrate populations is expected to be adverse and moderate for the CCRA and minor adverse for the ETPRA and ARA.

4.5.8 Effects on the Social and Economic Environment

Under Alternative 4, the SWFSC would no longer conduct or fund fieldwork for the fisheries and ecosystem research considered in the scope of this EA in all three research areas, and it is also assumed that associated funding to other agencies and entities would cease. This would likely reduce the $50 million in annual funding to the SWFSC that support fisheries research, including a direct loss of (currently) $22 million annually in direct expenditures to local economies in fees, taxes, equipment, fuel, and employment. Land-based research activity could continue, including the assessments of the effects of conservation and management measures on participants in fisheries, and on fishing communities.

NMFS manages finfish and shellfish harvest under the provisions of several major statutes (See Chapter 6), including the MSA, the Tuna Conventions Act, the MMPA, the ESA, the International Dolphin Conservation Program Act, and the AMLR Convention Act. Accomplishing the requirements of these

statutes requires specific research and the close interaction of numerous research entities. Lack of field surveys could detract from the reliability of estimates that provide future stock assessments and annual setting of catch limits, thereby creating increased economic uncertainty in the fishing industry and in fishing communities. It would also disturb the partnership and collaboration with other agencies, entities, and countries that collect, analyze, and share complementary data.

4.5.8.1 California Current

The direct and indirect effects of Alternative 4 would be minor to moderate for the CCRA without the support of SWFSC field data. Of the three research areas covered by the SWFSC, the CCRA would be most affected because of the large expenditures in at-sea field work that occur there, affecting the primary and secondary local economies. The SWFSC also has much larger interactions with ports and fishing communities in the CCRA than in the ETPRA or ARA. In addition, under the MSA, the SWFS has a responsibility to contribute reliable data to fisheries management, and also economically support fishing communities, which would be reduced under Alternative 4. While the relationship of field data to the productivity of fisheries cannot be readily quantified, it is probable that the effectiveness of fisheries management could be reduced long-term using data from other sources. The overall direct and indirect effect would be adverse and moderate.

4.5.8.2 Eastern Tropical Pacific Research Area

The SWFSC has few at-sea data collection efforts in the ETPRA and the voyages have limited interaction with ports in Mexico and South America. The data gathered supports research about global interactions of major marine ecosystems, which could indirectly and ultimately affect fisheries management, stocks, and fishing communities in the U.S. The lack of field work would also probably affect cooperative research with other countries and treaty commitments (see Chapter 6). Because of the existing relatively low level of field work and expenditures in the ETPRA, the overall direct and indirect effects of Alternative 4 would be adverse and minor.

4.5.8.3 Antarctica

The Antarctic field program is larger than that of the ETPRA in expenditures and voyages, but affects far fewer communities than that of the CCRA. The data gathered supports research about global interactions of major marine ecosystems, which could indirectly and ultimately affect fisheries management, stocks, and fishing communities in the U.S. The lack of field work would also probably affect cooperative research with other countries and treaty commitments (see Chapter 6). The overall direct and indirect effects of Alternative 4 would be adverse and minor.

CUMULATIVE EFFECTS CHAPTER 5

5.1 INTRODUCTION AND ANALYSIS METHODOLOGY

The Council on Environmental Quality (CEQ) defines cumulative impact as:

> *"The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 Code of Federal Regulations [CFR] 1508.7).*

Cumulative effects are assessed by aggregating the potential direct and indirect effects of the proposed action with the impacts of past, present, and reasonably foreseeable future actions in the vicinity of the project. The ultimate goal of identifying potential cumulative effects is to provide for informed decisions that consider the total effects (direct, indirect, and cumulative) of the project alternatives. As suggested by the CEQ handbook *Considering Cumulative Effects Under the National Environmental Policy Act* (1997), the following basic types of cumulative effects are considered:

- Additive – the sum total impact resulting from more than one action,
- Countervailing – adverse impacts that are offset by beneficial impacts, and
- Synergistic – when the total impact is greater than the sum of the effects taken independently.

Cumulative effects may result from the incremental accumulation of similar effects or the synergistic interaction of different effects. Repeated actions may cause effects to build up over time, or different actions may produce effects that interact to produce cumulative impacts greater than (or less than) the sum of the effects of the individual actions.

As directed by CEQ's National Environmental Policy Act (NEPA) regulations (40 CFR 1502.16), this chapter discusses direct and indirect impacts on specific physical, biological, and social resources in combination with varying levels of effects, ranging from minor to major. While the effects of individual actions may be only minor, substantial cumulative effects may result from multiple actions occurring in the same geographic area. The implementing regulations of NEPA require analysis of cumulative effects in order to alert decision makers of the full consequences of all actions affecting a resource component and assess the relative contribution of the proposed action and alternatives.

Chapter 3 of this Environmental Assessment (EA) provides baseline information on the physical, biological, and social components of the environment that may be affected by Southwest Fisheries Science Center (SWFSC) research activities, including summaries of historic activities within the three SWFSC Research Areas (California Current Research Area [CCRA], Eastern Tropical Pacific Research Area [ETPRA], and Antarctic Research Area [ARA]). Chapter 4 provides an analysis of the direct and indirect effects on these resources of the four alternatives considered in this EA. Because the first three alternatives involve the continuation of SWFSC research activities (referred to collectively as the research alternatives) and contribute similar effects to the cumulative effects on most resources, they are generally considered together in the following Chapter 5 analysis. The contribution of the No Research Alternative to cumulative effects is quite different and is considered separately for each resource.

5.1.1 Analysis Methodology

The cumulative effects analysis methodology is similar to the effect assessment methodology for direct and indirect effects in Section 4.1. It consists of the following steps:

1. **Define the geographic area and timeframe**. These may vary between resource components.

2. **Identify external actions**[13], including:
    a. Past actions that have already occurred and resulted in lasting effects (see Chapter 3),
    b. Present actions occurring within the same timeframe as the proposed action and alternatives (see Chapter 3), and
    c. Reasonably foreseeable future actions (RFFAs), which are planned and likely to occur (see Table 5.1-1).
3. **Evaluate the direct and indirect effects of the alternatives along with the adverse and beneficial effects of external actions and rate the cumulative effect using the effects criteria table** (Table 4.1-1).
4. **Assess the relative contribution of the alternatives to the cumulative effects**.

5.1.2 Geographic Area and Timeframe

This cumulative effects analysis considers external actions that influence the geographic areas where SWFSC surveys occur; these areas include the CCRA, ETPRA, and ARA, as described in Section 3.1 and illustrated in Figure 1.1-2. Some actions that originate outside of the SWFSC Research Areas, such as discharge of pollutants, or actions that influence populations of Highly Migratory Species (HMS), could potentially contribute to cumulative effects within the geographic areas of interest; such actions are considered in the analysis of cumulative effects. Other actions considered in the analysis of cumulative effects may be geographically widespread, such as those that could potentially result in climate change or ocean acidification.

The periods of time that must be considered to understand the baseline conditions vary between resource components. The availability of existing information for different resources also varies. All analyses project at least five years into the future from the date this EA is finalized (2013-2018).

5.1.3 Reasonably Foreseeable Future Actions

Table 5.1-1 summarizes the RFFAs external to SWFSC fisheries research that are likely to occur in the next five years, the areas where those actions are likely to occur, and the resources they are likely to affect. This information has been collected from a wide variety of sources, including recent NEPA documents, federal and state fishery agency websites and documents, the United States (U.S.) Navy website and documents, and a variety of documents concerning industrial developments. Wildlife management documents, such as take reduction plans, and conservation measures for sea turtles and marine mammals were also consulted to identify the potential for RFFAs to impact particular species and habitats.

Deciding whether to include actions that have already occurred, are ongoing, or are reasonably foreseeable in the cumulative impacts analysis depends on the resource being analyzed. Past, ongoing, and future actions must have some known or expected influence on the same resources that would be affected by the alternatives to be included in the cumulative impacts analysis. CEQ refers to this as the cause-and-effect method of connecting human activities and resources or ecosystems. The magnitude and extent of the effect of an action on a resource or ecosystem depends on whether the cumulative impacts exceed the capacity of the resource/ecosystem to sustain itself and remain productive over the long-term.

CEQ guidelines state that “it is not practical to analyze cumulative effects of an action on the universe; the list of environmental effects must focus on those that are truly meaningful.” In general, actions can be excluded from the analysis of cumulative impacts if:

[13] External actions are other human activities and natural occurrences that have resulted or will result in effects to the resource components that comprise the affected environment.

- The action is outside the geographic boundaries or time frame established for the cumulative impacts analysis.
- The action will not affect resources that are the subject of the cumulative impacts analysis.
- The action is not planned or is not reasonably foreseeable (e.g., formally proposed, planned, permitted, authorized, or funded).

Table 5.1-1 Reasonably Foreseeable Future Actions related to SWFSC Research Areas.

Blank cells indicate no effects on that resource.

Action	SWFSC Research Area			Effect on Physical Environment	Effect on Special Resource Areas	Effect on Water Quality	Effect on Fish	Effect on Marine Mammals	Effect on Seabirds	Effect on Sea Turtles	Effect on Invertebrates	Effect on Social and Economic Environment
	California Current	Eastern Tropical Pacific	Antarctic									
Other (Non-SWFSC) Scientific Research	X	X	X	Presence of additional vessel traffic Sea floor disturbance Generation of Marine debris	Habitat disturbance Contamination (Spills, Discharges)	Short-term turbidity increase Increased contaminant concentrations	Habitat disturbance Removal of individuals and biomass Behavioral disruptions	Behavioral displacement Loss/injury from ship strikes Noise responses	Loss from avian by-catch Potential for ship collisions (lighting attraction)	Loss/injury from ship strikes	Loss or displacement due to habitat disturbance Removal of individuals and biomass	Increased understanding of environment leading to better resource management
Federal and State Managed Fisheries	X	X		Presence of additional vessel traffic Sea floor disturbance Generation of marine debris	Habitat disturbance Contamination (Spills, Discharges) Generation of marine debris	Short-term turbidity increase Increased contaminant concentrations	Removal of managed targeted fisheries species By-catch removal of non-target species Habitat disturbance Behavioral disruption Loss from capture by derelict gear	Loss/injury from ship strikes Loss/injury from entanglement Noise responses Altered or reduced prey resources Behavioral displacement	Loss from avian by-catch Potential for ship collisions (lighting attraction) Alteration or reduction of prey resources	Loss/injury from ship strikes Loss/injury from turtle by-catch Loss/injury from entanglement with fishing gear	Direct loss or displacement due to bottom trawling Indirect loss or displacement due to habitat disturbance	Provision of jobs and economic opportunity Provision of food and industrial raw materials Cost of operations and gear requirements Need for catch limits for resource management Need for time/area closures for resource management
Other Fishing Operations (Charter, Private, or managed by treaty)	X	X	X	Presence of additional vessel traffic Sea floor disturbance Generation of marine debris	Habitat disturbance Contamination (Spills, Discharges) Generation of marine debris	Short-term turbidity increase Increased contaminant concentrations	Removal of managed targeted fisheries species By-catch removal of non-target species Habitat disturbance Behavioral disruption Loss from capture by derelict gear	Loss/injury from ship strikes Loss/injury from entanglement Noise responses Altered or reduced prey resources Behavioral displacement	Loss from avian by-catch Potential for ship collisions (lighting attraction) Alteration or reduction of prey resources	Loss/injury from ship strikes Loss/injury from turtle by-catch Loss/injury from entanglement with fishing gear	Direct loss or displacement due to bottom trawling Indirect loss or displacement due to habitat disturbance	Provision of jobs and economic opportunity Provision of recreational opportunities Provision of food
Military Operations (SOCAL Range Complex, etc.)	X	X	X	Contamination of water and sediment Generation of marine debris, including munitions	Contamination Generation of marine debris, including munitions	Increased contaminant concentrations	Noise effects (stress, altered behavior, auditory damage) Mortality near detonation Loss/injury from contamination Contamination of fish for human consumption	Loss/injury from ship strikes Noise effects (stress, altered behavior, auditory damage) Behavioral disturbance Displacement Injury/loss due to ingestion or entanglement in marine debris Mortality near detonation	Loss/injury due to entanglement in marine debris Potential for loss from ship collisions (lighting attraction) Behavioral disturbance Mortality near detonation	Noise effects (stress, altered behavior, auditory damage) Loss/injury from ship strikes Loss/injury from ingestion/entanglement in marine debris Mortality near detonation	Injury/loss due to contamination Mortality near detonation	Temporary and localized disruption of fishing due to operations Maintaining National Defense

Action	SWFSC Research Area			Effect on Physical Environment	Effect on Special Resource Areas	Effect on Water Quality	Effect on Fish	Effect on Marine Mammals	Effect on Seabirds	Effect on Sea Turtles	Effect on Invertebrates	Effect on Social and Economic Environment
	California Current	Eastern Tropical Pacific	Antarctic									
									Displacement			
Liquid Natural Gas (LNG) Terminals (Sempra Energy Terminal, Ensenada Mexico; Jordan Cove Project, Coos Bay, OR	X	X		Increased turbidity (construction phase) Sea floor disturbance Presence of additional vessel traffic Provision of new underwater structures	Contamination Increased turbidity Sea floor disturbance	Increased turbidity (construction phase) Localized changes in water temperature	Loss/injury from contamination Construction related habitat disturbance Provision of new structured habitat Contamination of fish for human consumption	Loss/injury from ship strikes Noise effects (construction, vessel) Behavioral disturbance Loss/injury from contamination Loss/injury due to ingestion/entanglement in marine debris Loss/injury due to entanglement in buoy chains Alteration or reduction of prey resources	Loss/injury from contamination Loss from structure or ship collision (lighting attraction) Loss/injury due to ingestion/entanglement in marine debris Alteration or reduction of prey resources	Loss/injury from ship strikes Noise effects (construction, vessel) Behavioral disturbance Loss/injury from contamination Loss/injury due to ingestion/entanglement in marine debris Alteration or reduction of prey resources	Habitat disturbance Increased risk from invasive species due to long-distance shipping activity Loss/injury from contamination Creation of new hard substrate habitats on structures	Fishing exclusion zones may displace fisheries Provision of new jobs Increased capacity for inexpensive fuel transport and handling
Oil Extraction	X	X		Increased turbidity (construction phase) Sea floor disturbance	Contamination Increased turbidity Sea floor disturbance	Increased contaminant concentrations Increased turbidity	Loss/injury from contamination Habitat disturbance Contamination of fish for human consumption	Loss/injury from ship strikes Noise effects (construction, vessels) Behavioral disturbance Loss/injury from contamination Alteration or reduction of prey resources	Loss/injury from contamination Loss from structure or ship collision (lighting attraction) Alteration or reduction of prey resources	Loss/injury from ship strikes Noise effects (construction, vessel) Behavioral disturbance Loss/injury from contamination Loss/injury due to ingestion/entanglement in marine debris Alteration or reduction of prey resources	Habitat disturbance Loss/injury from contamination	Fishing exclusion zones may displace fisheries Provision of new jobs
Vessel Traffic (Shipping)	X	X	X	Contamination of water and sediment	Increased risk from invasive species due to long-distance shipping activity Contamination	Increased contaminant concentrations Increased turbidity	Loss due to competition or predation from invasive species Loss/injury from contamination Noise effects (stress, altered behavior)	Loss/injury from ship strikes Displacement Noise effects (stress, altered behavior) Behavioral disturbance Loss/injury due to ingestion/entanglement in marine debris	Loss/injury from contamination Noise effects (stress, altered behavior) Loss/injury due to ingestion/entanglement in marine debris Ship collision (lighting attraction)	Loss/injury from contamination Noise effects (stress, altered behavior) Loss/injury due to ingestion/entanglement in marine debris	Loss due to competition or predation from invasive species Loss/injury from contamination	Provision of jobs and economic opportunity
Vessel Traffic (Other)	X	X	X	Contamination of water and sediment	Increased risk from invasive species due to long-distance shipping activity Contamination	Increased contaminant concentrations Increased turbidity	Loss due to competition or predation from invasive species Loss/injury from contamination Noise effects (stress, altered	Loss/injury from ship strikes Displacement Noise effects (stress, altered behavior) Behavioral disturbance Loss/injury due to ingestion/entanglement in	Loss/injury from contamination Noise effects (stress, altered behavior) Loss/injury due to ingestion/entanglement in marine	Loss/injury from contamination Noise effects (stress, altered behavior) Loss/injury due to ingestion/entanglement in marine debris	Loss due to competition or predation from invasive species Loss/injury from contamination	

Action	SWFSC Research Area			Effect on Physical Environment	Effect on Special Resource Areas	Effect on Water Quality	Effect on Fish	Effect on Marine Mammals	Effect on Seabirds	Effect on Sea Turtles	Effect on Invertebrates	Effect on Social and Economic Environment
	California Current	Eastern Tropical Pacific	Antarctic									
							behavior)	marine debris	debris Ship collision (lighting attraction)			
Ocean Disposal and Discharges	X	X	X	Sea floor disturbance Sedimentation	Contamination Disturbance of benthic habitats Sea floor disturbance Sedimentation	Increased turbidity Toxic contamination Eutrophication	Bioaccumulation of contaminants Loss/injury from contamination Habitat disturbance	Bioaccumulation of contaminants Loss/injury from contamination Loss/injury from ship strike Alteration or reduction of prey resources Habitat disturbance	Bioaccumulation of contaminants Loss/injury from contamination Alteration or reduction of prey resources Habitat disturbance	Bioaccumulation of contaminants Loss/injury from contamination Alteration or reduction of prey resources Habitat disturbance	Bioaccumulation of contaminants Loss/injury from contamination Habitat disturbance	Potential indirect impact on subsistence resources
Dredging	X	X		Sea floor disturbance Increased turbidity	Sea floor disturbance Increased turbidity	Increased turbidity Contamination (Discharges)	Loss of habitat due to sea floor disturbance Displacement due to turbidity	Noise effects (stress, altered behavior) Loss/injury from ship strikes Habitat disturbance/alteration Alteration or reduction of prey resources	Noise effects (stress, altered behavior) Habitat disturbance/alteration Alteration or reduction of prey resources	Mortality by entrainment in dredge Habitat disturbance/alteration	Direct loss or displacement due to bottom trawling Indirect loss or displacement due to habitat disturbance Loss/displacement due to turbidity	
Geophysical/ Geotechnical Activities	X	X	X	Sea floor disturbance	Sea floor disturbance	Localized turbidity	Habitat disturbance Noise effects from acoustic surveys	Noise effects from acoustic surveys Loss/injury from ship strikes Behavioral disturbance	Potential for loss due to ship collisions (lighting attraction) Behavioral disturbance	Loss/injury from ship strikes Behavioral disturbance	Habitat disturbance Localized benthos disturbance	
Sea Turtle Conservation Measures	X	X								Decreased serious injury and mortality		Cost to fisheries, gear modifications
Marine Mammal Conservation Measures	X	X	X					Decreased serious injury and mortality				Cost to fisheries Displacement of personnel from fishing and other marine activities Need for time/area closures
Climate Change	X	X	X	Sea level rise, saltwater infusion in estuaries and coastal habitats Increased erosion and siltation	Sea level rise, saltwater infusion in estuaries and coastal habitats Increased	Water chemistry changes	Unknown ecosystem level changes, variable effects on different species	Unknown ecosystem level changes, variable effects on different species	Unknown ecosystem level changes, variable effects on different species	Unknown ecosystem level changes, variable effects on different species	Unknown ecosystem level changes, variable effects on different species	Rising water levels in coastal areas Potential changes in fisheries due to ecosystem changes New regulations on

Action	SWFSC Research Area			Effect on Physical Environment	Effect on Special Resource Areas	Effect on Water Quality	Effect on Fish	Effect on Marine Mammals	Effect on Seabirds	Effect on Sea Turtles	Effect on Invertebrates	Effect on Social and Economic Environment
	California Current	Eastern Tropical Pacific	Antarctic									
				Increased water temperatures More extreme storm events	erosion and siltation Increased water temperatures More extreme storm events							greenhouse gas emissions Incentives for higher vessel fuel efficiency
Ocean Acidification	X	X	X	Increased pCO2 Decreased pH	Decreased calcification among food web organisms Change in primary production	Increased pCO2 Decreased pH	Potential adverse effects on prey, availability of nutritional minerals Potential direct adverse effects on growth, reproduction, development	Potential adverse effects on prey, availability of nutritional minerals	Potential adverse effects on prey, availability of nutritional minerals	Potential adverse effects on prey, availability of nutritional minerals	Decreased calcification, shell hardening impaired Potential adverse effects on prey, availability of nutritional minerals	Potential effects on fisheries, especially for invertebrate species

List of documents for SWFSC RFFA table:

* AMLR (Draft Programmatic EIS) on Codified Regulations at 50 CFR Part 300 Subparts A and G; June 2005
  Implementing Conservation and Management Measures Adopted by the Commission for the Conservation of Antarctic Marine Living Resources

* Pacific Offshore Cetacean Take Reduction Plan Regulations (50 CFR Part 229) Jan 1999

* Steller Sea Lion and Northern Fur Seal Research Final PEIS Chapter 4 May 2007

* Sempra Energy Mexico LNG terminal Construction Update.pdf (2009)

* http://www.energy.ca.gov/lng/documents/4_WEST_COAST_PROJECTS_PROPOSALS_STATUS_UPDATE.PDF

*Over-Sea-ice seismic reflection surveys in Antarctica (2005)

*Southern California Navy Range Complex EIS- Chapter 4 - http://www.socalrangecomplexeis.com/

5.2 CUMULATIVE EFFECTS ON THE PHYSICAL ENVIRONMENT

Activities external to SWFSC fisheries research that could potentially affect the physical environment in the CCRA, ETPRA, and ARA may include commercial and recreational fisheries, ocean disposal and discharges, dredging, coastal development, oil extraction, other scientific research, military operations, climate change, and ocean acidification. The potential effects of these activities are summarized in Table 5.1-1 and include:

- Sea floor disturbance
- Increased turbidity and re-suspension of sediments
- Presence of new underwater structures
- Effects of climate change such as increased water temperatures and sea level rise

5.2.1 California Current Research Area

External Factors in the CCRA

The physical environment of the CCRA has been affected by human activity since the colonization of the Americas. Until recent times, however, the magnitude of effects on the physical environment was limited. With the advent of offshore development and exploitation of resources from the ocean environment, cumulative impacts on the physical environment have increased substantially. Within the SWFSC CCRA, the physical environment continues to experience the effects of both natural and anthropogenic factors including climate change, ocean acidification, seafloor disturbance from commercial fisheries, substrate disturbance from geophysical/ geotechnical activities, contamination from spills and discharges, presence of vessel traffic, and marine debris. Sources of impacts to the physical environment from RFFAs are identified in Table 5.1-1.

Past activities that disturbed the seafloor were generally limited to commercial fishing activities, U.S. naval testing activities, the laying of underwater cables for communications systems, and offshore oil and gas exploration and development. These activities presently continue to influence benthic habitat in the CCRA. While the effects of these activities on benthic habitat could be acute, they are spatially limited to less than 10% of the CCRA. Additional activities that may disturb the seafloor include channel dredging, construction of offshore structures, and discharges to the ocean from land-based developments and agriculture. These activities may cause introduction or re-suspension of sediments into the water column, changes in benthic contours, and loss of benthic habitat. Offshore developments may have long-term effects on the physical environment over relatively small areas resulting from the presence of new underwater structures. Scientific research conducted by agencies other than the National Marine Fisheries Service (NMFS) may also result in localized adverse impacts to the seafloor in the CCRA. These impact-producing factors are likely to persist in the future at levels similar to those currently affecting the sea floor in the CCRA.

Climate change may affect the marine environment in a variety of ways, including changes in sea level, changes in water temperatures, extreme weather events, and alteration of ocean currents. These changes and others are expected to continue over the reasonably foreseeable future and could aggregate with the effects of industrial activity to impact the physical environment. In addition to changes in air and water temperatures, changes in the acidity of the world's oceans are expected to continue and accelerate over the reasonably foreseeable future (United States Geological Survey [USGS] 2011). Ocean acidification may have substantial impacts on the physical environment, and must be considered in combination with actions that may lead to cumulative impacts. Ocean acidification can harm organisms that build shells of calcium carbonate, including corals, mollusks and crustaceans, which add to the physical structure of the ocean floor in some sections of the CCRA. Although the root causes of climate change and the potential

magnitude and timing of its effects are poorly understood, there is general acknowledgement that the potential impacts resulting from climate change could be substantial.

Contribution of the Research Alternatives

Direct and indirect effects of the research alternatives on the physical environment in the CCRA are discussed in section 4.2.1. Direct and indirect effects to benthic habitat (seafloor disturbance) and removal of organisms that produce structure would be minimal in the CCRA because the SWFSC does not use bottom-contact trawl equipment in the CCRA and only has one small bottom longline survey (sablefish) and one anchored longline survey (thresher shark) in the CCRA. Likewise, SWFSC research activities are not expected to result in increased turbidity, re-suspension of sediments, or the presence of new underwater structures in the CCRA. Although CO_2 emissions from SWFSC research vessels would contribute to atmospheric CO_2 levels, the contribution would be minor compared to other natural and anthropogenic CO_2 sources. When aggregated with the impacts of past, present, and reasonably foreseeable future actions in the vicinity of the project, SWFSC research activities would make a minor additive contribution to cumulative adverse effects on the physical environment in the CCRA under each of the research alternatives.

Contribution of the No Research Alternative

The No Research Alternative would eliminate the risk of direct adverse impacts to physical resources within the CCRA resulting from SWFSC research activities. However, many of the SWFSC projects that would be eliminated under this alternative generate a great deal of information that, when combined with research conducted by other branches of NOAA and other agencies and institutions not included in this EA, is used to monitor the effects of climate change, ocean acidification, and other changes in the physical environment. This information may also be used by resource managers to limit fishing related impacts to physical habitat such as disturbance of benthic habitat and removal of organisms that produce seafloor structure in the CCRA. Without the input of SWFSC data, management authorities would lose important information needed to establish management measures in a meaningful fashion, and current conservation measures in place to protect ecological properties of the environment would become less effective. Although resource management agencies have other available data sources to support resource management decisions, the No Research Alternative is expected to result in increased uncertainty and changes in some management scenarios. Through these indirect effects on future management decisions, the contribution of this alternative to adverse cumulative impacts on physical resources would be minor to moderate.

5.2.2 Eastern Tropical Pacific Research Area

External Factors in the ETPRA

The physical environment of the ETPRA is affected by similar past, present, and reasonably foreseeable future factors as described for the CCRA.

Contribution of the Research Alternatives

Direct and indirect effects to benthic habitat (seafloor disturbance) and removal of organisms that produce structure would not occur in the ETPRA because SWFSC does not use bottom-contact trawl equipment in the ETPRA. Likewise, SWFSC research activities are not expected to result in increased turbidity, re-suspension of sediments, or the presence of new underwater structures in the ETPRA. Although CO_2 emissions from SWFSC research vessels would contribute to atmospheric CO_2 levels, the contribution would be minor compared to other natural and anthropogenic CO_2 sources. SWFSC research activities in the ETPRA would make insubstantial contributions to the impacts of climate change such as increased water temperatures and sea level. When aggregated with the impacts of past, present, and reasonably

foreseeable future actions in the vicinity of the project, SWFSC research activities would make a minimal additive contribution to cumulative adverse effects on the physical environment in the ETPRA under each of the research alternatives. Considering the magnitude of effects resulting from past, present, and reasonably foreseeable future actions external to SWFSC fisheries research activities, the contribution of SWFSC research activities to cumulative impacts on the physical environment would be minor under all the research alternatives.

Contribution of the No Research Alternative

The No Research Alternative would eliminate the risk of direct adverse impacts to physical resources within the ETPRA resulting from SWFSC research activities. However, as described for the CCRA, many of the SWFSC projects that would be eliminated under this alternative generate a great deal of information is important to resource managers to monitor environmental changes and design effective conservation measures for various resources. Without the input of SWFSC data, management authorities would lack important information needed to establish management measures in a meaningful fashion, and current conservation measures in place to protect ecological properties of the environment would become less effective. Although resource management agencies have other available data sources to support resource management decisions, the No Research Alternative would result in increased uncertainty and changes in some management scenarios. Through these indirect effects on future management decisions, the contribution of this alternative to adverse cumulative impacts on physical resources would be minor to moderate.

5.2.3 Antarctic Research Area

External Factors in the ARA

Anthropogenic impacts to the physical environment of the ARA have occurred more recently and at lower levels compared to those affecting the CCRA and ETPRA. Anthropogenic impact-producing factors were largely absent from the Antarctic Peninsula until after World War II. Most exploration of the ARA has occurred during the past 70 years and vast areas of the physical environment within the ARA are still poorly characterized. Past actions influencing the physical environment in this area include military operations and scientific research. The impacts of these activities on the physical environment within the ARA are poorly characterized. However, based on information gathered during SWFSC research activities, the benthic environment of the ARA appears to have been relatively unaffected by past actions compared to the other research areas. Commercial fishing operations may have historically removed structure-producing organisms and affected the benthic environment within the ARA but commercial harvests are presently prohibited throughout the ARA by the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR). Apart from SWFSC activities, very little scientific research occurs in the ARA, and that research is not expected to result in substantial effects on the physical environment.

Climate change may affect the marine environment in a variety of ways, including changes in sea level, changes in water temperatures, extreme weather events, and alteration of ocean currents. Antarctica is among the fastest warming regions, and as a result, the physical environment of the ARA is expected to experience rapid changes (Barnes and Conlan 2007). In the next century, temperature stress and the potential invasion of non-indigenous species may result in substantial impacts to both physical and biological resources in the Antarctic (Barnes and Conlan 2007). Distributions of sea ice are expected to change as a result of increasing temperatures. In addition to changes in air and water temperatures, changes in the acidity of the world's oceans are expected to continue and accelerate over the reasonably foreseeable future (USGS 2011). Ocean acidification may have substantial impacts on the physical environment, and must be considered in combination with actions that may lead to cumulative impacts. Ocean acidification can harm organisms that build shells of calcium carbonate, including corals, mollusks

and crustaceans, which add to the physical structure of the ocean floor in some sections of the ARA. Although the root causes of climate change and the potential magnitude and timing of its effects are poorly understood, there is general acknowledgement that these factors could produce substantial impacts to the physical environment within the ARA.

Contribution of the Research Alternatives

When aggregated with the impacts of past, present, and reasonably foreseeable future actions in the vicinity of the project, SWFSC research activities would make a minor additive contribution to cumulative adverse effects on the physical environment in the ARA under each of the research alternatives. Under each of the research alternatives, the SWFSC would occasionally use a hard-bottom trawl in order to collect information about demersal fish and benthic invertebrates within the ARA (Jones et al. 2009; Lockhart et al. 2009). Bottom contact fishing gear can break or disrupt corals, thereby reducing structural complexity, which may reduce species diversity of the corals and other animals that utilize the habitat (Freiwald et al. 2004). Effects of SWFSC research activities on organisms that produce structure would be independent of seasonal considerations since the organisms are not mobile and take long periods to recover. However, standard operating procedures involving acoustic reconnaissance to verify bottom conditions suitable for trawling, avoidance of coral areas, the small areal extent of surveys using bottom trawl gear, and the periodic nature of the surveys would minimize the magnitude of effects on the physical environment. Although CO_2 emissions from SWFSC research vessels would contribute to atmospheric CO_2 levels, the contribution would be minor compared to other natural and anthropogenic CO_2 sources. The primary factors affecting the physical environment in the ARA include natural oceanographic and atmospheric cycles and effects related to climate change. The contribution of the SWFSC research activities to these effects would be minor under all the research alternatives.

Contribution of the No Research Alternative

The No Research Alternative would eliminate the risk of direct adverse impacts to physical resources within the ARA resulting from SWFSC research activities. However, as described for the CCRA, many of the SWFSC projects that would be eliminated under this alternative generate a great deal of information is important to resource managers to monitor environmental changes and design effective conservation measures for various resources. Without the input of SWFSC data, fisheries management authorities and international treaty signatories would lose important information needed to establish management measures in a meaningful fashion, and current conservation measures in place to protect ecological properties of the environment would become less effective. Although resource management agencies have other available data sources to support resource management decisions, the No Research Alternative is expected to result in increased uncertainty and changes in some management scenarios. Through these indirect effects on future management decisions, the contribution of this alternative to adverse cumulative impacts on physical resources would be minor to moderate.

5.3 CUMULATIVE EFFECTS ON SPECIAL RESOURCE AREAS

Activities external to SWFSC fisheries research that could potentially affect special resource areas in the CCRA, ETPRA, and ARA may include commercial and recreational fisheries, ocean disposal and discharges, dredging, coastal development, oil extraction, other scientific research, military operations, climate change, and ocean acidification. The potential effects of these activities are summarized in Table 5.1-1 and may include:

- Contamination resulting from spills or discharges
- Habitat disturbances
- Increased risk of invasive species introductions resulting from long-distance shipping activity

- Effects of climate change such as increased water temperatures and sea level rise
- Effects of ocean acidification such as decreased calcification among food web organisms and
- Changes in primary production

5.3.1 California Current Research Area

External Factors in the CCRA

As described in Section 3.1.2, special resource areas within the CCRA include Essential Fish Habitat (EFH), Habitat Areas of Particular Concern (HAPC), Closed Areas, and Marine Protected Areas (MPAs), including National Marine Sanctuaries (NMS). The cumulative effects of activities that disturb the physical environment in special resource areas are similar to those discussed for the physical environment in Section 5.2. Cumulative impacts to biological resources within special resource areas are discussed in Sections 5.4 through 5.8. The effects of proposed offshore projects in the CCRA related to oil extraction, dredging, military operations, and geophysical exploration, would be considered as part of the Federal permitting process. Contributions to cumulative effects from such activities would be limited by permit conditions and mitigation measures required by permitting agencies. Impacts resulting from commercial fishing operations would affect EFH and HAPC areas, but would not directly affect closed areas or some marine reserves that are closed to commercial fishing. In some cases, closed areas have been designated to allow the recovery of areas that were heavily affected by commercial fisheries in the past. In addition to the SWFSC, the Northwest Fisheries Science Center (NWFSC) also conducts fisheries research in the CCRA. In instances where the research activities of multiple science centers overlap in space and time, impacts resulting from those activities would accumulate in an additive or synergistic fashion. The cumulative effect from all external sources of disturbance to special resource areas is expected to be minor to moderate.

Contribution of the Research Alternatives

When aggregated with the impacts of past, present, and reasonably foreseeable future actions in the vicinity of the project, SWFSC research activities would make a minor additive contribution to cumulative adverse impacts to special resource areas in the CCRA under each of the research alternatives. Because the SWFSC does not employ bottom-contact research gear within the CCRA, which is the only SWFSC research area where federally designated EFH exists, there would be no direct impacts to EFH benthic habitat. Impacts to pelagic habitats within special resource areas resulting from SWFSC research activities using a combination of surface and mid-water trawl gear, as well as various plankton nets, water sampling devices and acoustic survey equipment would generally not extend beyond the duration of the survey period, and the magnitude and geographic extent of such impacts would be minor. Although the magnitude of future effects of climate change and ocean acidification on special resource areas is uncertain, the contribution of SWFSC research activities to the effects of climate change and ocean acidification would be minor. Likewise, SWFSC research activities are not expected to contribute to the risk of invasive species introductions or contamination from spills or discharges. Considering the magnitude of effects resulting from past, present, and reasonably foreseeable future actions external to SWFSC fisheries research activities, the contribution of SWFSC research activities to cumulative impacts on special resource areas would be minor under all research alternatives.

Contribution of the No Research Alternative

The No Research Alternative would result in elimination of any direct impacts to special resource areas that could potentially occur under each of the research alternatives. However, the SWFSC research activities proposed under the research alternatives would generate information important to resource managers to monitor environmental changes and design effective conservation measures for the special

resource areas. This type of information is especially important for management of special resource areas designated to protect and conserve natural resources that are susceptible to natural fluctuations and anthropogenic impacts. Without the input of SWFSC data, management authorities would lose important information needed to effectively manage and conserve special resource areas. Although resource management agencies have other available data sources to support resource management decisions, the No Research Alternative is expected to result in increased uncertainty and changes in some management scenarios. Through these indirect effects on future management decisions, the contribution of this alternative to adverse cumulative impacts on special resource areas, including National Marine Sanctuaries would be minor to moderate.

5.3.2 Eastern Tropical Pacific Research Area

External Factors in the ETPRA

Special resource areas in the ETPRA are affected by the same past, present, and reasonably foreseeable future factors as described for the CCRA (Table 5.1-1). Because the ETPRA does not include EFH, HAPC, or National Marine Reserves, cumulative impacts to these areas would not occur in the ETPRA. The cumulative impacts resulting from all external sources of disturbance to special resource areas are expected to be minor to moderate.

Contribution of the Research Alternatives

Under each of the research alternatives, the SWFSC would not employ bottom-contact research gear within the ETPRA and would remove small numbers of fish and invertebrates from ecosystems. Effects resulting from past, present, and reasonably foreseeable future actions external to SWFSC fisheries research activities, described in Table 5.1-1, would dominate the cumulative effects to special resource areas in the ETPRA. When aggregated with the impacts of past, present, and reasonably foreseeable future actions, SWFSC research activities would make a minor additive contribution to cumulative adverse effects on the special resource areas in the ETPRA under each of the research alternatives.

Contribution of the No Research Alternative

The No Research Alternative would result in elimination of all direct impacts to special resource areas that could potentially occur under any of the research alternatives. However, as described for the CCRA, data from SWFSC research activities is important to inform science-based decisions related to the management of special resource areas and meet obligations under international treaties. The loss of information currently provided by SWFSC research activities would have minor to moderate adverse contributions to cumulative impacts on special resource areas in the ETPRA under the No Research Alternative.

5.3.3 Antarctic Research Area

External Factors in the ARA

Cumulative impacts to special fishery related areas within the ARA are subsets of the cumulative impacts to specific physical, biological, and socioeconomic resources that are addressed in the resource specific sections of this EA. Past, present, and reasonably foreseeable future factors likely to impact physical resources within Antarctic special resource areas are discussed in Section 5.2. Special resource areas within the ARA include closed areas established by CCAMLR conservation measures (CCAMLR 2010). Taking of all finfish, other than for scientific research purposes, is prohibited in CCAMLR statistical subareas 48.1 and 48.2, which overlap with the SWFSC ARA (Figure 3.1-5). The closed areas established by CCAMLR theoretically eliminate any present or reasonably foreseeable future impacts from commercial fisheries to finfish resources within the ARA. In addition, very little scientific research is

conducted in the ARA by entities other than SWFSC. Past, present, and reasonably foreseeable future impacts to special resource areas within the ARA resulting from commercial fishing, scientific research, military operations, and vessel traffic are expected to be minor. The future effects of climate change on Antarctic special resource areas are difficult to quantify, but some sources suggest that these factors could produce substantial impacts to special resource areas within the ARA (Barnes and Conlan 2007).

Contribution of the Research Alternatives

When aggregated with the impacts of past, present, and reasonably foreseeable future actions, SWFSC research activities would make a minor additive contribution to cumulative adverse effects on the special resource areas in the ARA under each of the research alternatives. Periodic bottom trawl sampling and removals of fish and invertebrates (krill) would make minor contributions to cumulative impacts on ARA special resource areas under each of the research alternatives. Although the magnitude of future effects of climate change and ocean acidification on special resource areas is uncertain, the contribution of SWFSC research activities to the effects of climate change and ocean acidification would be minor. Likewise, SWFSC research activities are not expected to contribute to the risk of invasive species introductions or contamination from spills or discharges. The primary factors affecting the physical and biological environments in ARA special resource areas would be related to climate change and ocean acidification, as well as natural oceanographic and atmospheric cycles. The contribution of the SWFSC research activities to these effects would be minor under all the research alternatives.

Contribution of the No Research Alternative

The No Research Alternative would eliminate any direct adverse impacts to special resource areas within the ARA resulting from SWFSC research activities. However, the loss of scientific information currently provided by SWFSC survey activities would make it difficult for CCAMLR managers to assess the efficacy of special resource areas in fulfilling the ecosystem functions for which they were designated. If the SWFSC discontinued research in the ARA, management authorities would lack the information needed to establish management measures in a meaningful fashion, and over time the conservation measures currently in place to protect ecological properties of the environment would become obsolete. In addition, the No Research Alternative would preclude fulfillment of U.S. commitments to CCAMLR and obligations under the Antarctic Treaty. The loss of scientific information currently provided by SWFSC research activities would have minor to moderate adverse contributions to cumulative impacts under the No Research Alternative for the ARA.

5.4 CUMULATIVE EFFECTS ON FISH

Activities external to SWFSC fisheries research that could potentially affect fish species in the CCRA, ETPRA, and ARA may include commercial and recreational fisheries, ocean disposal and discharges, dredging, coastal development, oil extraction, other scientific research, military operations, climate change, and ocean acidification. These activities and potential effects are summarized in Table 5.1-1 and include:

- Injury or mortality due to directed catch or bycatch in commercial and recreational fisheries
- Habitat disturbances
- Changes in distribution and food availability due to climate change or habitat degradation

5.4.1 California Current Research Area

5.4.1.1 Endangered Species Act (ESA)-listed Species

External Factors in the CCRA

Several ESA-listed fish species occur in the CCRA (see Section 3.3.1.1), yet few are caught incidental to SWFSC fisheries research. Species periodically caught include canary rockfish, Pacific eulachon, steelhead trout, and all four species of ESA-listed salmon Only canary rockfish and Chinook and coho salmon will be discussed here, as the other ESA-listed species are rarely caught.

The past, present, and reasonably foreseeable future activities that have or are likely to have the greatest effect on endangered fish in the CCRA external to SWFSC fisheries research are intentional and incidental mortalities in commercial and recreational fisheries. Habitat alterations, especially for anadromous species, and periodic short-term and longer term climate changes may also affect population viability and stock sizes. In addition, research conducted by other NMFS fisheries sciences centers, such as the Northwest Fisheries Science Center (NWFSC), occurs in some of the same areas affected by SWFSC research, and is therefore considered in the set of external factors that contribute to cumulative effects in the CCRA.

The main factors responsible for the decline of canary rockfishes are overfishing in the commercial and recreational fisheries, habitat degradation, water quality problems, contaminants, and inadequacy of existing regulatory mechanisms (75 Federal Register [FR] 22276,). The spawning biomass of canary rockfish began to rapidly decline during the late 1970s, reached a minimum in the mid-1990s, and was declared overfished in 1999. Management actions (trip/bag limits, spatial closures, and gear restrictions) reduced the rate of removal and overfishing has not occurred since before 1999. Canary rockfish are harvested by commercial trawl and non-trawl fisheries, as bycatch in the Pacific whiting (hake) fishery, in recreational fisheries, and during research. Total catches in 2008-2010 ranged from 38 mt to 82 mt (Wallace and Cope 2011).

Threats and impacts to threatened and endangered Pacific salmonids include logging, agriculture, mining activities, urbanization, stream channelization, dams, wetland loss, water withdrawals, hydropower, and unscreened diversions (77 FR 19552). In addition, ocean-atmosphere climatic shifts over decadal time scales (e.g., the Pacific Decadal Oscillation) may lead to decreased ocean productivity that exacerbates degraded freshwater habitat conditions important to salmon (http://www.nmfs.noaa.gov/pr/species/fish/salmon.htm). There is evidence of strong correlations between oceanic productivity "regimes" and salmon population abundance (Good et al. 2005 and citations therein).

Commercial and recreational fisheries are closed for coho salmon in California, but the Central California Coast coho salmon ESU may still be incidentally captured in fisheries for other species. The impacts of incidental bycatch are not well known (77 FR 19552). Commercial and recreational fisheries for Chinook and coho salmon in the Pacific Fisheries Management Council-managed waters along the U.S. West Coast (ocean fisheries between the U.S./Canada border and the U.S./Mexico border from 3 to 200 nm offshore) are responsible for the greatest direct removal of salmon in the area. In 2011, commercial harvests of Chinook salmon were 160,304 fish or 933,947 kilograms (kg) dressed weight; recreational harvests were 83,380 fish. Fewer coho salmon were harvested, with a commercial harvest of 17,130 fish (44,000 kg) and 58,737 fish in the recreational fishery. Commercial harvests include Treaty Indian fisheries (Pacific Fisheries Management Council [PFMC] 2012).

The activities external to SWFSC fisheries research affecting ESA-listed fish will likely continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

The three research alternatives considered in this EA include similar scopes of research in the SWFSC CCRA. The primary differences lie in the number and types of associated mitigation measures for protected species. The SWFSC does some directed research on ESA-listed Pacific salmon and only a few listed species have been caught incidental to the California Cooperative Oceanic Fisheries Investigation (CalCOFI), Coastal Pelagic Species (CPS), Juvenile Salmon, and Juvenile Rockfish surveys. Chinook and coho salmon catch incidental to offshore surveys average 705 kg and 132 kg, respectively, each year. This level of mortality is sufficiently small that effects on stocks would be considered minor, particularly from non-listed stocks.

As noted in Section 4.2.3, an average of 156 kg (0.156 mt) of canary rockfish is currently removed annually during SWFSC research. This level of mortality accounts for a very small fraction (0.002%) of the spawning biomass and is considered minor. It is also a small fraction of the total commercial catch of canary rockfish, accounting for 0.41% of the total catch in 2009 and 0.19% of the 2010 commercial catch. In addition, it is unclear what proportion of this catch, if any, belong to the Puget Sound/Georgia Basin threatened DPS.

When considered in conjunction with commercial and recreational fisheries, and aggregated with other past, present, and reasonably foreseeable future activities affecting ESA-listed fish in the CCRA, the contribution of SWFSC fisheries research activities to cumulative effects would be minor.

Contribution of the No Research Alternative

Under the No Research Alternative, SWFSC would no longer conduct or fund fieldwork for fisheries and ecosystem research in the CCRA, so would not directly contribute to cumulative effects on threatened and endangered fish species in this region. In the absence of research surveys, important scientific information would not be collected about the status of fish stocks used for fisheries and conservation management, including trends in abundance, recruitment rates, and the amount of fish being harvested relative to overfishing metrics. This loss of scientific data would make it much more difficult for fisheries managers to effectively monitor the status of stocks, develop fishery regulations, and rebuild overfished stocks such as canary rockfish. SWFSC research also provides information on ecosystem characteristics important for monitoring potential effects from climate change and increases in ocean acidification, which could impact the population and distribution of many marine and anadromous species. Under Alternative 4, the loss of scientific data would make it increasingly difficult for fisheries managers to effectively monitor the status of stocks, develop meaningful fishery regulations, and rebuild overfished stocks such as canary rockfish. Although resource management agencies have other available data sources to support resource management decisions, the No Research Alternative is expected to result in increased uncertainty and changes in some management scenarios. Through these indirect effects on future management decisions, the contribution of this alternative to adverse cumulative impacts on fish stocks would be moderate. The indirect contribution of the No Research Alternative to cumulative effects on any one species is difficult to ascertain due to numerous unknown variables, but would likely impact long-term monitoring and management capabilities for ESA-listed species.

5.4.1.2 Target Species

External Factors in the CCRA

The numerous target species in the CCRA are managed through the PFMC and several fisheries management plans (FMPs) (Table 3.3.1). Target species taken by SWFSC during research surveys in quantities greater than 100 kg per year (Table 4.2-5) are included in the effects analysis. HMS are discussed in the following section; Pacific coast groundfish and coastal pelagic species are included here.

By definition, target species are those managed for recreational and commercial fisheries. These fisheries are the primary past, present, and reasonably foreseeable future activities that have or are likely to have the greatest effect on these species in the CCRA external to SWFSC fisheries research. In addition, research conducted by other NMFS fisheries sciences centers, such as the Northwest Fisheries Science Center (NWFSC), occurs in some of the same areas affected by SWFSC research, and is therefore considered in the set of external factors that contribute to cumulative effects in the CCRA. Natural population fluctuations, and periodic short-term and longer term climate changes also affect population viability and stock sizes.

The Pacific whiting (hake) fishery is the largest fishery along the west coast from northern California to British Columbia, with total landings (U.S. and Canada combined) of 217,000 mt in 2010. The 2011 spawning biomass was estimated to be 2 million mt. Since 2001, total catches have been below coast-wide Allowable Biological Catches (ABCs) (Stewart and Forrest 2011).

Among the species included in the CPS FMP are Pacific sardines, Pacific mackerel, Northern anchovy, and Jack mackerel. The first two are actively managed; the latter two are monitored species (PFMC 2011a). West Coast landings of Pacific sardine, Pacific mackerel, Jack mackerel, and anchovy in 2010 were 66,817 mt, 2,104 mt, 314 mt, and 1,284 mt, respectively. The estimated recreational harvest of Pacific mackerel in 2010 was 233.41 mt (PFMC 2011a).

Pacific sardines supported the largest fishery in the western hemisphere during the 1930s and 1940s, after which the population and fishery declined until reaching extremely low levels in the 1970s. With increasing abundance during the 1980s, a directed purse-seine fishery was reestablished. Pacific sardine landings are now made in the Pacific Northwest and in Baja California, México (Hill et al. 2011).

Pacific mackerel supported one of California's major fisheries during the 1930s and 1940s before experiencing a long-term decline. In the early 1970s, the State of California implemented a 'moratorium' on the directed fishery. Following a period of recovery, the moratorium was lifted and, through the 1990s, the fishery ranked third in volume for finfish landed in California (PFMC 2011a). The estimated total biomass in 2011 was 211,126 mt (Crone et al. 2011).

California landings of northern anchovy increased in the 1960s, but declined after reaching peak levels in 1975. From 2000 to 2010, northern anchovy landings averaged 322 mt for Washington, 71 mt for Oregon, and 9,028 mt for California (PFMC 2011a).

Jack mackerel has not been significantly targeted on the West Coast. Landings of jack mackerel in the California pelagic wetfish fishery through the 1990s averaged under 1,900 mt over 1990-2000, with a maximum of 5,878 mt in 1992 (PFMC 2011a).

The activities external to SWFSC fisheries research affecting target species will likely continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures and management schemes. The potential effects of climate variability are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

The average catch of target species during SWFSC research surveys (Table 4.2-5) is orders of magnitude smaller than commercial and recreational harvest levels. For example, the SWFSC average annual catch of Pacific mackerel (7,534 kg) is 0.36% of 2010 commercial landings. Average annual research catch of Pacific whiting (1,045 kg) is the equivalent of 0.0005% of the 2010 commercial landings. In addition, the SWFSC research catch represents much less than 0.1% of the ABC or other fisheries metric for the target species (Table 4.2-5). For all target species in the CCRA, mortality from SWFSC research surveys is considered minor on the population level.

When considered in conjunction with commercial and recreational fisheries and aggregated with other past, present, and reasonably foreseeable future activities affecting target species in the CCRA, the

contribution of SWFSC fisheries research activities to cumulative effects would be minor under all the research alternatives.

Contribution of the No Research Alternative

Under the No Research Alternative, SWFSC would no longer conduct or fund fieldwork for fisheries and ecosystem research in the CCRA, so would not directly contribute to cumulative effects on target species in this region. In the absence of research surveys, important scientific information would not be collected about the status of fish stocks used for fisheries and conservation management, including trends in abundance, recruitment rates, and the amount of fish being harvested relative to overfishing metrics. This loss of data would make it much more difficult for fisheries managers to effectively monitor the status of stocks, develop fishery regulations, and rebuild overfished stocks. Ceasing or interrupting long-term data series on oceanography, abundance and distribution of various species, and diet studies (e.g., 60 years of CalCOFI) would have long-term effects on the ability of scientists to monitor and model effects of ecosystem changes. The loss of information and increasing uncertainty about the status of fish stocks and their habitats would have serious implications for fisheries management. Through these indirect effects on future management decisions, the contribution of this alternative to adverse cumulative impacts on fish stocks would be moderate. The indirect contribution of the No Research Alternative to cumulative effects on any one species is difficult to ascertain, but will likely impact long-term monitoring and management capabilities for numerous economically and ecologically important species.

5.4.1.3 Highly Migratory and Prohibited Species

External Factors in the CCRA

HMS are designated due to their wide geographic distribution and their significant, but variable migrations across ocean basins. This makes them more available for harvest by multiple fisheries and more challenging to manage (PFMC 2011). HMS in the Pacific Region that are actively managed under the HMS FMP include various tunas, sharks, billfish/swordfish, and dorado, also known as dolphinfish or mahi-mahi (PFMC 2011b).

There is no single, pan-Pacific institution that manages all HMS throughout their ranges. Within the U.S., HMS fishery management in the Pacific is the responsibility of the Western Pacific Regional Fishery Management Council, North Pacific Fishery Management Council (NPFMC), PFMC, and the adjacent states (PFMC 2011b).

HMS along the U.S. West Coast are harvested commercially and recreationally. Commercial gears include surface hook and line, pelagic drift gillnet, pelagic longline, purse seine and harpoon. Sport fisheries target albacore, mixed tunas and dorado, billfish, and sharks (PFMC 2011b). The albacore fishery is the largest HMS fishery in the CCRA and is comprised of vessels that predominately troll for albacore using jigs, and to a lesser extent live bait. Surface hook-and-line gear accounts for most West Coast albacore landings (PFMC 2011b). The 2010 commercial landings in California, Oregon, and Washington combined were 11,822.6 mt (PFMC 2011c). Drift gillnet vessels operating off California, Oregon and Washington, and longline vessels targeting swordfish, beyond the West Coast Exclusive Economic Zone (EEZ) also harvest albacore. The recreational fishery for albacore harvests up to 1,500 mt in some years (PFMC 2011b).

California commercial landings of other HMS that are also targeted by SWFSC include 67.9 mt of thresher sharks in the large mesh drift gillnet fishery and 17.2 mt of mako sharks and 1.4 mt of thresher sharks in set gillnets (PFMC 2011c).

The activities external to SWFSC fisheries research affecting HMS fish will likely continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures and management schemes. The potential effects of climate

variability are unpredictable, but are also likely to impact these species and to continue into the foreseeable future.

Contribution of the Research Alternatives

The HMS caught by SWFSC research in the CCRA includes blue sharks, common thresher shark, North Pacific albacore tuna, and shortfin mako. The level of catch by SWFSC is relatively small compared to known harvests in commercial and recreational fisheries and, in the case of North Pacific albacore tuna, a fraction (0.0003%) of the ABC (Table 4.2-5). The effects of SWFSC research on these HMS are considered minor.

When considered in conjunction with commercial and recreational fisheries and aggregated with other past, present, and reasonably foreseeable future activities affecting HMS fish in the CCRA, the contribution of SWFSC fisheries research to cumulative effects would be minor.

Contribution of the No Research Alternative

Under the No Research Alternative, the SWFSC would not directly contribute to cumulative effects on HMS in the CCRA. In the absence of research surveys, important scientific information would not be collected, such as stock abundance and recruitment, making it more difficult for fisheries managers to effectively monitor status of stocks, develop fishery regulations, and rebuild overfished stocks. SWFSC research on HMS supports U.S. commitments to international management of HMS in the Pacific Ocean, including stock assessment and management advice to NMFS and U.S. officials and commissioners to the Inter-American Tropical Tuna Commission (IATTC) and other international committees. The loss of this scientific information would compromise the U.S. support of such international treaties and agreements.

SWFSC research also provides information on ecosystem characteristics important for monitoring potential effects from climate change and increases in ocean acidification, which could impact the population and distribution of many marine species. The indirect effects of the No Research Alternative could, therefore, result in adverse effects to fish stocks through a lack of information essential for informed decision making and conservation of fish, their prey, and their habitats. The indirect contribution of the No Research Alternative to cumulative effects for any particular species is difficult to ascertain, however the No Research Alternative would likely impact long-term monitoring and management capabilities for many economically and ecologically important species. When considered in conjunction with commercial and recreational fisheries and aggregated with other past, present, and reasonably foreseeable future activities affecting marine fish in the CCRA, the contribution of the No Research Alternative to cumulative effects on fish would be minor to moderate.

5.4.2 Eastern Tropical Pacific Research Area

External factors in the ETPRA

Fisheries in the Eastern Tropical Pacific (ETP) range from small-scale artisanal to large-scale industrial operations. Targeted species include herring, sardines, anchovies, mackerel, various tuna species, and squid (FAO 2005). The tuna purse seine fishery is one of the largest and most closely monitored, largely due to present and historical marine mammal by-catch. Yellowfin tuna, followed by skipjack and big-eye tuna, are the primary target species of the tuna fishery. The IATTC is an international convention with U.S. membership that provides the framework for conservation and management of tuna resources in the ETP. The implementing statute for the IATTC Convention is the Tuna Conventions Act of 1950 (PFMC 2011c).

The U.S. tuna purse seine fleet operating in the ETP decreased from 155 large (>362.8 mt) vessels in 1976 to about five such vessels per year from 2001 through 2003. About ten or fewer small purse seine vessels (< 100 mt) mostly target coastal pelagic species (Pacific mackerel and sardine) but occasionally

catch tuna in the ETP (National Oceanic and Atmospheric Administration [NOAA] 2004). The international fleet comprises the majority of fishing effort and carrying capacity in the ETP tuna fishery. From 1997 through 2001, an average of 132 international tuna purse seine vessels greater than 400 mt carrying capacity and an average of 71 vessels smaller than 400 mt carrying capacity fished in the ETP annually. The smaller vessels fish for tuna year-round off the coasts of Central and South America (NOAA 2004, and citations therein).

Commercial catches of yellowfin, skipjack, and big eye tuna in the Eastern Pacific Ocean in 2010 were 256,126 mt, 150,661mt, and 81,391mt, respectively. Most were caught by purse seine. Nearly half of the 2010 yellowfin purse seine catch (104,969 mt) was from Mexican flagged boats (IATTC 2011).

Commercial fisheries are the primary activity impacting fish species in the ETPRA and will likely continue into the foreseeable future. The level of impact will depend on the application and efficacy of current and proposed mitigation measures and management schemes. Potential effects of climate variability are possible and are unpredictable, but are also likely to impact these species and to continue into the foreseeable future.

Contribution of the Research Alternatives

The current SWFSC research activities in the ETPRA that are common to all three research alternatives are not oriented toward stock assessments of any target species and remove only very small quantities of fish, primarily larval and juvenile size classes caught in plankton nets. The overall catch of fish is only about 1 kg per year, which is considered minor for all species in the ETP.

The proposed longline survey in the ETPRA will be used by the SWFSC to monitor the abundance and distribution of HMS in the ETPRA. Given the small amount of effort (60 sets) over a very large area, the resulting fish mortality will likely be very small relative to any of the fish populations and the effects would be minor. When compared with the commercial tuna fisheries whose annual catch levels are in the hundreds of thousands of kg, and aggregated with other past, present, and reasonably foreseeable future activities, the contribution of the SWFSC proposed longline catch to cumulative effects would be considered minor.

Contribution of the No Research Alternative

Under the No Research Alternative, the SWFSC would not directly contribute to cumulative effects on other fish in this region. Indirectly, however, the loss of information obtained through this research could have adverse impacts on management decisions and analysis of long-terms trends affecting tuna fisheries in the ETP and their associated environmental impacts, especially bycatch of dolphins. The SWFSC is responsible for monitoring and conducting research on dolphins incidentally caught in the ETP tuna purse-seine fishery. This research is mandated by the Marine Mammal Protection Act (MMPA) and supports the U.S. delegation to the Agreement on the International Dolphin Conservation Program (AIDCP). SWFSC is the only entity that provides dolphin monitoring and research results to the AIDCP parties, which forms the basis for management measures taken, including setting annual dolphin mortality limits and establishing independent observer program requirements for the tuna fisheries. In the absence of the SWFSC research, the AIDCP parties would have no information on the efficacy of current management measures or whether new measures are needed, and the U.S. delegation would fail to meet its obligations to the other AIDCP parties and the Secretariat (SWFSC 2010). The indirect contribution of the No Research Alternative to cumulative effects on any one species is difficult to ascertain, but will likely impact long-term monitoring and management capabilities for many economically and ecologically important species. When considered in conjunction with commercial and recreational fisheries and aggregated with other past, present, and reasonably foreseeable future activities affecting marine fish in the ETPRA, the contribution of the No Research Alternative to cumulative effects on fish would be minor to moderate.

5.4.3 Antarctic Research Area

External Factors in the ARA

The primary activities external to SWFSC research in the ARA likely to impact fish in the region are commercial fisheries and, most likely, climate change.

The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) was signed in 1980, with the primary purpose of protecting and conserving marine living resources in the waters surrounding Antarctica, including krill, icefish and other finfish, mollusks, crustacea, and all other species of living organisms (NMFS 2006). CCAMLR sets catch limits for both established (assessed) fisheries and new and exploratory fisheries. These catch limits are for total catch by all countries in the convention area; there are no individual country allocations (NMFS 2006). CCAMLR currently regulates commercial fishing for Antarctic krill (*Euphausia superba*), Patagonian/Antarctic toothfish (*Dissostichus* spp.), icefish (*Champsocephalus gunnari*), and other species such as lantern fish (*Electrona carlsbergi*), squid (*Martialia hyadesi*), and crabs (*Paralomis* spp.) (http://www.ccamlr.org/pu/e/sc/fish-monit/hs-intro.htm, accessed May 7 2012).

Of these managed species, only mackerel icefish (*Champsocephalus gunnari*), was among the species taken in appreciable amounts (>100 kg) in the most recent SWFSC bottom trawl surveys. The CCAMLR Working Group recently recommended that the catch limit for *C. gunnari* should be set at 3,072 mt in 2011/12 and 2,933 mt in 2012/13 (CCAMLR 2011).

Several stocks of Antarctic finfish in the Southern Scotia Arc region were decimated in the 1970s and 1980s due to unmanaged commercial harvest. As a result, CCAMLR imposed a moratorium on all finfish fishing in 1990 in order to protect the remaining fish stocks (NOAA 2011b).

According to Turner et al. (2009), accelerated global warming and increased UV-B levels resulting from the ozone hole that develops in spring are the most important anthropogenic changes currently affecting the Antarctic. They note that the Antarctic marine ecosystem has been affected by climate change over the last fifty years, especially on the western side of the Antarctic Peninsula, with warming ocean temperatures and declining sea ice. A projected continued decline in sea ice could affect production of marine algae, with cascading effects through higher trophic levels, fish included. Increased ocean acidification is another potential side effect of environmental change (Turner et al. 2009).

The activities external to SWFSC fisheries research affecting fish in the ARA will likely continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures and management schemes. The potential effects of climate variability are unpredictable, but are also likely to have continued impacts into the foreseeable future.

Contribution of the Research Alternatives

SWFSC surveys in the ARA primarily focus on Antarctic krill, which are discussed in Section 4.2.7. Every two to three years, the SWFSC also conducts bottom trawl surveys in the South Orkney Islands area to monitor the recovery of several finfish that were overfished in the 1970s and 1980s. During the last research survey, conducted during the 2008-2009 season, only seven species were caught in totals greater than 100 kg (Table 4.2-6). Of these, only mackerel icefish is among the species for which CCAMLR recommended catch limits (see above). The level of periodic catch by SWFSC is minor (0.02% of the recommendation). The overall contribution of SWFSC research to cumulative effects on fish species in the ARA would be considered minor under all research alternatives.

Contribution of the No Research Alternative

Under the No Research Alternative, the SWFSC would not directly contribute to cumulative effects on fish in the ARA. Indirectly, however, the loss of information obtained through this research could impact

management decisions affecting fish species in the Antarctic. SWFSC research includes estimating stock status and characterizing population dynamics for commercially important finfish, as well as other demersal Antarctic finfishes. SWFSC research is regularly presented to the scientific advisory bodies to the CCAMLR. In addition, SWFSC is the primary source of scientific advice to the U.S. Commissioner and delegation to CCAMLR. The loss of this information would have adverse effects on the management of fish in the ARA and would compromise the U.S. compliance with international treaty obligations. The indirect contribution of the No Research Alternative to cumulative effects on any one species is difficult to ascertain, but will likely impact long-term monitoring and management capabilities for many economically and ecologically important species. When considered in conjunction with commercial fisheries and aggregated with other past, present, and reasonably foreseeable future activities affecting marine fish in the ARA, the contribution of the No Research Alternative to cumulative effects on fish would be minor to moderate.

5.5 CUMULATIVE EFFECTS ON MARINE MAMMALS

5.5.1 California Current Research Area

Activities external to SWFSC fisheries research that may potentially affect marine mammals in the CCRA include commercial and recreational fisheries, vessel traffic, ocean discharges, dredging, geophysical activities and oil extraction, other scientific research, military operations, conservation measures, and climate change. These activities and potential effects are summarized in Table 5.1.1 and include:

- Disturbance/behavioral changes or physical effects from anthropogenic noise (e.g., marine vessels of all types, military readiness operations, navigational equipment, construction)
- Injury or mortality due to vessel collisions, entanglement in fishing gear, and contamination of the marine environment
- Changes in food availability due to prey removal, ecosystem change, or habitat degradation

5.5.1.1 ESA-listed Species

External Factors in the CCRA

The endangered marine mammal species in the CCRA include the Southern Resident killer whale (SRKW) Distinct Population Segment (DPS), sperm whales, humpback, blue, fin, and sei whales. Threatened species include Guadalupe fur seals, the Eastern DPS of Steller sea lions (proposed for delisting), and the southern subspecies of sea otters. Commercial whaling was the single greatest historical source of mortality for the endangered whale species (except killer whales), as was commercial sealing for Guadalupe fur seals during the 19th century (Carretta et al. 2011 and citations therein, Perry et al. 1999). Commercial harvests of sperm whales ended worldwide in 1986 (NMFS 2010). Humpback whales and blue whales were protected in 1966 (NMFS 1998, Perry et al. 1999). The International Whaling Commission (IWC) banned hunting of fin whales throughout the North Pacific in 1976 (Perry et al. 1999). Hunting of sei whales in the eastern North Pacific ended after 1971 and after 1975 in the western North Pacific (Perry et al. 1999).

Live capture of killer whales in Washington and British Columbia for use in aquaria was a major historical source of population decline for SRKWs between 1962 and 1977. Seventy percent (47 or 48 animals) of the whales retained or killed were Southern Residents (NMFS 2008, and citations therein).

Commercial harvests of sea otters for their pelts during the 18th and 19th centuries nearly extirpated the species throughout its range. Southern sea otter populations gradually expanded along the central California coast after being protected under the International Fur Seal Treaty in 1911 (Carretta et al. 2011, and citations therein).

More recent past, present, and reasonably foreseeable future conservation concerns and threats to recovery are outlined in the respective recovery plans for the ESA-listed species for which plans exist. Those for blue whales (NMFS 1998), humpback whales (NMFS 1991), sperm whales (NMFS 2010c), fin whales (NMFS 2010a), sei whales (NMFS 2011), SRKWs (NMFS 2008a), Steller sea lions (NMFS 2008b), and southern sea otters (U.S. Fish and Wildlife Service [USFWS] 2003) were finalized or recently updated. Noted conservation concerns and threats include vessel collisions, entanglement in fishing gear, anthropogenic noise, vessel/human disturbance, pollutants and pathogens, disease, habitat degradation, competition with fisheries for prey, and climate change.

Vessel collisions are considered threats for several endangered large whales, particularly blue, humpback, and fin whales. The contribution of ship strikes to the annual average anthropogenic sources of mortality is noted in Section 3.2.2 under the respective species descriptions. The Pacific coast of the U.S. includes numerous shipping lanes, active ports and vessel traffic. The major container ports are Seattle, Tacoma, Portland, Oakland, Long Beach and Los Angeles. The Santa Barbara Channel, through which most Long Beach and Los Angeles-bound vessels transit, contains some of the highest densities of commercial maritime traffic in the world. An average of 6,500 large (over 300 gross tons) vessels annually pass through the Channel, most at speeds greater than 14 knots (kts) (Channel Islands National Marine Sanctuary [CINMS] 2006 cited in Abramson et al 2009). In addition, there are several large Naval bases (e.g., Naval Base San Diego, the largest on the west coast and home to the Pacific Fleet) and U.S. Coast Guard (USCG) Stations in Washington and California.

Fin whales had the highest incidence of confirmed ship strike mortality (five whales), followed by blue whales (two) and humpback whales (one) along the Washington coast between 1980 and 2006. Three of the fin whales and one of the blue whales were discovered draped over the bows of container ships. Possible additional ship strike mortalities include two fin whales, one sperm whale, and one sei whale (Douglas et al. 2008).

An average of three large whales per year was found dead along the California coast between 2000 and 2011with injuries caused by ship strike (Kennedy 2012). Between September and November 2007, five blue whale deaths in the Southern California Bight near the Northern Channel Islands were attributed to ship strikes. NMFS designated these deaths an Unusual Mortality Event (UME), which the MMPA defines as "a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response" (CINMS 2008). In 2010, two blue whales, one humpback, and two fin whales were found dead in and around Monterey Bay, Gulf of the Farallones, and Cordell Bank NMS and one blue whale was found dead on San Miguel Island within CINMS (Kennedy 2012).

In response to the UME in 2007, NOAA developed numerous mitigation and monitoring measures to address ship strikes, especially in the Santa Barbara Channel. This includes a seasonal Whale Advisory Zone. When five or more blue, humpback, and/or fin whales are sighted in the Whale Advisory Zone during monitoring of shipping lanes, NOAA coordinates with USCG and National Weather Service to broadcast a notice to mariners advising ships over 300 gross tons to watch for large whales and to maintain speeds of 10 kts or less (http://channelislands.noaa.gov/focus/management.html). Based on Automatic Identification System station data on ships transiting within and outside the Santa Barbara Channel during 2007-2009, CINMS staff found that most ships have not slowed to 10 kts (Kennedy 2012).

The USCG completed a Port Access Route Study in 2011 for San Francisco Bay. A formal proposal was submitted to the IMO to extend the northern (17 nm), western (3 nm), and southern (8.5 nm) shipping lanes and to narrow the northern and western lanes to three nautical miles wide each. The northern and western shipping lanes were also shifted slightly (33 CFR 167). These changes will keep vessels on a more predictable path and avoid the Area of Special Biological Significance at Point Reyes and an important feeding area for whales at Cordell Bank National Marine Sanctuary (NOAA 2012).

Disturbance by vessels is a possible contributing factor in the recent decline in the population of SRKWs (NMFS 2008a). In order to protect killer whales from interference and noise associated with vessels, in 2011, NMFS established regulations prohibiting vessels from approaching killer whales within 200 yards (182.9 meters [m]) and from parking in the path of whales when in inland waters of Washington State (76 FR 20870). This should help reduce the number and severity of vessel incidents and promote population growth and recovery (NMFS 2010b).

Entanglement in fishing gear is another concern for several ESA-listed species. Overall, the level of take for ESA-listed marine mammals in the CCRA is relatively low. There are no fisheries mortalities or serious injuries documented for blue, fin, or sei whales, and the mean annual take of sperm whales by unknown fisheries was ≥0.2. The mean annual take of humpback whales (≥3.2) in pot or trap fisheries and unknown fisheries exceeds 10 percent of the potential biological removal (PBR), so is not approaching a zero mortality and serious injury (M&SI) rate (Carretta et al. 2011). Drift and set gillnet fisheries may cause incidental mortality of Guadalupe fur seals, but there are no reports of mortality or injuries in the U.S. and information is not available for Mexico. Steller sea lions have been taken in the Pacific whiting trawl fishery (0.8 mean annual take, 2000-2004), but there were no fishery-related strandings between 2004 and 2008 (Allen and Angliss 2011). Information on takes of southern sea otters in commercial fisheries is limited, although drift and set gillnet fisheries, purse seine fisheries, pot fisheries, and hook and line fisheries have the potential to kill or injure southern sea otters (Carretta et al. 2011).

The Pacific Offshore Cetacean Take Reduction Plan (POCTRP) was finalized in 1997 to reduce the level of M&SI of several marine mammal stocks, including sperm and humpback whales, in the California/Oregon drift gillnet fishery for thresher shark and swordfish (62 FR 51805). Data from 2008-2009 indicated that the POCTRP achieved the MMPA short term goal of reducing serious injuries and mortalities of all strategic stocks to below PBR and the long term goal of reducing serious injuries and mortalities of all marine mammals (except long-beaked common dolphins) to insignificant levels (POCTRT 2009).

The potential effects of commercial fisheries on prey availability are not clear. Direct competition with fisheries for prey is unlikely for blue, fin, and sei whales whose diet consists of 80-100% large zooplankton, primarily krill (Barlow et al. 2008). Humpbacks consume roughly 50% large zooplankton, along with small pelagic and miscellaneous fish. Sperm whales consume about 60% large squid, and a mix of various fish, small squid, and benthic invertebrates. Krill is not commercially harvested, nor are most of the other prey items (Barlow et al. 2008).

Recovery plans for SRKWs identified reduced prey availability as a risk to the population. Chinook salmon is overwhelmingly the most frequently consumed prey, of which 80-90% is from the Fraser River (Hanson et al 2010). The SRKW population may consume 12–23% of available Fraser River Chinook in the region from May–September, which might exceed takes from all fisheries in the region combined. As both species have at-risk conservation status and transboundary (Canada–U.S.) ranges, there could be competition between conservation objectives for killer whales and Chinook salmon (Williams et al. 2011).

The potential for competition for prey exists for the eastern DPS of Steller sea lions. Steller sea lions are known to consume several commercially important species including Pacific whiting, salmonids, Pacific herring, and squid. Although the fishery for Pacific whiting is one of the largest off the west coast, there are no indications of resource competition along the Oregon and Washington outer coasts. In addition, the coastal Pacific whiting fishery is essentially closed south of 42°N latitude eliminating direct fishery impacts on Steller sea lions in central California, and minimizing potential resource competition during the summer months when the Steller sea lion population is concentrated on rookeries in southern Oregon and northern California (Baraff and Loughlin 2000, NMFS 2008b).

Climate change impacts on ESA-listed species are possible through changes in habitat and food availability. Migration, feeding, and breeding locations influenced by ocean currents and water

temperature could be impacted, which could, ultimately, affect productivity of ESA-listed species (NMFS 2010, NMFS 2011). In addition, research conducted by other NMFS fisheries sciences centers, such as the Northwest Fisheries Science Center (NWFSC), occurs in some of the same areas affected by SWFSC research, and is therefore considered in the set of external factors that contribute to cumulative effects in the CCRA.

With the exception of the historical sources of population decline, all of the aforementioned effects are likely to continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

No collisions with ESA-listed species have been reported from any fisheries research activities conducted or funded by the SWFSC in CCRA, as described in Section 4.2.4. Given the relatively slow speeds of research vessels, mitigation measures, and the small number of research cruises, the likelihood of fisheries research vessels causing serious injury or mortality to ESA-listed species due to ship strikes is considered possible but the potential risk is minor.

The potential effects from use of active acoustic devices for research activities would have rare or infrequent and temporary behavioral avoidance effects on ESA-listed marine mammals throughout the CCRA. Relative to the volume of other ship traffic and anthropogenic sources of acoustic disturbance, the contribution of noise from SWFSC research would be minor.

There have been no adverse interactions or takes of ESA-listed marine mammals during SWFSC fisheries research in the CCRA and, with one exception, takes of ESA-listed species are not anticipated. Based on historical takes of an analogous species, California sea lions, the SWFSC Letter of Authorization (LOA) application (Appendix C) estimated that Steller sea lions from the threatened Eastern DPS could be taken in the future by trawl gear (average of two animals per year or ten over the five-year LOA period, including one take per five-year period attributed to “undetermined pinniped species”) and longline gear (average of 0.4 animals per year or two over the five-year LOA period, including one take per five-year period attributed to “undetermined pinniped species”). Given the existing and proposed additional mitigation measures, and the lack of historical takes of this species, it is unlikely that the requested level of take would be realized. A total average of 2.4 lethal takes of Steller sea lions per year due to SWFSC research, if they occurred, combined with other sources of anthropogenic mortality (average of 40.8 animals per year from the stock, Allen and Angliss 2011), would still be well below 10 percent of PBR for the stock (238 animals). The contribution of SWFSC research activities to the cumulative impacts on the population would be minor adverse.

Although there is some overlap in prey of ESA-listed marine mammals in the CCRA and the species collected during SWFSC research surveys, the total amount sampled is minimal compared to overall biomass and commercial fisheries removals. In addition, the size classes of fish targeted in SWFSC research are generally smaller than that preyed upon. The contribution of research catches to the cumulative effects on marine mammals through competition for prey is therefore considered minor for all species in the CCRA.

The cumulative effects from all past and present factors on ESA-listed species have, by definition, major impacts on the populations of these species. However, when considered in conjunction with other past, present, and reasonably foreseeable future activities affecting ESA-listed marine mammals in the CCRA, the contribution of the three research alternatives to cumulative effects on ESA-listed marine mammals would be minor and adverse through incidental take. However, research conducted by the SWFSC also provides valuable information for the conservation and management of ESA-listed species and this contribution to cumulative effects would be beneficial for these species.

Contribution of the No Research Alternative

Under the No Research Alternative, NMFS would not promulgate rulemaking or issue LOAs for SWFSC fisheries research. SWFSC would no longer conduct or fund fisheries or ecosystem survey activities in the CCRA and would not directly contribute to cumulative effects on threatened and endangered species in this region. Indirectly, however, the loss of information obtained from SWFSC ecosystem research on the abundance and distribution of marine mammals, their feeding ecology, oceanographic components of their habitat, status of prey stocks, and fisheries interactions could adversely impact management decisions regarding the recovery of these ESA-listed species and analysis of long-term trends affecting the marine ecosystem. The indirect contribution of the No Research Alternative to cumulative effects is difficult to ascertain for individual species, but will likely impact long-term monitoring and management capabilities for many ESA-listed marine mammals in the CCRA. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting ESA-listed marine mammals in the CCRA, the contribution of the No Research Alternative to cumulative effects on ESA-listed marine mammals would be minor to moderate.

5.5.1.2 Other Cetaceans

External Factors in the CCRA

The cetacean species included in this section are not listed as threatened or endangered. These species are all subject to similar types of effects from external activities as described above for ESA-listed species. Interactions with commercial fisheries are likely to have the greatest effect on most of these species and are generally well-documented.

Fisheries in which these species have been subject to mortality or serious injury between 2004 and 2008 include set gillnet fisheries (harbor porpoise), Washington/Oregon/California domestic groundfish trawl (Dall's porpoise), Puget Sound salmon drift gillnet (Dall's porpoise), California/Oregon thresher shark/swordfish drift gillnet fishery (Pacific white-sided dolphins, Risso's dolphins, short- and long-beaked common dolphins, and nothern right whale dolphin), West Coast limited entry bottom trawl fishery (Pacific white-sided dolphins), California squid purse seine (short-beaked common dolphins), California small mesh drift gillnet fishery for white seabass, yellowtail, barracuda, and tuna (long-beaked common dolphins), and unknown fisheries (Carretta et al. 2011). The reported number of takes is less than 10 percent of the respective PBR levels for each of these species, so population-level effects from commercial fishery takes are minor. There were no reported takes of striped dolphins, short-finned pilot whales, pygmy or dwarf sperm whales during that time period.

Mitigation measures effectively reduced Level A takes for harbor porpoise in central California coastal gillnet fisheries and for several species in the California/Oregon thresher shark/swordfish drift gillnet fishery. A 2002 ban on gillnets inshore of the 60 fathom (110 m) isobath from Point Arguello to Point Reyes was thought to reduce potential harbor porpoise mortality to near zero for the Morro Bay, Monterey Bay, and San Francisco-Russian River stocks (Carretta et al. 2011). Low levels of take of harbor porpoise in unknown and marine set gillnet fisheries occur north of the closure area from northern California to the Washington coast (Carretta et al. 2011). Implementation of the POCTRP in 1997 (62 FR 51805) resulted in considerable decreases in overall cetacean entanglement rates in the drift gillnet fishery. Data from 2008-2009, indicated that the POCTRP achieved the MMPA short term goal of reducing serious injuries and mortalities of all strategic stocks to below PBR and the long term goal of reducing serious injuries and mortalities of all marine mammals (except long-beaked common dolphins) to insignificant levels (POCTRT 2009).

Prey consumed by the odontocetes considered here includes some commercially valuable species, such as herring and anchovies that are preyed upon by harbor porpoise, plus an array of non-commercially

important mesopelagic fish, small pelagic fish, squid, and miscellaneous fish (Barlow et al. 2008). It is unlikely that commercial fisheries affect the availability of prey for non ESA-listed cetaceans.

Climate change impacts are difficult to predict, but will likely affect non ESA-listed cetaceans through changes in habitat and food availability.

The activities external to SWFSC fisheries research affecting cetaceans are likely to continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

There have been no documented cases of cetaceans being disturbed or changing their behavior in response to SWFSC research vessels other than bow-riding by dolphins and Dall's porpoise, which is a common behavior not considered detrimental. However, potential disturbance from acoustic sources could take place under the surface of the water and be undetectable by observers on the deck of a research vessel. Based on an analysis of sound source characteristics of acoustic equipment used in research and hearing capacities of marine mammals, the potential effects from use of active acoustic devices for research activities would likely be rare or infrequent and cause temporary avoidance reactions in cetaceans throughout the CCRA, which is considered to have an overall minor impact.

Two species of cetaceans, Pacific white-sided dolphins and northern right whale dolphins, have been caught or entangled in SWFSC research trawl gear in the past. The SWFSC LOA application (Appendix C) includes estimates of the number of other cetaceans that may have adverse interactions with research gear based on similarities to these two species and historical takes in analogous commercial fisheries (Table 4.2-10). These species include two porpoise species, seven species of dolphins, short-finned pilot whale, and pygmy and dwarf sperm whales. As described in the ESA-listed species section above, the SWFSC does not think this many cetaceans will actually be taken in the next five years but has chosen to use a conservative estimation procedure to ensure accounting for the maximum amount of potential take.

For all but one cetacean species (bottlenose dolphins), the estimated average annual take from SWFSC research is less than 10 percent of PBR (Table 4.2-10) and is considered minor in magnitude. For bottlenose dolphins (two small stocks), estimated takes in the LOA application are greater than 10 percent and less than 50 percent of PBR and are considered moderate in magnitude. When the contribution of estimated incidental take from SWFSC research is added to other sources of anthropogenic mortality (primarily incidental take in commercial fisheries and ship strikes, Carretta et al. 2011), total anthropogenic mortality and serious injury for most species remains much less than 10 percent of PBR and the cumulative magnitude of effect is considered minor.

For Risso's dolphin (PBR = 39), the contribution of estimated future research take (2.6 animals per year, including one take per five-year period attributed to "undetermined delphinid species"), when added to other mortality and serious injury (1.6 animals per year, Carretta et al. 2011), causes the cumulative mortality and serious injury (4.2 animals per year) to exceed 10 percent of PBR (3.9 animals per year). This cumulative impact, if it occurred, would be considered moderate in magnitude. However, as described in the direct and indirect effects analysis in section 4.2.4, in addition to the magnitude of effects, NEPA analyses must also consider other elements such as the frequency or duration of effects and their likelihood of occurrence. For Risso's dolphin, the estimated takes and contribution of research to historic takes are based on one incident in 2008 when 11 Pacific white-sided dolphins were caught in one trawl set. Although Risso's dolphins have never been caught in SWFSC research gear in the past, there is the possibility for multiple animals to be caught at one time. However, given the implementation of several new mitigation measures since 2008, including MMEDs in Nordic 264 trawl nets, the SWFSC considers future takes of this species at the estimated rate to be unlikely and to occur only rarely. The

overall contribution of SWFSC research to the cumulative effects of adverse gear interactions with this species is therefore considered minor.

For Pacific white-sided dolphins and northern right whale dolphins, the average annual mortality and serious injury data from all anthropogenic sources reported in Table 4.2-10 includes historic incidental takes of these species in SWFSC and Northwest Fisheries Science Center fisheries research (Carretta et al. 2011). For Pacific white-sided dolphins (PBR = 193), the contribution of estimated future research take (average 7.2 animals per year, including one take per five-year period attributed to "undetermined delphinid species"), when added to non-research mortality and serious injury (10.5 animals per year), brings the cumulative mortality and serious injury (17.7 animals per year) close to 10 percent of PBR (19.3 animals per year). This cumulative impact, if it occurred, would be considered minor in magnitude.

For northern right whale dolphins (PBR = 48), the contribution of estimated future research take (average 2.2 animals per year, including one take per five-year period attributed to "undetermined delphinid species"), when added to non-research mortality and serious injury (3.6 animals per year), causes the cumulative mortality and serious injury (5.8 animals per year) to exceed 10 percent of PBR (4.8 animals per year) but be less than 50 percent of PBR (24 animals per year). This cumulative impact, if it occurred, would be considered moderate in magnitude. As described for Risso's dolphins above, NEPA analyses must also consider the frequency or duration of effects and their likelihood of occurrence. For northern right whale dolphins, the estimated takes and contribution of research to historic takes are based on one incident in 2008 when six northern right whale dolphins were caught in one trawl set. Given the implementation of several new mitigation measures since that time, including MMEDs in Nordic 264 trawl nets, the SWFSC considers future takes of this species at the estimated rate to be unlikely and to occur only rarely. The overall contribution of SWFSC research to the cumulative effects of adverse gear interactions with this species is therefore considered minor.

For bottlenose dolphins (PBR = 5.5 for the offshore stock and 2.4 for the coastal stock), anthropogenic sources of mortality and serious injury is low (0.2 animals per year for each of the two stocks) and does not include any past incidental takes from NMFS research (Carretta et al. 2011). In the LOA application the estimated takes for these two stocks are divided by gear type and includes takes assigned to both stocks for "undetermined delphinid species" for trawl gear. The total estimated average take in trawl gear is 1.8 animals per year in trawl gear for the offshore stock and 0.8 animals per year for the coastal stock. In addition, the LOA application includes an estimated take of one bottlenose nose dolphin in a five-year period in longline gear from the offshore stock only (average of 0.2 animals per year). When added to historic takes from other sources, the total estimated take in both trawl and longline gear for both stocks is greater than 10 percent of PBR but less than 50 percent of PBR for each stock. This cumulative impact, if it occurred, would be considered moderate in magnitude for both stocks. Given the lack of historical takes of this species in research gear and the implementation of new mitigation measures since 2008, the SWFSC considers future takes of this species at the estimated rate to be unlikely and to occur only rarely. As described above for Risso's dolphins and northern right whale dolphins, the overall contribution of SWFSC research to the cumulative effects of adverse gear interactions with this species is therefore considered minor adverse.

Although there is some overlap in prey of non ESA-listed cetaceans in the CCRA and the species collected during SWFSC research surveys (e.g., sardines, anchovy, and mackerel), the total amount sampled is minimal compared to overall biomass and commercial fisheries removals. The contribution of research catches to the effects on marine mammals through competition for prey is therefore considered minor adverse for cetaceans in the CCRA.

When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting non-ESA-listed cetaceans in the CCRA, the contribution of the three research alternatives to cumulative effects on cetaceans would be primarily through adverse gear interactions and would be minor and adverse. This conclusion depends largely on the efficacy of mitigation measures implemented by the

SWFSC, future levels of take in commercial fisheries, and the actual annual take during the course of research operations. Research conducted by the SWFSC also provides valuable information for the conservation and management of marine mammals and this contribution to cumulative effects would be beneficial for cetaceans in the CCRA.

Contribution of the No Research Alternative

Under the No Research Alternative, NMFS would not promulgate rulemaking or issue LOAs for SWFSC fisheries research. SWFSC would not directly contribute to cumulative effects on non-ESA-listed cetaceans in the CCRA. Indirectly, however, the loss of information obtained from SWFSC ecosystem research on the abundance and distribution of marine mammals, their feeding ecology, oceanographic components of their habitat, status of prey stocks, and fisheries interactions could adversely affect management decisions and analysis of long-term trends affecting the marine ecosystem. The indirect contribution of the No Research Alternative to cumulative effects is difficult to ascertain for individual species, but would likely impact long-term monitoring and management capabilities for all cetaceans in the CCRA. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting non-ESA-listed cetaceans in the CCRA, the contribution of the No Research Alternative to cumulative effects on non-ESA-listed cetaceans would be minor to moderate and adverse.

5.5.1.3 Other Pinnipeds

External Factors in the CCRA

Four species of non-ESA-listed pinnipeds commonly occur in the CCRA, including California sea lions, northern fur seals, harbor seal (several stocks), and northern elephant seals. These species are all subject to similar types of effects from external activities as described above for other species. Interactions with commercial fisheries likely have the greatest effect on most of these species and are also generally well-documented.

Fisheries in which California sea lions have been subject to mortality or serious injury in the CCRA include California/Oregon thresher shark/swordfish large mesh drift gillnet fishery, California angel shark/halibut and other species large mesh (>3.5 inches) set gillnet fishery, CA small-mesh drift gillnet fishery for white seabass, yellowtail, barracuda, and tuna; CA anchovy, mackerel, and tuna purse seine fishery; Washington/Oregon/California domestic groundfish trawl fishery; Washington/Oregon/California domestic groundfish bottom trawl fishery; Washington/Oregon salmon net pen fishery; and unknown entangling net fisheries. The minimum total annual take (2000-2004) was ≥159 animals, but well below ten percent of the PBR of 8,511 (Carretta et al. 2011).

Of the several stocks of harbor seals in the CCRA, the California stock experiences the highest level of incidental take (an average of 388 per year, 1999-2003), primarily in the California angel shark/halibut and other species large mesh (>3.5 in) set gillnet fishery. Low levels of takes were reported in the Washington/Oregon/California groundfish trawl and unknown net and hook fisheries. This level of annual mortality is greater than ten percent of the calculated PBR (1,896), so cannot be considered insignificant and approaching zero M&SI rate and could, therefore, have a minor effect at the population level. There is currently no PBR estimate for the Oregon/Washington coastal stock, but levels of annual mortality are low (≥1.8, 2004-2008) in the Northern Washington marine set gillnet fishery and the Washington/Oregon/California groundfish trawl (Carretta et al. 2011).

Northern elephant seals are taken in small numbers (> 8.8 mean annual take, 2000-2004), primarily in the California/Oregon thresher shark/swordfish large mesh drift gillnet fishery. Some mortality reported in U.S. fisheries may be of seals from the breeding population in Mexico and some of the U.S. breeding population may be taken in drift gillnet fisheries along the Pacific coast of Baja California, Mexico (Carretta et al. 2011). The reported level of incidental take is well below ten percent of PBR (4,382), so considered minor in magnitude.

While it is possible for northern fur seals from the Eastern Pacific stock to be taken during the winter/spring along the continental U.S. west coast, for the purposes of the stock assessment reports, NMFS considers any northern fur seals taken by commercial fisheries off California, Oregon and Washington to be from the San Miguel Island stock. Between 2004 and 2008, there were no reported deaths in any observed fishery along the west coast of the continental U.S., for an estimated mean mortality rate of zero for this stock (Carretta et al. 2011).

Pinnipeds in the CCRA have a diverse diet that includes Pacific whiting, market squid, northern anchovy, Pacific herring, and Pacific sardine. All support commercially valuable fisheries which could potentially affect prey availability (Baraff and Loughlin 2000). Pacific whiting is widely available as prey, commonly consumed, and is one of the most commercially valuable and abundant groundfish resources of the California Current. There are, however, no indications of resource competition along the Oregon and Washington outer coasts and, since the fishery is essentially closed south of 42°N latitude, impacts on pinnipeds in southern and central California are unlikely. Pinniped predation on herring and the commercial fishery coincide during the fall–winter spawning season, but there do not appear to be any conflicts over prey availability (Baraff and Loughlin 2000).

Climate change impacts are difficult to predict, but may affect non ESA-listed pinnipeds through changes in habitat and food availability.

The activities external to SWFSC fisheries research affecting pinnipeds are likely to continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

Fisheries research activities conducted by SWFSC in the CCRA are most likely to impact pinnipeds through periodic interactions with survey gear. Potential effects of active acoustic devices used in research activities would be considered minor throughout the CCRA during all seasons.

California sea lions and northern fur seals have been incidentally caught or entangled in trawl and longline gear during past SWFSC fisheries research surveys (Tables 4.2-7 and 4.2-8). The SWFSC LOA application (Appendix C) includes calculations of potential takes of these and other pinnipeds that may interact with research gear based on similarities to these two species and historical takes in analogous commercial fisheries (Table 4.2-10). As described in the ESA-listed species section above, the SWFSC does not think this many pinnipeds will actually be taken in the next five years but has chosen to use a conservative estimation procedure to ensure accounting for the maximum amount of potential take.

For California sea lions (PBR = 9,200), the total estimated take of 5.4 animals per year in SWFSC research surveys (average of 4.2 in trawl gear and 1.2 in longline gear, including takes assigned for "undetermined pinniped species" for both trawl and longline gear), even when added to annual takes in commercial fisheries (average of 431 per year, Carretta et al. 2011), would be much less than 10 percent of PBR (920 animals) and would be considered minor in magnitude. These incidental takes of California sea lions in commercial and scientific fishing gear occur on a regular basis and a wide geographic area but the overall impact to the population of California sea lions is considered minor. The contribution of SWFSC fisheries research takes to this cumulative effect, if they occur, would be considered minor adverse.

For northern fur seals, northern elephant seals, and harbor seals, estimated takes in SWFSC research trawl gear, when added to all other sources of anthropogenic mortality, is much less than 10 percent of PBR for each species and would be considered minor in magnitude. Incidental takes of these species from other sources occur rarely (northern fur seals) or periodically (harbor seals and elephant seals) and are

distributed over a large geographic area. The contribution of SWFSC fisheries research takes to cumulative effects on these species, if they occur, would be considered minor adverse.

Although there is some overlap in prey of non ESA-listed pinnipeds in the CCRA and the species collected during SWFSC research surveys (e.g., sardines, anchovy, and mackerel), the total amount sampled is minimal compared to overall biomass and commercial fisheries removals. The contribution of research catches to the effects on marine mammals through competition for prey is therefore considered minor adverse for cetaceans in the CCRA.

When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting non-ESA-listed pinnipeds in the CCRA, the contribution of the three research alternatives to cumulative effects on these species through disturbance, direct takes, and prey removal would be minor and adverse. However, research conducted by the SWFSC provides valuable information for the conservation and management of marine mammals and this contribution to cumulative effects would be beneficial for pinnipeds in the CCRA.

Contribution of the No Research Alternative

Under the No Research Alternative, NMFS would not promulgate rulemaking or issue LOAs for SWFSC fisheries research. SWFSC would not directly contribute to cumulative effects on non-ESA-listed pinnipeds in the CCRA. Indirectly, however, the loss of information obtained through SWFSC fisheries and ecosystem research on the abundance and distribution of pinnipeds, their feeding ecology, oceanographic components of their habitat, status of prey stocks, and fisheries interactions could affect management decisions and analysis of long-term trends affecting the marine ecosystem. The indirect contribution of the No Research Alternative to cumulative effects is difficult to ascertain for individual species but will likely impact long-term monitoring and management capabilities for all pinniped species in the CCRA. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting pinnipeds in the CCRA, the contribution of the No Research Alternative to cumulative effects on these species would be minor to moderate and adverse.

5.5.1.4 Sea otters

External Factors in the CCRA

Sea otters along the Washington coast were extirpated by an intensive harvest for their pelts beginning in the 18th century. Sea otters were absent from the state from 1911 until 1969, when 59 sea otters were reintroduced to the Washington coast from Amchitka Island, Alaska (Lance et al. 2004).

More recent past, present, and reasonably foreseeable future conservation concerns and threats include oil spills, contaminants, disease, marine biotoxins, entanglement and entrapment, habitat loss, and low genetic diversity (Lance et al. 2004). The relatively small population size and range of northern sea otters in Washington may leave them particularly vulnerable to habitat destruction or loss and, currently, oil spills and disease are of primary concern (Lance et al. 2004).

Fisheries interactions also occur. In Washington, a small number of sea otters are taken in tribal gill net fisheries along the northern coast. Non-treaty gill nets are prohibited throughout the current sea otter range on the outer coast of Washington, but tribal gill nets are used along the northern coast and into the Strait of Juan de Fuca. Incidental takes of sea otters in salmon gill net fisheries conducted by Makah tribal fishermen are considered rare, but do occur. There have been no sea otter deaths attributed to pot gear in Washington (Lance et al. 2004).

Sea otters in Washington State primarily consume sea urchins, clams, crabs, and mussels. Localized fisheries management issues are possible given that several shellfish species are also important to commercial, recreational, and tribal fisheries in Washington (Lance et al. 2004).

The activities external to SWFSC fisheries research that affect northern sea otters are likely to continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures.

Contribution of the Research Alternatives

Sea otters inhabit nearshore waters that are either not covered by SWFSC research activities (e.g., Puget Sound) or are much closer to shore than research vessels typically travel or sample. There have been no interactions with past SWFSC research activities and the risk of future disturbance, injury, or competition for prey under any of the research alternatives is considered minor. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting sea otters in the CCRA, the contribution of the three research alternatives to cumulative effects on this species through disturbance, direct takes, and prey removal would be minor adverse.

Contribution of the No Research Alternative

Under the No Research Alternative, SWFSC would not directly contribute to cumulative effects on sea otters in the CCRA. Indirectly, however, the loss of information obtained through SWFSC fisheries and ecosystem research on the oceanographic components of sea otter marine habitat and status of prey stocks could have adverse impacts on management decisions concerning sea otters. The indirect contribution of the No Research Alternative to cumulative effects on sea otters is difficult to ascertain but, when considered in conjunction with other past, present, and reasonably foreseeable future activities affecting sea otters in the CCRA, the contribution of the No Research Alternative to cumulative effects on this species would be minor adverse.

5.5.2 Eastern Tropical Pacific Research Area

Activities external to SWFSC research that may potentially affect marine mammals in the ETPRA include commercial fisheries, vessel traffic, ocean discharges, Liquid Natural Gas terminals, oil extraction and geophysical activities, dredging, other scientific research, military operations, conservation measures, and climate change. These activities and potential effects are summarized in Table 5.1.1 and include:

- Disturbance/behavioral changes or physical effects from anthropogenic noise
- Injury or mortality due to vessel collisions, entanglement in fishing gear, and contamination of the marine environment
- Changes in food availability due to prey removal, ecosystem change, or habitat degradation

5.5.2.1 ESA-listed Species

External Factors in the ETPRA

The endangered marine mammals that occur in the ETPRA include blue, fin, sei, humpback, and sperm whales (Table 3.2-4). The only threatened species and ESA-listed pinniped in the ETPRA is the Guadalupe fur seal. Commercial whaling was the single greatest historical source of mortality for these whale species, as was commercial sealing for Guadalupe fur seals during the 19th century (Carretta et al. 2011 and citations therein). Commercial harvests of sperm whales ended worldwide in 1986 (NMFS 2010). Humpback whales and blue whales were protected in the North Pacific in 1966 and Southern Hemisphere stocks of humpback whales were protected in 1963 (Leaper and Miller 2011, NMFS 1998, Perry et al. 1999). The IWC banned hunting of fin whales throughout the North Pacific in 1976 (Perry et al. 1999). Hunting of sei whales in the eastern North Pacific ended after 1971 (Perry et al. 1999).

The ETPRA is an expansive region encompassing approximately seven million square miles (NOAA 2004) and the coastlines of Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama,

Colombia, Ecuador, Peru, and the French Territory Clipperton Island. The region is, therefore, subject to an array of governmental policies and regulations; vessel traffic (national and international); coastal and offshore, large and small-scale, national and international fisheries; possible military activities; and coastal development.

The actual level of vessel traffic throughout the region would be difficult to quantify and the incidence of marine mammal-vessel interactions is largely unknown. There are several major ports and transit routes throughout this region, including the Panama Canal. The total number of transits through the canal exceeded 14,000 per year in 2009, 2010, and 2011. Included were bulk carriers, cargo ships, fishing vessels, LNG carriers, tankers, passenger ships, military, barges, dredges, and others (Canal de Panamá website http://www.pancanal.com/eng/op/transit-stats/index.html, accessed 19 April 2012). The only documented incident was of an unknown large whale that was hit, and presumably injured, by the research vessel Surveyor west of Callao, Peru in 1992 (Jensen and Silber 2004, Laist et al. 2001).

Fisheries in the ETPRA range from small-scale artisanal to large-scale industrial operations. Targeted species include herring, sardines, anchovies, mackerel, various tuna species, and squid (FAO 2005). The tuna purse seine fishery is one of the largest and most closely monitored due to present and historical marine mammal by-catch. The tuna-dolphin fishery interaction is detailed below under "Other Cetaceans." The U.S. tuna purse seine fleet operating in the ETPRA decreased from 155 large (>362.8 mt) vessels in 1976 to about five such vessels per year from 2001 through 2003. No more than 10 small purse seine vessels (< 100 mt) mostly fish for coastal pelagic species (Pacific mackerel and sardine) but occasionally harvest tuna in the ETPRA (NOAA 2004). The international fleet comprises the majority of fishing effort and carrying capacity in the ETPRA tuna fishery. From 1997 through 2001, an average of 132 international tuna purse seine vessels greater than 400 mt carrying capacity and an average of 71 vessels smaller than 400 mt carrying capacity fished in the ETPRA annually. The smaller vessels fish for tuna year-round off the coasts of Central and South America (NOAA 2004, and citations therein). There are no documented mortalities of ESA-listed species in this fishery.

Climate change impacts on ESA-listed species are possible, particularly for the long-distance migrants that spend at least part of the year in high-latitude waters that are considered more susceptible to the effects of climate change. Climate and oceanographic change could potentially affect habitat and food availability. Migration, feeding, and breeding locations influenced by ocean currents and water temperature could be impacted. Such changes could, ultimately, affect productivity of ESA-listed species (NMFS 2010, NMFS 2011). There is currently no evidence of environmental change in terms of decadal-scale climate shifts in the ETPRA since 1977. However, the time period over which data are available is too short to make meaningful inferences about decadal variability or long-term climate change (Fiedler 2002).

The activities external to SWFSC fisheries research affecting ESA-listed marine mammals in the ETPRA are likely to continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

Behavioral disturbance of small numbers of ESA-listed marine mammals from use of active acoustic equipment during SWFSC research cruises is possible, but considered minor in magnitude throughout the ETPRA, temporary in duration, and would likely have minor effects on all ESA-listed marine mammals throughout the ETPRA. Given the large number of other commercial fishing and shipping vessels that also use acoustic gear for navigation and fish finding, the contribution of SWFSC research to cumulative effects of acoustic disturbance would be minor.

There have been no collisions with ESA-listed marine mammals during any fisheries research activities conducted by SWFSC in the ETPRA and none are anticipated in the future.

The SWFSC research activities in the ETPRA have no history of taking marine mammals because they have not deployed fishing gear in the past. With the addition of a small longline survey under Alternatives 2 and 3, there is a risk of entanglement in the future. However, the SWFSC LOA application does not include any estimated takes of ESA-listed marine mammals based on the small sampling effort, rarity of the species and implementation of mitigation measures. The risk of adverse interactions between ESA-listed marine mammals is considered very small and is not expected to occur in the next five years.

The potential for prey removal or competition for resources by SWFSC sampling in the ETPRA is unlikely. The amount of plankton and fish removed is minor in magnitude, temporary, and highly localized. The highly migratory fish species that will be sampled in the proposed longline surveys are not consumed by most of the ESA-listed species, expect, perhaps, sperm whales. Given the much larger harvests of potential prey by commercial fisheries in the ETPRA, the contribution of SWFSC research to cumulative removal of prey is minor.

When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting ESA-listed marine mammals in the ETPRA, the contribution of the three research alternatives to cumulative effects on these species through disturbance, direct takes, and prey removal would be minor and adverse. However, research conducted by the SWFSC provides valuable information for the conservation and management of marine mammals and this contribution to cumulative effects would be beneficial for ESA-listed species in the ETPRA.

Contribution of the No Research Alternative

Under the No Research Alternative, NMFS would not promulgate rulemaking or issue LOAs for SWFSC fisheries research. SWFSC would no longer conduct or fund research in the ETP, so would not directly contribute to potentially adverse cumulative effects on threatened and endangered species in this region. Indirectly, however, the loss of information obtained through this research on the abundance and distribution of marine mammals, their feeding ecology, oceanographic components of their habitat, status of prey stocks, and fisheries interactions could have adverse impacts on management decisions and analysis of long-terms trends affecting the marine ecosystem. The indirect contribution of the No Research Alternative to cumulative effects is difficult to ascertain for individual species, but will likely impact long-term monitoring and management capabilities for many ESA-listed marine mammals in the ETPRA. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting ESA-listed marine mammals in the ETPRA, the contribution of the No Research Alternative to cumulative effects on ESA-listed marine mammals would be minor adverse.

5.5.2.2 Other Cetaceans

External Factors in the ETPRA

In addition to the ESA-listed species, there are two other species of baleen whales (Bryde's and Common minke whales) and at least 23 other odontocetes in the ETPRA (Table 3.2-4). Although subject to many of the same potential impacts noted above for ESA-listed species, interactions with the tuna purse-seine fishery has had the greatest impact on several populations of dolphins in the ETP. The offshore stocks of spotted dolphins and spinner dolphins (eastern and whitebelly) are the most frequently associated with tuna and historically set upon by purse seiners starting in the 1950s. The northeastern offshore spotted dolphin population declined roughly 80% and the spinner dolphin populations by roughly 50% as a result (Gerrodette and Forcada 2005, Perrin 2009a, 2009b). Other species taken in lesser numbers include common dolphins, striped, rough-toothed, bottlenose, and Fraser's dolphins (NOAA 2004).

A series of combined management actions, including passage of the MMPA in 1972, subsequent amendments, regulations, and mitigation measures were developed to address the serious bycatch problem. In addition to the MMPA in the U.S., are several international agreements, which are particularly important as the U.S. fleet diminished and the foreign fleet increased. The IATTC, an

international fisheries management organization concerned with the long-term conservation and sustainable use of tunas, billfish, and other components of the ecosystem (e.g., dolphins, turtles, non-target finfish, and sharks) that may be affected by fishing operations in the Eastern Pacific Ocean, was established in 1949. It currently includes 21 nations and fishing entities, including the U.S. The AIDCP is closely aligned with the IATTC. The AIDCP is a legally-binding multilateral agreement established in 1999. States which have ratified or acceded to the Agreement include Belize, Costa Rica, Ecuador, El Salvador, European Union, Guatemala, Honduras, Mexico, Nicaragua, Panama, Peru, U.S., Vanuatu, and Venezuela; Bolivia and Colombia are provisionally applying the Agreement. The first objective of the program is to reduce incidental dolphin mortalities in the purse-seine fishery in the eastern Pacific Ocean to levels approaching zero. AIDCP includes a Dolphin Safe Tuna Certification supported by a multilateral tracking and verification system administered by member governments (Colombia, Costa Rica, Ecuador, El Salvador, the European Union, Guatemala, Honduras, Mexico, Nicaragua, Panama, Peru, the U.S., Vanuatu and Venezuela) and the treaty organization (IATTC International Dolphin Conservation Program (IDCP) website: http://www.iattc.org/IDCPENG.htm, Accessed April 19 2012).

As a result of these agreements and actions, dolphin bycatch and mortality has decreased substantially. During 2010, 93% of all sets on tuna associated with dolphins were done without mortality or serious injury to the dolphins. The total mortality of dolphins in the fishery decreased from 98,882 in 1987 to 1,170 in 2010 (IATTC IDCP website: http://www.iattc.org/IDCPENG.htm, Accessed April 19, 2012).

Climate and oceanographic change could potentially affect habitat and food availability of non-ESA-listed cetaceans in the ETPRA. Migration, feeding, and breeding locations influenced by ocean currents and water temperature could be impacted, as a result. Population effects of the El Niño Southern Oscillation (ENSO) on ETPRA dolphins have not been detected, but potential responses may include moderate changes on seasonal and ENSO time scales (Fiedler 2002). There is currently no evidence of environmental change in terms of decadal-scale climate shifts in the ETPRA since 1977. However, the time period over which data are available is too short to make meaningful inferences about decadal variability or long-term climate change (Fiedler 2002).

The activities external to SWFSC fisheries research affecting cetaceans in the ETPRA are likely to continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

Some temporary behavioral disturbance of small numbers of cetaceans from active acoustic gear is possible, as described in 4.2.4, but would likely have minor effects on cetaceans throughout the ETP. Given the large number of other vessels in the ETPRA, primarily commercial fishing and bulk carriers that use active acoustic gear, the contribution of the research alternatives to cumulative effects of acoustic disturbance would be minor adverse.

There have been no collisions with marine mammals during any fisheries research activities conducted by SWFSC in the ETPRA and, given the relatively slow speeds of research vessels and bridge observers during transits, none are anticipated in the future.

The SWFSC research activities in the ETPRA have no history of taking marine mammals under the Status Quo Alternative but there is a possibility of taking cetaceans in longline gear under the Preferred and Modified Research Alternatives. In the absence of historical takes during past research surveys, the LOA application (Appendix C) used data from commercial longline fisheries to estimate which species may be vulnerable to takes in future SWFSC research using similar gear (Table 4.3-2). This includes potential takes of one each of nine cetacean species per five year period: Risso's dolphin, short-beaked common dolphin, long-beaked common dolphin, striped dolphin, Pantropical spotted dolphin, bottlenose dolphin, false killer whale, short-finned pilot whale, and dwarf sperm whale. Given the relatively large

populations of these species in the ETPRA, a take of one animal over a five-year period, if it occurred, would be considered minor in magnitude at the population level for each of these species. Given the small amount of projected sampling effort and the mitigation measures that would be implemented, the SWFSC considers the risk of these potential takes to be very small; takes of any of these species would be rare and unlikely to actually occur in the next five years.

The potential for prey removal or competition for resources by SWFSC sampling in the ETPRA is unlikely. The amount of plankton and juvenile fish removed is minimal. The highly migratory fish species that will be sampled in the proposed longline surveys may also be prey of some of the larger odontocetes, but considering the small scientific sampling effort and the extensive commercial fisheries in the area, the contribution of the research alternatives to impacts on prey availability would be minor.

When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting non-ESA-listed cetaceans in the ETPRA, the contribution of the three research alternatives to cumulative effects on these species through disturbance, direct takes, and prey removal would be minor and adverse. However, research conducted by the SWFSC provides valuable information for the conservation and management of these species and this contribution to cumulative effects would be beneficial for non-ESA-listed cetaceans in the ETPRA.

Contribution of the No Research Alternative

Under the No Research Alternative, NMFS would not promulgate rulemaking or issue LOAs for SWFSC fisheries research. The SWFSC fisheries and ecological research program would not directly contribute to cumulative effects on other cetaceans in the ETPRA. Indirectly, however, the loss of information obtained through this research could substantially impact international management decisions and analysis of long-term trends affecting cetaceans in the ETPRA. SWFSC is responsible for monitoring and conducting research on dolphins incidentally caught in the ETPRA tuna purse-seine fishery. Some elements, but not all, of this research are covered under this EA (observational information on the distribution and abundance of dolphins in the ETPRA). Research on this fishery is mandated by the MMPA and supports the U.S. delegation to the AIDCP. SWFSC is the only entity that provides dolphin monitoring and research results to the AIDCP parties, which forms the basis for management measures taken by the Parties, including setting annual dolphin mortality limits and establishing independent observer program requirements. In the absence of the data provided by SWFSC fisheries and ecological research covered under this EA, the AIDCP parties would have little information on the efficacy of current management measures or whether new measures are needed, and the U.S. delegation would fail to meet its obligations to the other AIDCP parties and the Secretariat (SWFSC 2010).

The indirect contribution of the No Research Alternative to cumulative effects is difficult to ascertain for individual species, but will likely impact long-term monitoring and management capabilities for many cetaceans in the ETPRA. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting non-ESA-listed cetaceans in the ETPRA, the contribution of the No Research Alternative to cumulative effects on these species would be minor for some species and moderate for those dolphin species associated with tuna fisheries.

5.5.2.3 Other Pinnipeds

External Factors in the ETPRA

In addition to the ESA-listed Guadalupe fur seal, there are three other species of pinnipeds in the ETPRA (Table 3.2.4), including California sea lion, Northern elephant seal, and South American sea lion. Distribution in the ETPRA is limited and pinnipeds are infrequently seen during surveys of the area. Sightings of California sea lions and Northern elephant seals are usually limited to the northern end of the survey area along the coast of Baja California, Mexico, while South American sea lions are usually observed along the Peruvian coast (Jackson et al. 2004, Kinzey et al. 1999). In these respective areas,

potential impacts include vessel and fishery interactions, discharges and pollution, coastal development, anthropogenic noise, and climate change, as described above for other species. Although pinnipeds have been sighted in the ETPRA, they are not known to interact regularly with tuna purse seines (NOAA 2004).

The activities external to SWFSC fisheries research that may affect pinnipeds in the ETPRA will likely continue into the foreseeable future (see Table 5.1-1). The level of impact depends on numerous factors, including the efficacy of current and proposed mitigation measures that affect pinnipeds. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

The infrequency with which pinnipeds are observed during SWFSC research likely minimizes impacts of the research activities on pinnipeds in the ETPRA. Temporary behavioral disturbance from active acoustics could affect small numbers of pinnipeds and would likely have minor effects on pinnipeds encountered in the ETPRA. Given the large number of other vessels in the ETPRA, primarily commercial fishing and bulk carriers that use active acoustic gear, the contribution of the research alternatives to cumulative effects of acoustic disturbance would be minor.

There have been no collisions with marine mammals during any fisheries research activities conducted by SWFSC in the ETPRA and, given the relatively slow speeds of research vessels and bridge observers during transits, no collisions with pinnipeds are anticipated in the future. The potential for prey removal or competition for resources with pinnipeds as a result of SWFSC sampling in the ETPRA is unlikely. The amount of plankton and juvenile fish removed is minimal. Smaller size classes of highly migratory fish species that will be sampled in the proposed longline surveys might occasionally be consumed by pinnipeds, but given the extensive commercial fisheries in the area, the contribution of the research alternatives to impacts on prey availability would be minor.

The SWFSC research activities in the ETPRA have no history of taking marine mammals under the Status Quo Alternative but there is a possibility of taking pinnipeds in longline gear under the Preferred and Modified Research Alternatives. In the absence of historic takes during past research surveys, the LOA application (Appendix C) used data from commercial longline fisheries to estimate which species may be vulnerable to takes in future SWFSC research using similar gear (Table 4.3-2). Estimated potential takes include one take per year (for a total of five over a five-year period) for California sea lions and South American sea lions. Considering the small number of longline sets that are being proposed in the area and the mitigation measures included, the SWFSC considers the risk of these potential takes to be very small; takes of these pinniped species would be rare and unlikely to actually occur in the next five years. The estimated loss of one animal per year from these species, if it occurred, would be much less than 10 percent of PBR for both species and would be considered minor in magnitude.

When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting non-ESA-listed pinnipeds in the ETPRA, the contribution of the three research alternatives to cumulative effects on these species through disturbance, direct takes, and prey removal would be minor and adverse. However, research conducted by the SWFSC provides valuable ecological information that may be used for the conservation and management of these species and this contribution to cumulative effects would be beneficial.

Contribution of the No Research Alternative

Under the No Research Alternative, NMFS would not promulgate rulemaking or issue LOAs for SWFSC fisheries research. SWFSC would not directly contribute to cumulative effects on pinnipeds in the ETPRA. Indirectly, however, the loss of information obtained through this research on the ecology,

oceanography, and fisheries of the ETPRA could impact long-term monitoring and management decisions and analysis of long-terms trends affecting the ETPRA ecosystem. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting pinnipeds in the ETPRA, the contribution of the No Research Alternative to cumulative effects on pinnipeds would be minor.

5.5.3 Antarctic Research Area

Activities external to SWFSC research that may potentially affect marine mammals in the ARA include commercial fisheries, vessel traffic, ocean discharges, geophysical activities, other scientific research, military operations, conservation measures, and climate change. These activities and potential effects are summarized in Table 5.1.1 and include:

- Disturbance/behavioral changes or physical effects from anthropogenic noise
- Injury or mortality due to vessel collisions, entanglement in fishing gear, and contamination of the marine environment
- Changes in food availability due to prey removal, ecosystem change, or habitat degradation

International conservation and management entities and treaties for Southern Ocean resources were created to address actual or foreseeable adverse impacts to the region. The following are of particular relevance to marine mammals. The International Convention for the Regulation of Whaling was signed in 1946 and established the IWC for the purposes of managing whale resources (IWC website: http://www.iwcoffice.org/commission/iwcmain.htm, accessed April 17 2012). The Antarctic Treaty was signed in 1959 to ensure that Antarctica shall be forever used exclusively for peaceful purposes and that scientific investigation and cooperation continue (ATS website: http://www.ats.aq/e/ats.htm, accessed April 17 2012). The Convention for the Conservation of Antarctic Seals was signed in 1972 for the protection, scientific study, and rational use of Antarctic seals (Leaper and Miller 2011). The CCAMLR was signed in 1980 in response to concerns that an increased krill fishery could seriously affect populations of krill and the marine predators that depend on krill for food. The aim of the CCAMLR is to conserve marine life of the Southern Ocean, without excluding harvesting done in a rational manner (CCAMLR website: http://www.ccamlr.org/pu/e/gen-intro.htm, accessed April 17, 2012).

5.5.3.1 ESA-listed Species

External Factors in the ARA

The endangered marine mammal species in the ARA include sperm, humpback, blue, fin, sei, and southern right whales. Commercial whaling was the single greatest historical source of mortality for each of these species, resulting in substantial population declines through overexploitation (Perry et al. 1999). The southern right whale was protected in 1935 (Leaper and Miller 2011). In the Southern Hemisphere, humpback whales were protected in 1963, blue whales in 1967 (Leaper and Miller 2011), fin whales in 1976, and sei whales in 1977 (Perry et al. 1999). Commercial harvests of sperm whales ended worldwide in 1986 (NMFS 2010). Over the last two decades, previous illegal whaling and under-reporting of catches by the Soviet whaling fleet have come to light. The actual takes for many stocks grossly exceeded reported harvests. For example, between 1946 and 1986, the reported catch of humpbacks in the Antarctic was 2,710, while the actual catch was 48,721. Similarly, four southern right whales were reported, yet 3,368 were actually taken (Ivashchenko et al. 2011).

After the global ban on commercial whaling, the government of Japan began operating a scientific permit whaling program beginning with the 1987/1988 season. Antarctic minke whales (eastern Indian Ocean and western South Pacific stocks) are the primary target with sample sizes proposed for full-scale research beginning in 2008/2009 of 850 whales per year; however, takes of 50 humpbacks (D and E stocks) and 50 fin whales (Indian Ocean and western South Pacific stocks) were also proposed (Leaper

and Miller 2011). The most recently reported takes under these permits were 507 minkes and 1 fin whale in 2009/2010 and 171 minkes and 2 fin whales in 2010/2011; no humpbacks have yet been taken (http://www.iwcoffice.org/conservation/table_permit.htm, accessed April 17, 2012). The harvest areas (and stocks) do not overlap with the SWFSC research area.

A recent review by Leaper and Miller (2011) summarizes the threats likely to impact baleen whales in the Antarctic. The final recovery plans for sperm whales (NMFS 2010c), fin whales (NMFS 2010a) and sei whales (NMFS 2011) also include sections on Southern Hemisphere stocks and potential threats to those populations. The following derives largely from these documents and from the Final Programmatic Environmental Impact Statement (EIS) on Codified Regulations at 50 CFR Part 300 Subparts A and G Implementing Conservation and Management Measures Adopted by the CCAMLR (NMFS 2006).

In addition to scientific whaling, other noted threats include pollutants, particularly in coastal areas near to base stations and tourist destinations; noise from shipping, research, and tour ships; ship strikes; fisheries interactions; competition for resources; and climate change (Leaper and Miller 2011, NMFS 2010). To date, ship traffic in the area is still relatively low and there have been only three reported ship strikes of humpback whales in the western Antarctic Peninsula region (Jensen and Silber 2004, Leaper and Miller 2011). Fisheries interaction, including potential removal of prey resources, and climate change are likely to have the greatest impacts on marine mammals in this region.

The toothfish fishery, which primarily uses longline gear, and the krill fishery, which uses trawl gear, are the fisheries most likely to interact with marine mammals in Antarctic waters. Entanglement of marine mammals with longline gear is considered rare in CCAMLR Convention waters. Killer whales and sperm whales have been known to take toothfish off longline hooks, but there were no marine mammal entanglements during longline testing trials by the U.S. vessels (NMFS 2006). No cases of marine mammal mortalities in CCAMLR fisheries were reported in 2010 (CCAMLR 2010).

There have been no reports of whales directly interacting with the krill trawl fishery in any CCAMLR Area (NMFS 2006). However, since most baleen whales in the Antarctic feed predominately on krill, the greatest potential indirect effect of the fishery would likely be competition for food. A survey of krill and cetaceans in Area 48, which includes the ARA, by CCAMLR and the IWC in 2000 estimated that cetaceans in Area 48 consume approximately 5% (about 2.5 million mt) of the krill standing stock (Reilly et al., 2004 cited in NMFS 2006). Although some area-specific competition is possible, available information on cetacean abundance estimates, consumption rates, and the krill standing stock suggest that the krill fishery is unlikely to negatively impact cetaceans (NMFS 2006).

According to Turner et al. (2009), accelerated global warming and increased UV-B levels resulting from the ozone hole that develops in spring are the most important anthropogenic changes currently affecting the Antarctic. They note that the Antarctic marine ecosystem has been affected by climate change over the last fifty years, especially on the western side of the Antarctic Peninsula, with warming ocean temperatures and declining sea ice. A long-term decline in krill abundance was linked to the loss of winter sea ice (under which krill over-winter) and global warming (Atkinson et al. 2004). Large reductions in krill stocks could substantially impact Antarctic marine mammals that depend on krill as a primary prey.

Responses of baleen whale populations to climate change may be difficult to interpret and distinguish from lingering effects of over-exploitation, and, since whales are long-lived, effects may not be detected for some time (Turner et al. 2009). In the long term, climate change could affect the recovery rate of species that are in the early stages of recovery from whaling. Climate change impacts on baleen whales will most likely occur through changes in sea ice dynamics that alter habitat characteristics and changes in prey abundance and distribution (Turner et al. 2009 and citations therein). Prey availability could affect whale population dynamics. Leaper et al. (2006) suggest that breeding success of southern right whales off South Georgia is driven by underlying relationships with the availability of krill, which fluctuates relative to sea surface temperature anomalies. Climate change may similarly affect sperm whales through changes in habitat and food availability and, possibly, reproductive rates (NMFS 2010).

The activities external to SWFSC fisheries research affecting ESA-listed marine mammals in the ARA will likely continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

Temporary behavioral disturbance from active acoustic gear used by SWFSC research vessels could affect small numbers of ESA-listed marine mammals throughout the ARA. Given the relatively small area covered and small number of research days at sea, the contribution of the research alternatives to cumulative effects of acoustic disturbance would be minor.

There have been no historic takes, serious injuries, or mortalities of ESA-listed species during SWFSC research in the ARA due to ship strikes or entanglement in gear. Given the relatively slow speeds of research vessels, the presence of bridge observers during transits and other mitigation measures, and the small sampling effort, no takes of these species are expected in the future under any of the research alternatives.

SWFSC Antarctic Marine Living Resources (AMLR) surveys in the Antarctic monitor krill and remove a small amount of post-larval and adult krill during sampling with small-mesh midwater trawl nets (IKMT) in order to estimate krill biomass around the South Shetland Islands and South Orkney Islands. The amount of krill and other zooplankton collected during research is a minor fraction of overall biomass and would not affect the abundance or availability of prey to any marine mammals, so the impact of the removal is minor.

The SWFSC also conducts periodic (every two to three years) bottom trawl surveys in the South Orkney Islands area to monitor the recovery of several finfish that were overfished in the 1970s and 1980s. Although the importance of these fish species as marine mammal prey is unknown, the relative infrequency with which the surveys occur and the relatively small amount of fish removed over a large area make it unlikely that the surveys affect prey distribution or availability for marine mammals.

When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting ESA-listed whales in the ARA, the contribution of the three research alternatives to cumulative effects on these species through disturbance and prey removal would be minor and adverse. However, research conducted by the SWFSC provides valuable information for the conservation and management of marine mammals in the ARA and this contribution to cumulative effects would be beneficial

Contribution of the No Research Alternative

Under the No Research Alternative, NMFS would not promulgate rulemaking or issue LOAs for SWFSC fisheries research. SWFSC would not directly contribute to cumulative effects on ESA-listed species in the ARA. Indirectly, however, the loss of information obtained through this research could impact management decisions and analysis of long-terms trends affecting ESA-listed species in the Antarctic. For example, SWFSC research surveys collect observational data on whale distribution, abundance, and behavior in the Scotia Sea. In conjunction with data collected on the abundance and distribution of krill and other species, this data has provided valuable ecological information for the conservation of many species and results of SWFSC research are regularly presented to the scientific advisory bodies to the CCAMLR. In addition, SWFSC is the primary source of scientific advice to the U.S. Commissioner and delegation to CCAMLR. The indirect contribution of the No Research Alternative to cumulative effects is difficult to ascertain for individual species, but would likely impact long-term monitoring and management capabilities for many ESA-listed marine mammals in the ARA. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting ESA-listed marine mammals in the ARA, the contribution of the No Research Alternative to cumulative effects on ESA-listed marine mammals would be minor to moderate and adverse.

5.5.3.2 Other Cetaceans

External Factors in the ARA

In addition to the ESA-listed whales, minke whales and at least 16 other odontocetes occur in the ARA. Please refer to Section 3.2.2 and Appendix C for species lists and descriptions.

Antarctic minke whales of the eastern Indian Ocean and western South Pacific stocks are the primary target of Japanese scientific whaling operations. As noted above, recent takes numbered 507 and 171 minke whales during the 2009/2010 and 2010/2011 seasons, respectively (http://www.iwcoffice.org/conservation/table_permit.htm, accessed April 17 2012). Neither the harvest areas nor stocks, however, overlap with the SWFSC research area.

Similar to the ESA-listed species, other potential threats include pollutants, particularly in coastal areas near to base stations and tourist destinations; noise from shipping, research, and tour ships; ship strikes; fisheries interactions; competition for resources; and climate change (Leaper and Miller 2011). Fisheries interactions, including potential removal of prey resources, and climate change are likely to have the greatest impacts on Antarctic cetaceans.

There have been no recent reports of marine mammal mortalities in CCAMLR fisheries, but competition for prey resources apparently occurs. Killer whales (and sperm whales) depredate toothfish off longline hooks, which is more of a detriment to the fishers than to the whales. Fishers often move to other locations to avoid sperm and killer whales in order to increase catch rates (NMFS 2006).

As with the ESA-listed baleen whales, minke whales in the Antarctic feed predominately on krill, so the greatest potential indirect effect of the krill fishery would likely be competition for food. The two species of minke whales (Dwarf and Antarctic) in the Southern Ocean consume approximately two-thirds of the estimated total krill consumed by baleen whales in the Southern Ocean (NMFS 2006). As noted above, some area-specific competition is possible, yet available information on cetacean abundance estimates, consumption rates, and the krill standing stock suggest that the krill fishery is unlikely to negatively impact cetaceans (NMFS 2006).

Climate change effects described above for ESA-listed species would be similar for other cetaceans in the ARA. The most likely effects could be changes in habitat and food availability and, possibly, reproductive rates.

The activities external to SWFSC fisheries research affecting cetaceans in the ARA will likely continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

The contribution of SWFSC research to cumulative effects on other cetaceans would be the same as described above for ESA-listed marine mammals.

When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting cetaceans in the ARA, the contribution of the three research alternatives to cumulative effects on these species through disturbance and prey removal would be minor and adverse. However, research conducted by the SWFSC provides valuable information for the conservation and management of marine mammals and this contribution to cumulative effects would be beneficial for cetaceans in the ARA.

Contribution of the No Research Alternative

Under the No Research Alternative, NMFS would not promulgate rulemaking or issue LOAs for SWFSC fisheries research. SWFSC would not directly contribute to cumulative effects on non-ESA-listed

cetaceans in the ARA. Indirectly, however, the loss of information obtained through this research could impact management decisions and analysis of long-terms trends affecting cetaceans in the Antarctic. For example, SWFSC research surveys collect observational data on whale distribution, abundance, and behavior in the Scotia Sea. In conjunction with data collected on the abundance and distribution of krill and other species, this data has provided valuable ecological information for the conservation of many species and results of SWFSC research are regularly presented to the scientific advisory bodies to the CCAMLR. In addition, SWFSC is the primary source of scientific advice to the U.S. Commissioner and delegation to CCAMLR. The indirect contribution of the No Research Alternative to cumulative effects is difficult to ascertain for individual species, but would likely impact long-term monitoring and management capabilities for many cetaceans in the ARA. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting cetaceans in the ARA, the contribution of the No Research Alternative to cumulative effects on cetaceans would be minor and adverse.

5.5.3.3 Other Pinnipeds

External Factors in the ARA

The nine species of pinnipeds in the ARA are listed in Section 3.2.2 and described in Appendix C. None are ESA-listed.

Large-scale hunting during the exploratory and commercial sealing periods of the 18th and 19th centuries severely depleted populations of many southern fur seal species, including the Antarctic fur seal, and larger seals, such as elephant seals (Boyd 2009, Forcada and Stanland 2009).

More recent and reasonably foreseeable potential threats to Antarctic pinniped species are similar to those outlined above for ESA-listed and other cetaceans. As with the other species, fisheries interactions and climate change are likely to have the greatest effects.

Fur seals may be both directly and indirectly impacted by the krill fishery. Since krill is a primary component of the Antarctic fur seal diet, competition with the krill fishery is possible. Depletion of krill stocks or entanglement in trawls are potential threats to fur seal populations (NMFS 2006). In 2002/2003, at least 114 Antarctic fur seals were caught in krill fishing operations in Area 48; 53 died and 61 were released alive. In the 2003/2004, 142 fur seals were observed killed and 12 released alive aboard the F/V Top Ocean, a U.S. flagged vessel. United Kingdom scientific observers aboard six of the nine vessels fishing in Subarea 48.3 (the area including South Georgia and the South Sandwich Islands) reported a minimum take of 292 fur seals (NMFS 2006). The take of Antarctic fur seals in the 2003/2004 fishing season was very small compared to an estimated population of 4,500,000 – 6,200,000 fur seals from a 1999/2000 census of South Georgia (the area of take) (NMFS 2006).

The incidental take of Antarctic fur seals in krill fishing trawls was attributed to the lack of effective mitigation measures (escape panels in the nets) and inexperienced crews new to the fishery. Experienced vessels, using effective mitigation measures, caught no seals (NMFS 2006).

The southern elephant seal is the only Antarctic pinniped species known to have toothfish in its diet. Interpreting trophic links between toothfish and elephant seals is complicated by the long distances traveled by elephant seals and the amount of time between visits ashore for breeding and molting (NMFS 2006 and citations therein).

The other Antarctic pinnipeds are ice-associated. Since fishery operations are confined to ice-free environments, direct interactions are unlikely.

The primary impacts of climate change are likely to be the same as described for ESA-listed species, including changes in abundance, quality, or stability of food resources caused by food web modifications related to changes in the physical environment (Turner et al. 2009). Loss of a stable food supply and shortage of food, rather than other habitat constraints, are more likely to affect long-term fitness.

Antarctic fur seals are exposed to increasing ecosystem fluctuation caused by extreme climatic events manifest near one of the regions' most rapidly warming areas, the Antarctic Peninsula (Turner et al. 2009).

The activities external to SWFSC fisheries research affecting pinnipeds in the ARA will likely continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

The contribution of SWFSC research to cumulative effects on pinnipeds would be the same as described above for ESA-listed marine mammals and other cetaceans.

When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting pinnipeds in the ARA, the contribution of the three research alternatives to cumulative effects on these species through disturbance and prey removal would be minor and adverse. However, research conducted by the SWFSC provides valuable information for the conservation and management of marine mammals and this contribution to cumulative effects would be beneficial for pinnipeds in the ARA.

Contribution of the No Research Alternative

Under the No Research Alternative, NMFS would not promulgate rulemaking or issue LOAs for SWFSC fisheries research. SWFSC would not directly contribute to cumulative effects on pinnipeds in the ARA. Indirectly, however, the loss of information obtained through this research could impact management decisions and analysis of long-terms trends affecting pinnipeds in the Antarctic. For example, SWFSC research surveys collect observational data on pinniped distribution, abundance, and behavior in the Scotia Sea. In conjunction with data collected on the abundance and distribution of krill and other species, this data has provided valuable ecological information for the conservation of many species and results of SWFSC research are regularly presented to the scientific advisory bodies to the CCAMLR. In addition, SWFSC is the primary source of scientific advice to the U.S. Commissioner and delegation to CCAMLR. The indirect contribution of the No Research Alternative to cumulative effects is difficult to ascertain for individual species, but would likely impact long-term monitoring and management capabilities for many pinnipeds in the ARA. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting pinnipeds in the ARA, the contribution of the No Research Alternative to cumulative effects on pinnipeds would be minor and adverse.

5.6 CUMULATIVE EFFECTS ON BIRDS

Activities external to SWFSC fisheries research that could potentially affect birds in the CCRA, ETPRA, and ARA may include commercial and recreational fisheries, ocean disposal and discharges, dredging, coastal development, oil extraction, other scientific research, military operations, climate change, and ocean acidification. The potential effects of these activities are summarized in Table 5.1-1 and may include:

- Mortality from avian by-catch
- Potential for ship collisions
- Alteration or reduction of prey resources
- Loss or injury due to ingestion of or entanglement in marine debris
- Behavioral disturbance

5.6.1 California Current Research Area

External Factors in the CCRA

Seabirds in the CCRA are being affected by the cumulative effects of past and present manmade and natural factors.

Manmade factors include: mortality in longline and gill-net fisheries, ingestion of plastic debris, human use and development of nesting habitat, oil spills, attraction to and disorientation by artificial lights leading to exhausted birds landing in dangerous situations and colliding with power lines and other structures, habitat destruction, predation by non-native terrestrial mammals, nesting habitat loss and degradation from guano mining and invasive species, pollution, competition with fisheries for prey species, underwater explosions from industrial and military operations, entanglement in debris, ingestion of marine debris, vessel collisions, and hunting. Some seabird species travel long distances over the ocean and have many potentially adverse interactions with humans and their activities, such as commercial and recreational fisheries, and oil spills from transport vessels and offshore oil wells. Human activities on land can also affect them at sea or at inland nest sites, such as oil and gas exploration, coastal development and transportation, dock construction, marine pollution, and dredging, as well as agricultural and urban runoff contamination and land clearing for resource development.

Natural factors include: threats to their nesting habitat on volcanic islands, predation on adults, eggs, and young by birds and mammals, and habitat loss due to encroachment of vegetation. Natural factors such as changes in ocean currents, prey availability, and severe weather can drive population fluctuations for many species (Ainley and Hyrenbach 2007).

The factors that have affected seabirds in the CCRA in the past are likely to do so in the future. Reasonably foreseeable future actions include continuation and possible expansion of fisheries activities, military operations, oil and gas exploration and production, marine vessel traffic, ocean disposal and discharge, climate change, and ocean acidification.

The cumulative effects on seabirds in the CCRA resulting from external anthropogenic factors (past actions, present actions, and RFFAs) are considered major (for some ESA-listed species) to minor (other species).

Contribution of the Research Alternatives

No seabirds have ever been caught incidentally in SWFSC fisheries surveys and changes in availability of seabird prey resulting from SWFSC research surveys are expected to be localized and insubstantial. The contribution of SWFSC research activities to seabird collisions with vessels and loss or injury of seabirds from interactions with marine debris are expected to be minor. Discharge of contaminants from vessels used during research surveys is possible, but unlikely, and if it occurs, would be isolated in both time and location and likely small in volume. When aggregated with the impacts of past, present, and reasonably foreseeable future actions, SWFSC research activities would make a minor additive contribution to cumulative adverse effects on birds in the CCRA due to slight increases in the potential for injury or mortality, changes in food availability due to discards and removal of prey, and alterations to seabird habitat under each of the research alternatives. However, research conducted by the SWFSC provides valuable information for the conservation and management of seabirds and this contribution to cumulative effects would be beneficial.

Contribution of the No Research Alternative

The lack of research under this alternative would eliminate any direct effects on seabirds in the CCRA. It is important to note that some of the SWFSC projects that would be eliminated under this alternative include bird observers when space is available and generate a great deal of information on the abundance, distribution, and feeding behaviors of seabirds in the CCRA. The loss of this information could indirectly

affect resource management decisions concerning the conservation of seabirds. Resource management authorities would lose important information needed to establish management measures in a meaningful fashion, and current conservation measures in place to protect ecological properties of the environment would become less effective. There are too many unknown variables to estimate the level of impact this lack of information would have on any particular species of seabirds but the contribution of this alternative to cumulative impacts on seabirds would likely be minor.

5.6.2 Eastern Tropical Pacific Research Area

External Factors in the ETPRA

Seabirds in the ETPRA are being affected by the same types of manmade and natural factors described above in the CCRA section, and are likely to be affected by the same types of RFFAs. When aggregated with the impacts of past, present, and reasonably foreseeable future actions, SWFSC research activities would make a minor additive contribution to cumulative adverse effects on birds in the ETPRA under each of the research alternatives. Overall cumulative effects to seabirds in the ETPRA resulting from external anthropogenic factors (past actions, present actions, and RFFAs) would be considered major for some ESA-listed species to minor for other species.

Contribution of the Research Alternatives

No seabirds have ever been caught incidentally in SWFSC fisheries surveys in the ETPRA and, although the future longline survey in the ETPRA may increase that risk, the future risk is still considered very low. Changes in the availability of seabird prey resulting from SWFSC research surveys are expected to be localized and insubstantial. When aggregated with the impacts of past, present, and reasonably foreseeable future actions, SWFSC research activities would make a minor additive contribution to cumulative adverse effects on birds in the ETPRA due to slight increases in the potential for injury or mortality and changes in food availability due to discards and removal of prey under each of the research alternatives. However, research conducted by the SWFSC provides valuable information for the conservation and management of seabirds in the ETPRA and this contribution to cumulative effects would be beneficial.

Contribution of the No Research Alternative

For the same reasons as described under the CCRA section, the indirect contribution of the No Research Alternative to cumulative impacts on seabirds would be minor and adverse through the loss of information used for the management and conservation of seabirds.

5.6.3 Antarctic Research Area

External Factors in the ARA

Seabirds in the ARA are being affected by the same types of manmade and natural factors described above in the CCRA section, and are likely to be affected by the same RFFAs. The cumulative effects on seabirds in the ETPRA resulting from external anthropogenic factors (past actions, present actions, and RFFAs) are considered major (for some albatross and penguin species) to minor (other species).

Contribution of the Research Alternatives

No seabirds have ever been caught incidentally in SWFSC fisheries surveys in the ARA and are not likely to be caught in the future. The contribution of SWFSC research activities to seabird collisions with vessels and loss or injury of seabirds from interactions with marine debris are expected to be minor. Discharge of contaminants from vessels used during research surveys is possible, but unlikely, and if it occurs, would be isolated in both time and location and likely small in volume. When aggregated with the

impacts of past, present, and reasonably foreseeable future actions, SWFSC research activities would make a minor additive contribution to cumulative adverse effects on birds in the ARA due to slight increases in the potential for injury or mortality and changes in food availability due to discards and removal of prey under each of the research alternatives. However, research conducted by the SWFSC provides valuable information for the conservation and management of seabirds in the ARA, especially for penguins and albatross, and this contribution to cumulative effects would be beneficial.

Contribution of the No Research Alternative

For the same reasons as described under the CCRA section, the indirect contribution of the No Research Alternative to cumulative impacts on seabirds would be minor and adverse through the loss of information used for the management and conservation of seabirds, especially for penguins and albatross.

5.7 CUMULATIVE EFFECTS ON SEA TURTLES

Activities external to SWFSC fisheries research that could potentially affect sea turtles in the CCRA, ETPRA, and ARA may include commercial and recreational fisheries, ocean disposal and discharges, dredging, coastal development, oil extraction, other scientific research, military operations, climate change, and ocean acidification. The potential effects of these activities are summarized in Table 5.1-1 and may include:

- Loss or injury of turtles resulting from ship strikes
- Loss or injury resulting from turtle bycatch or entanglement in fishing gear
- Alteration or reduction of prey resources
- Loss or injury due to ingestion of or entanglement in marine debris
- Behavioral disturbance

5.7.1 California Current and Eastern Tropical Pacific Research Areas

External factors in the CCRA and ETPRA

Sea turtles are susceptible to impacts resulting from natural and anthropogenic factors, both on land and in the water (Table 5.1-1). Effects on land involve habitat degradation, injury, and mortality through numerous mechanisms: beach erosion, beach armoring and nourishment, artificial lighting, increases in human presence, beach cleaning, recreational beach equipment, beach driving, coastal construction, fishing piers, disturbance of dunes and beach vegetation, and poaching. Increases in human presence near nesting beaches have led to the introduction of exotic fire ants, dogs, raccoons, and armadillos, all of which may feed on turtle eggs. Adverse impacts to sea turtles also involve habitat degradation, injury, and mortality through numerous mechanisms: oil and gas exploration, coastal development and transportation, dock construction, marine pollution, dredging, underwater explosions, offshore artificial lighting, entanglement in debris, ingestion of marine debris, fishery interactions, boat collisions, and poaching.

Threats to sea turtles in the CCRA and ETPRA include incidental capture, injury, and mortality during commercial fishing operations. This conservation issue has been the subject of numerous conservation engineering studies. The implementation of turtle excluder devices and time/area restrictions in commercial trawl fisheries has reduced the level of captures and mortality in trawl fisheries. Use of circle hooks instead of ‘J’ hooks and finfish bait instead of squid bait in commercial pelagic longline fisheries has also reduced sea turtle mortalities (Watson et al. 2005). However, capture and entanglement in several types of fishing gear continues to be a conservation concern, especially since all sea turtle species are listed as threatened or endangered under the ESA (NMFS and USFWS 1992 and 2008c).

Multiple past and present actions have affected sea turtles in the CCRA and ETPRA, and many of these impact producing factors are likely to continue for the foreseeable future. All species of sea turtles that occur in the SWFSC research areas are threatened or endangered, and have therefore been subject to major population-level cumulative effects.

Contribution of the Research Alternatives

Fisheries research activities conducted and funded by the SWFSC have had no recorded interactions with Olive Ridley, Green, Loggerhead, or Hawksbill sea turtles, and the contributions of proposed fisheries research to the cumulative effects on these species are considered minor under each of the research alternatives. In the CCRA, there has been one incident of sea turtle entanglement resulting from SWFSC research using a standard Nordic 264 trawl configured for surface fishing. In that instance, the turtle was released alive. There have been no reported interactions resulting in sea turtle mortality. Likewise, contributions of the research alternatives to ship strikes, changes in availability of prey for sea turtles, loss or injury due to ingestion of or entanglement in marine debris, and alterations to sea turtle habitat are expected to be minor. In addition, a number of SWFSC fisheries research projects have been oriented toward reducing turtle bycatch in fisheries and studying habitat needs of sea turtles and therefore contribute to conservation efforts for these species. Thus, SWFSC fisheries research activities would result in both potentially adverse and potentially beneficial contributions to cumulative impacts on sea turtles in the CCRA and ETPRA. When aggregated with the impacts of past, present, and reasonably foreseeable future actions, the overall contribution of SWFSC research activities to cumulative effects on sea turtles in the CCRA and ETPRA would be minor and potentially adverse under each of the research alternatives.

Contribution of the No Research Alternative

The No Research Alternative would eliminate any direct impacts to sea turtles that could potentially occur under the research alternatives. However, it is important to note that several of the SWFSC projects that would be eliminated under this Alternative generate data concerning the distribution of sea turtles and their habitat quality in the CCRA and ETPRA. These data are used to inform science-based decisions related to the management of sea turtles. Under the No Research Alternative, the loss of information currently provided by SWFSC research activities would have a minor to moderate contribution to adverse cumulative impacts to sea turtles in the CCRA and ETPRA through indirect effects on management decisions important to the conservation and recovery of these species.

5.8 CUMULATIVE EFFECTS ON INVERTEBRATES

Activities external to SWFSC fisheries research that could potentially affect invertebrates in the CCRA, ETPRA, and ARA may include commercial and recreational fisheries, ocean disposal and discharges, dredging, coastal development, oil extraction, other scientific research, military operations, climate change, and ocean acidification. The potential effects of these activities are summarized in Table 5.1-1 and may include:

- Loss or displacement due to habitat disturbance
- Removal of individuals and biomass
- Bioaccumulation of contaminants
- Disruption due to changes in water temperature resulting from climate change
- Decreased calcification due to ocean acidification

5.8.1 All SWFSC Research Areas

External factors in the CCRA, ETPRA, and ARA

Marine invertebrates continue to be susceptible to natural and anthropogenic effects including exploitation through commercial and recreational fishing, habitat degradation and disturbance, pollution, competition with invasive species, and climate change. Because marine invertebrates do not regulate their body temperature, changes in water temperature may affect the distribution of certain species as well as growth rates, reproductive ability and survival (Harley et al. 2006). In addition, ocean acidification is expected to have adverse effects on invertebrate species that form calcium carbonate shells or exoskeletons.

Degradation of invertebrate habitat can occur as a result of commercial and recreational fisheries that involve gear coming into contact with the sea floor (See Section 4.2.7.3). Other sources of habitat disruption identified in the RFFAs (Table 5.1-1) include ocean dredging, waste disposal, and offshore development projects. In addition, pollution can adversely affect the quality of water and benthic habitats upon which invertebrates depend. Effects of pollution may include decreased foraging ability and reproductive success and increased mortality (Milligan et al. 2009). However, these effects are expected to be localized to small geographic areas.

Overexploitation of undersized or immature individuals can have serious implications for the sustainability of stocks, and the overall body size of individuals in a fished population may also change with intense fishing pressure on a single size (Donaldson et al. 2010). Some commercially valuable species of invertebrates (e.g., abalone) have had population declines in the past due to overharvest.

Contribution of the Research Alternatives

SWFSC research surveys remove small numbers of invertebrates from all three research areas, primarily plankton, pelagic jellyfish and squid. Mortality resulting from SWFSC fisheries research would make minor contributions under each of the research alternatives to adverse cumulative effects on invertebrates of mortality from commercial fishing and dredging. . Because the SWFSC does not use bottom-trawl gear in the CCRA and ETPRA, SWFSC research would not contribute to benthic habitat disturbance in those areas. In the ARA, SWFSC research activities would make a minor additive contribution to adverse cumulative effects on benthic invertebrate habitat (section 4.2.7.3). The contributions of SWFSC research activities to habitat contamination, climate change, and ocean acidification are expected to be insubstantial. SWFSC fisheries research would contribute to future management decisions related to invertebrate populations in the CCRA and ARA, where commercial fisheries target market squid and krill respectively. There are no direct links between SWFSC research in the ETPRA and management of any invertebrate species in that area. When aggregated with the impacts of past, present, and reasonably foreseeable future actions, the direct contribution of SWFSC research activities to cumulative effects on invertebrates would be minor and potentially adverse under each of the research alternatives. However, research conducted by the SWFSC on invertebrates in the CCRA and ARA contributes to sustainable management of certain species and this contribution to cumulative effects would be beneficial.

Contribution of the No Research Alternative

The No Research Alternative would eliminate any direct impacts to invertebrates that could potentially occur under the research alternatives. However, increased adverse effects could result indirectly from a loss of scientific information necessary for sustainable fisheries management and conservation of invertebrates and their habitats. Data from SWFSC research activities are used to inform science-based decisions related to the management of commercially-fished invertebrates in the CCRA and ARA. Without the input of SWFSC data, management authorities would lose important information needed to establish management measures in a meaningful fashion, and current conservation measures in place to protect ecological properties of the environment would soon become obsolete. Resource management

agencies would have to adequately compensate for this loss of information through changes in management scenarios based on greater uncertainty. The indirect contribution of the No Research Alternative to cumulative effects is difficult to ascertain for individual species, but would likely impact long-term monitoring and management capabilities for commercially important invertebrates in the CCRA and ARA. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting invertebrates in the CCRA and ARA, the contribution of the No Research Alternative to cumulative effects on invertebrates would be minor to moderate. Because there is no direct connection between SWFSC research and managed invertebrates in the ETPRA, there would be no contribution to cumulative effects in the ETPRA under this alternative.

5.9 CUMULATIVE EFFECTS ON THE SOCIAL AND ECONOMIC ENVIRONMENT

Activities external to SWFSC fisheries research that could potentially affect the social and economic environment in the CCRA, ETPRA, and ARA may include commercial and recreational fisheries, shipping, coastal development, oil extraction, other scientific research, military operations, climate change, and ocean acidification. The potential effects of these activities are summarized in Table 5.1-1 and may include:

- Provision of jobs and economic opportunity
- Changes in commercial fishing opportunities
- Economic costs of changes in resource availability due to climate change and ocean acidification

5.9.1 California Current Research Area

External factors in the CCRA

This section describes the contribution of SWFSC research activities to cumulative effects on the social and economic environment from past, present, and reasonably foreseeable future actions. The cumulative effects of fisheries research and management associated with the CCRA are closely related to socioeconomic conditions in Washington, Oregon, and California. Overall, California's economy had a gross state product of about $1.9 trillion in 2010, characterized by great diversity among economic sectors (U.S. Department of Commerce 2010). Potential future socioeconomic cumulative effects from developments in non-fishing industries, such as liquid natural gas terminals, oil extraction, shipping commerce, or climate change cannot be feasibly estimated with available data, but would be expected to dominate the economy in the future.

In regard to fishing opportunity, cumulative fishing and non-fishing industry actions would be more noticeable in coastal communities. Specific fisheries management decisions, to which the SWFSC research program contributes, could also have an effect over time. Reductions in certain stocks as a result of ocean ecosystem changes, or overfishing, which results in commercial or recreational area closures, would result in noticeable changes in the socioeconomic status of communities.

RFFAs that could contribute to cumulative effects to the social and economic environment include updates to species take reduction plans, and fishery management measures. Species take reduction plans could include measures that would lead to increased costs for fishermen through required gear modifications. These plans could also call for time and/or area closures that could affect fishing fleet locations.

Contribution of the Research Alternatives

The fundamental purpose of fisheries management is to monitor and counteract the contribution of commercial and sport fishing to the adverse cumulative effects on fish stocks from past, present, and reasonably foreseeable actions. SWFSC research is one of the most effective mechanisms to monitor the

status of fish stocks and changes in the marine environment, providing substantial beneficial contributions to cumulative effects through scientific input to fishery management and other environmental decision-making processes. Continuation of this research would provide consistent data to allow evaluation of fish stock trends and the effects of actions not related to fishing.

In all research alternatives, at-sea and laboratory research, and cooperative fisheries management activities that are currently directed by SWFSC would continue. This would help promote sustainable fish populations and have substantial benefits for local economies dependent on stable fishing opportunities. Long-term sustainable catches would be promoted, increasing stability in the fishing communities and reducing boom and bust cycles related to over-exploitation of target species.

In addition, research results that identify effects not related to commercial or recreational fishing that could threaten species recoveries and sustainable yield levels would be identified in sufficient time to take corrective action before population level effects would be noticed by fishers in the form of reduced abundance and lower catches. The cumulative effect to the social and economic environment of U.S. West Coast fisheries as a result of Alternatives 1 and 2 would be beneficial and moderate in magnitude. Mitigation measures in Alternative 3 that reduce the ability of the SWFSC to sample commercial fish and invertebrate stocks in certain places and times could represent a slightly reduced benefit, as at-sea sampling operations would be reduced from the current level of comprehensiveness.

The socioeconomic effects of non-fishing industry actions are likely to dominate any cumulative effects on the socioeconomic environment of the CCRA. The research alternatives would contribute moderate (beneficial) effects to the cumulative effects because they SWFSC research provides a substantial portion of the information needed to determine if fisheries management actions are successful, and therefore balance the needs for stock recovery and sustainable catch quotas that minimize impacts to fishing communities. The at-sea surveys also provide measures to detect the result of cumulative changes contributed by non-fishing industries and climate change. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting the socioeconomic environment in the CCRA, the contribution of the research alternatives to cumulative effects on the socioeconomic environment would be moderate and beneficial in that it reduces the potential for negative cumulative effects on commercial and recreational fisheries.

Contribution of the No Research Alternative

Under the No Research Alternative, NMFS would not promulgate rulemaking or issue LOAs for SWFSC fisheries research. SWFSC would not contribute to the information base needed for sustainable fisheries management. Fisheries research activities conducted by state and private organizations are not likely to be sufficient to identify trends in target fish stocks and set sustainable fishery harvest limits without the contribution from the SWFSC. Some major commercial species would likely receive attention from state and private research efforts, so potential adverse effects would not likely be uniform across the fishing communities. Some fishers that target these major species may continue to benefit from sustainable fisheries management, but others may be affected by lack of information on their target species. Lack of consistent data input into the fisheries management process would have moderate adverse effects on the quality of the management analyses, and subsequently to the value of the management process. Elimination of at-sea operations would reduce science-based input into fisheries management decisions, which would increase the potential for negative cumulative effects on commercial fisheries.

When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting the socioeconomic environment in the CCRA, the No Research Alternative would contribute a moderate adverse effect to the cumulative effects on the socioeconomic environment because at-sea research efforts of the SWFSC that could detect and anticipate cumulative effects on fisheries resources, which are important for fisheries management decisions that strongly influence the socioeconomic conditions of fishing communities, would not be conducted.

5.9.2 Eastern Tropical Pacific Research Area

External Factors in the ETPRA

RFFAs associated with both fishing and non-fishing industries, and climate change, have the potential to affect international economic dynamics, in a region extending from Mexico to Peru. The SWFSC has only limited interaction with coastal communities associated with the ETPRA, and few at-sea missions there.

Contribution of the Research Alternatives

Alternative 1 retains the same level of SWFSC at-sea research, and Alternatives 2 and 3 add a new longline survey for HMS. SWFSC research in the ETP contributes to an understanding of this international ecosystem. International fishing and non-fishing activity and practices in the vast area of the ETPRA contribute to cumulative fisheries outcomes and management in many countries. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting the socioeconomic environment in the ETPRA, the research alternatives add a minor beneficial contribution to socioeconomic cumulative effects because they are not directly related to fisheries management decisions other than to monitor the effectiveness of conservation measures to protect dolphins from bycatch in the tuna fisheries.

Contribution of the No Research Alternative

When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting the socioeconomic environment in the ETPRA, the No Research Alternative, with the suspension of at-sea research in the ETP, would have a minor adverse contribution to socioeconomic cumulative effects in the ETPRA because the lack of information from research could cause fisheries management decisions to become more conservative (lower fishing quotas) in order to compensate for higher uncertainty about the status of marine mammal stocks associated with the fisheries.

5.9.3 Antarctic Research Area

External Factors in the ARA

RFFAs associated with both fishing and non-fishing industries, and climate change, have the potential to affect international socioeconomic dynamics. The SWFSC has only limited interaction with coastal communities associated with Antarctica, and few at-sea missions there. The Antarctic area is distinguished by treaty agreements that establish cooperative research, although the U.S. provides the bulk of information about the Scotia Sea region of the Southern Ocean (the ARA).

Contribution of the Research Alternatives

All the research alternatives retain the same level of SWFSC at-sea research, which have limited interaction with ports in South America and Antarctic field stations. SWFSC research in the Antarctic area contributes to an understanding of the Southern Ocean ecosystem, which supports many international economic ventures. International fishing and non-fishing activity and practices in the vast area of the ARA contribute to cumulative fisheries outcomes and management in many countries. The research conducted by the SWFSC is an important component of fisheries management decisions made by CCAMLR, especially with the economically important krill fisheries. When aggregated with other past, present, and reasonably foreseeable future activities, the research alternatives would add a moderate beneficial contribution to socioeconomic cumulative effects that would be dominated by international fisheries and tourist industry elements.

Contribution of the No Research Alternative

When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting the socioeconomic environment in the ARA, the No Research Alternative, which would eliminate at-sea research in the Antarctic region, would have moderate adverse contributions to the cumulative effects on socioeconomic conditions in the area due to the lack of scientific data in the ARA used to support fishery management and conservation decisions. The increased uncertainty about the status of krill stocks could cause reductions in harvest guidelines for the krill fisheries. Finfish fisheries that have been closed since 1990 may also remain closed due to uncertainty about the recovery of overfished species.

6.1 NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act (NEPA) is the primary law directing the preparation of this programmatic Environmental Assessment (EA). In addition to addressing NEPA, this document contains an analysis of a proposed action and alternatives that is adequate for compliance with the laws and policies included in this section.

NEPA (42 United States Code [U.S.C.] §§ 4331, et seq.) establishes the U.S. national environmental policy and provides an interdisciplinary framework for environmental planning by federal agencies, and contains action-forcing procedures to ensure that federal decision-makers take environmental factors into account. NEPA does not require that the most environmentally desirable alternative be chosen but does require that the environmental effects of all the alternatives be analyzed equally for the benefit of decision makers and the public.

NEPA has two principal purposes:

1. To require federal agencies to evaluate the potential environmental effects of any major planned federal action to ensure that public officials make well-informed decisions about the potential impacts.
2. To promote public awareness of potential impacts at the earliest planning stages of major federal actions by requiring federal agencies to prepare a detailed environmental evaluation for any major federal action significantly affecting the quality of the human environment.

NEPA requires an assessment of the biological, social and economic consequences of fisheries research, and requires that members of the public have an opportunity to be involved in and to influence decision making on federal actions. In short, NEPA ensures that environmental information is available to government officials and the public before decisions are made and actions taken.

Title II, Section 202 of NEPA (42 U.S.C. 4332) created the Council on Environmental Quality (CEQ). The CEQ is responsible for the development and oversight of regulations and procedures implementing NEPA. The CEQ regulations provide guidance for federal agencies regarding NEPA's requirements (40 Code of Federal Regulations [CFR] Part 1500) and require agencies to identify processes for issue scoping, consideration of alternatives, developing evaluation procedures, involving the public and reviewing public input, and coordinating with other agencies - all of which are applicable to the Southwest Fisheries Science Center's (SWFSC) development of fishery research plans.

The National Oceanic and Atmospheric Administration (NOAA) has prepared environmental review procedures for implementing NEPA (NOAA Administrative Order [NAO] 216-6). This administrative order describes NOAA's policies, requirements, and procedures for complying with NEPA and the implementing regulations issued by the CEQ. The administrative order also expands on guidance for consideration of cumulative impacts and "tiering" in the environmental review of NOAA actions.

6.1.1 California Environmental Quality Act

The California Environmental Quality Act (CEQA) requires public agencies to disclose to the public the environmental implications of proposed actions. It also requires mitigations for adverse environmental effects. Guidelines for Implementation of the CEQA (CCR Title 14, Section 15000), provides compliance procedures for agencies.

6.2 THE MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

In 1976, Congress passed the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801, *et seq*.). This law authorizes the United States (U.S.) to manage its fishery resources in an area extending from a state's territorial sea (generally extending from 3 miles [mi.] [4.8 kilometers (km.)] from shore out to 200 mi. [320 km.]). This area is termed the Exclusive Economic Zone (EEZ). The MSA was updated in 2006, and is known as the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act.

Two of the main purposes of the MSA are to promote domestic commercial and recreational fishing under sound conservation and management principles, and to provide for fishery management plans (FMPs). The FMPs are intended to achieve and maintain, on a continuing basis, the optimum yield from each fishery. The MSA standards require that FMPs contain certain conservation and management measures. The standards include measures necessary to prevent overfishing; rebuilding overfished stocks; ensuring conservation; facilitating long-term protection of Essential Fish Habitat (EFH); and realizing the full potential of the nation's fishery resources. Furthermore, the MSA also declares that the National Fishery Conservation and Management Program must utilize the best scientific information available; involves, and is responsive to the needs of interested and affected states and citizens; considers efficiency; and draws upon federal, state, and academic capabilities in carrying out research, administration, management, and enforcement.

Some stocks of fish been substantially reduced in number. They could be severely affected by (a) increased fishing pressure; (b) inadequacy of fishery resource conservation and management practices and controls; or, (c) direct and indirect habitat losses which have resulted in a diminished capacity to support existing fishing levels.

The resource and research surveys conducted by the SWFSC are designed to meet the requirements of the MSA by providing the best scientific information available to fishery conservation and management scientists and managers. This supports a management program that is able to respond to changing ecosystem conditions, and manages risk by developing science-based decision tools.

The U.S. Commission on Ocean Policy has identified the need for more holistic assessments of the status of marine ecosystems. The President's Ocean Action Plan has endorsed the concept of marine Ecosystem-Based Management. Sustained ecosystem monitoring programs are essential for tracking the health of marine ecosystems as part of this overall approach. The individual SWFSC surveys comprise a broader ecosystem monitoring program that meets this emerging critical need.

The EFH provisions of the MSA require the National Marine Fisheries Service (NMFS) to provide recommendations to federal and state agencies for conserving and enhancing EFH, and for any actions that may adversely impact EFH. EFH is defined as "…those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity…" Federal agencies must consult with NMFS and assess the effects of their actions on EFH. There is no separate permit or authorization process; EFH consultation is typically addressed during the NEPA process and incorporated into other permits. The SWFSC will use this EA to consult with the Southwest Region EFH Coordinator to assess the impacts of SWFSC fisheries research activities on EFH.

The proposed action meets the MSA's definition of scientific research activity conducted by a scientific research vessel and is therefore exempt from some requirements of the MSA. Some of the research projects do not alter the nature of commercial fishing activity, as specified by FMP regulations but merely involve scientific data collection from the catch. Other projects involve modifications to the methods or locations of the commercial fishing efforts, which then require experimental fishing permits under the MSA. Section 404 of the MSA requires the Secretary of Commerce to initiate and maintain, in cooperation with the Fishery Management Councils, a comprehensive program of fishery research to carry out and further the purposes, policy, and provisions of the MSA.

1996 amendments to the MSA require assessment, specification, and description of the effects of conservation and management measures on participants in fisheries, and on fishing communities:

> *Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities.*

The Sustainable Fisheries Act of 1996 is also an amendment to the MSA. Sections 103 and 104 clarify issues surrounding highly migratory fish, and the international treaties that govern fisheries. Among the topics covered by these sections are Atlantic and Pacific fishing in international waters; fishing in the Bering Sea, shared with Russia; and congressional rules setting time limits on approval of international fishing treaties. Sections 116 to 406 of the Sustainable Fisheries Act detail the research necessary to implement the act. These sections specify the agencies responsible for research and the nature of the research to be conducted in each of several specific fishing areas, including the Pacific Ocean.

6.3 MARINE MAMMAL PROTECTION ACT

The Marine Mammal Protection Act (MMPA) of 1972 (16 U.S.C. 1361 *et seq*.), as amended, prohibits the "take" [14] of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S. The primary management objective of the MMPA is to maintain the health and stability of the marine ecosystem, with a goal of obtaining an optimum sustainable population of marine mammals within the carrying capacity of the habitat. The MMPA is intended to work in concert with the provisions of the Endangered Species Act (ESA). The secretary is required to give full consideration to all factors regarding regulations applicable to the takeof marine mammals, including the conservation, development, and utilization of fishery resources, and the economic and technological feasibility of implementing the regulations.

Section 101(a)(5)(A-D) of the MMPA provides a mechanism for allowing, upon request, the "incidental," but not intentional, taking, of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing or directed research on marine mammals) within a specified geographic region. The NMFS Office of Protected Resources (OPR) processes applications for incidental takes of small numbers of marine mammals. Authorization for incidental takes may be granted if NMFS finds a negligible impact on the species or stock(s), and if the methods, mitigation, monitoring and reporting for takes are permissible.

The purpose of issuing incidental take authorizations is to provide an exemption to the take prohibition in the MMPA, and to ensure that the action complies with the MMPA and NMFS' implementing regulations. ITAs may be issued as either: (1) regulations and associated Letters of Authorization (LOAs) under Section 101(a)(5)(A) of the MMPA; or (2) Incidental Harassment Authorizations (IHAs) under Section 101(a)(5)(D) of the MMPA. An IHA can only be issued when there is no potential for serious injury and/or mortality or where any such potential can be negated through required mitigation measures. Pursuant to Section 101(a)(5)(A) of the MMPA, NMFS, upon application from the SWFSC, plans to propose regulations to govern the unintentional taking of marine mammals, by harassment, incidental to the proposed fisheries research activities by the SWFSC in the Pacific and Southern Oceans from 2012 through 2017. The issuance of MMPA incidental take regulations and associated LOAs to the SWFSC is a federal action, thereby requiring NMFS to analyze the effects of the action on the human environment pursuant to the NEPA and NMFS' NEPA procedures.

[14] The MMPA defines take as: "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal." Harassment means any act of pursuit, torment, or annoyance which, 1) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment); or 2) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B Harassment).

After an application is submitted, the NMFS OPR may authorize incidental takes of marine mammals through either a one-year IHA or LOAs, which is a rulemaking process that can cover activities for up to five years. The SWFSC will be applying for an LOA for the small number of incidental takes of marine mammals that could occur during their fisheries research surveys from 2012 through 2017. This EA will provide informational support for that LOA application and provide NEPA compliance for the authorization.

The International Dolphin Conservation Program Act (IDCPA) is a 1997 amendment to the U.S. MMPA. The Act addresses and codifies the obligations of the U.S. under the International Dolphin Conservation Program, a legally binding instrument for dolphin conservation and ecosystem management in the eastern tropical Pacific Ocean. The IDCPA directed NMFS to conduct studies to determine whether the intentional deployment on or encirclement of dolphins with purse seine nets is having a significant adverse impact on any depleted dolphin stock in the Eastern Tropical Pacific (ETP) Ocean. The observational research on marine mammal distribution and abundance conducted by the SWFSC in the ETPRA, included in this EA, provides a portion of the scientific data required under the IDCPA and helps meet U.S. obligations under the Agreement.

6.4 ENDANGERED SPECIES ACT

The Endangered Species Act (ESA) of 1973 as amended (16 U.S.C. 1531, *et seq*.), provides for the conservation of endangered and threatened species of fish, wildlife, and plants. The statute is administered jointly by NMFS and the U.S. Fish and Wildlife Service (USFWS), with some exceptions - NMFS oversees marine mammal species, marine and anadromous fish species, and marine plant species; and the USFWS oversees walrus, sea otter, seabird species, and terrestrial and freshwater wildlife and plant species.

The listing of a species as threatened or endangered is based on the biological health of that species. Threatened species are those likely to become endangered in the foreseeable future (16 U.S.C. 1532[20]). Endangered species are those in danger of becoming extinct throughout all or a significant portion of their range (16 U.S.C. 1532[20]). Species can be listed as endangered without first being listed as threatened.

In addition to listing species under the ESA, the appropriate expert agency (NMFS or USFWS) must designate critical habitat of the newly listed species within a year of its listing to the “maximum extent prudent and determinable” (16 U.S.C. 1533[b] [1] [A]). The ESA defines critical habitat as those specific areas that are essential to the conservation of a listed species and that may be in need of special consideration. Federal agencies are prohibited from undertaking actions that destroy or adversely modify designated critical habitat. Some species, primarily cetaceans (whales), which were listed in 1969 under the Endangered Species Conservation Act and carried forward as endangered under the ESA, have not received critical habitat designations.

Federal agencies have an affirmative mandate to conserve listed species. An assurance of this is that federal actions, activities, or authorizations must be in compliance with the provisions of the ESA. Section 7 of the ESA provides a mechanism for consultation by the federal action agency with the appropriate expert agency. Informal consultations are conducted for federal actions that have no adverse effects on the listed species and typically result in letters of concurrence from the expert agency. In cases where a proposed action may affect listed species or critical habitat, the action agency prepares a biological assessment to determine if a proposed action would adversely affect listed species or modify critical habitat. The biological assessment contains an analysis based on biological studies of the likely effects of the action on the species or habitat. The expert agency either concurs with the assessment or provides its own analysis to continue the consultation.

If the action agency or expert agency concludes that a proposed action may have adverse effects on a listed species, including take[15] of any listed species, they must enter formal consultations under Section 7 of the ESA. The expert agency must then write a Biological Opinion (BiOp) that determines whether a proposed action places the listed species in jeopardy of extinction or adversely modifies its critical habitat. If the BiOp concludes the proposed (or ongoing) action will cause jeopardy to the species or adversely modify its critical habitat, it must also include reasonable and prudent alternatives that would modify the action so it no longer poses jeopardy to the listed species. These reasonable and prudent alternatives must be incorporated into the federal action if it is to proceed. Regardless of whether the BiOp reaches a jeopardy or no jeopardy conclusion, it often contains a series of mandatory and/or recommended management measures the action agency must implement to further reduce the negative impacts to the listed species and critical habitat (50 CFR 402.24[j]). If a proposed action would likely involve the taking of any listed species, the expert agency may append an incidental take statement to the BiOp to authorize the amount of take that is expected to occur from normal promulgation of the action. The SWFSC will use this EA to initiate Section 7 consultation on the proposed action with the Protected Resource Offices of both NMFS and USFWS.

Section 4(f) of the ESA directs NOAA's NMFS to develop and implement recovery plans for threatened and endangered species, unless such a plan would not promote conservation of the species. According to the statute, these plans must incorporate, at a minimum:

- a description of site-specific management actions necessary to achieve recovery of the species
- objective, measurable criteria which, when met, would result in a determination that the species be removed from the list
- estimates of the time and costs required to achieve the plan's goal

NMFS' Program on Cooperative Conservation with States (section 6 of the ESA) was developed to assist states that have a cooperative agreement with NMFS in developing and implementing their conservation program for species listed in that agreement, including providing funding for management, research and monitoring that has a direct conservation benefit to the species. Conservation actions may also be carried out by federal agencies as part of their obligations under section 7(a)(1) of the ESA, or as a means to minimize activities that adversely affect a species as part of an interagency consultation. States, local agencies and private entities may conduct conservation actions as a means to minimize or mitigate "incidental take" of species as part of a Conservation Plan under section 10 of the ESA.

In order to meet these requirements and to support recovery plan development, the SWFSC conducts research aimed at determining recovery criteria and assessing threats that may potentially impede the recovery of threatened and endangered species. In addition, these activities enable NMFS, state and local agencies, and private entities to fulfill the conservation requirements outlined within the ESA.

6.5 MIGRATORY BIRD TREATY ACT

The Migratory Bird Treaty Act (MBTA) protects approximately 836 species of migratory bird species from any attempt at hunting, pursuing, wounding, killing, possessing, or transporting any migratory bird, nest, egg, or part thereof, unless permitted by regulations (i.e. for hunting and subsistence activities). Additional protection is allotted under the Bald and Golden Eagle Protection Act for the identified species. Compliance with the MBTA does not require a permit or authorization; however, the USFWS often requests that other agencies incorporate MBTA mitigation measures as stipulations in their permits. In addition, a recently signed Memorandum of Understanding (MOU) between NMFS and USFWS focuses on the means and intent to avoid and minimize, to the extent practicable, adverse impacts on

[15] The ESA defines “take” as: to “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct.” (16 U.S.C. 1538[a][1][B])

migratory birds through enhanced interagency collaboration. In compliance with the MOU, the SWFSC has identified and evaluated the impacts of the proposed actions on migratory birds, which are considered minor. NMFS will provide a copy of this Draft EA to the USFWS and will consider all comments from them concerning compliance with the MBTA as necessary.

6.6 FISH AND WILDLIFE COORDINATION ACT

The Fish and Wildlife Coordination Act (FWCA) requires USFWS and NMFS to consult with other state and federal agencies in a broad range of situations to help conserve fish and wildlife populations and habitats in cases where federal actions affect natural water bodies (16 U.S.C. 661 1934). Specific provisions involve conservation or expansion of migratory bird habitats related to water body impoundments or other modifications. FWCA requires consultation among agencies and the incorporation of recommended conservation measures if feasible but does not involve a separate permit or authorization process. NMFS will provide a copy of this Draft EA to the state fish and wildlife agencies in every state affected by the fisheries research activities examined in this EA. NMFS will consider all comments from these agencies and take steps to comply with FWCA as necessary.

6.7 NATIONAL HISTORIC PRESERVATION ACT

Section 106 of the National Historic Preservation Act (NHPA) requires review of any project funded, licensed, permitted, or assisted by the federal government for impact on significant historic properties. The agencies must allow the State Historic Preservation Officer (SHPO) and the Advisory Council on Historic Preservation, a federal agency, to comment on a project. NMFS will provide a copy of this Draft EA to the SHPOs in every state affected by the fisheries research activities examined in this EA. NMFS will consider all comments from the SHPOs and take steps to comply with NHPA.

6.8 EXECUTIVE ORDER 12989, ENVIRONMENTAL JUSTICE

Executive Order 12898 directs federal agencies to take the appropriate and necessary steps to identify and address disproportionately high and adverse effects of federal projects on the health or environment of minority and low-income populations to the greatest extent practicable and permitted by law. No such effects are identified in this EA.

6.9 EXECUTIVE ORDER 12114, ENVIRONMENTAL EFFECTS ABROAD OF MAJOR FEDERAL ACTIONS

Executive Order 12114 directs federal agencies to extend their compliance with NEPA and other specified laws to major federal actions outside of the U.S., its territories, and possessions. The purpose of the order is to establish internal procedures for federal agencies to consider the significant effects of their actions on the environment outside the U.S. but it does not require redress of those effects. The Draft EA does not identify any significant effects in areas outside of the U.S., although the final determination of significance will be made after the public has an opportunity to comment on the document.

6.10 EXECUTIVE ORDER 13158, MARINE PROTECTED AREAS

The purpose of this order is to strengthen and expand the Nation's system of marine protected areas (MPAs) to enhance the conservation of our Nation's natural and cultural marine heritage and the ecologically and economically sustainable use of the marine environment for future generations. The order encourages Federal agencies to use science-based criteria and protocols to identify and prioritize natural and cultural resources in the marine environment that should be protected to secure valuable ecological services and to monitor and evaluate the effectiveness of MPAs. Each Federal agency whose actions affect the natural or cultural resources that are protected by an MPA shall identify such actions. To the extent permitted by law and to the maximum extent practicable, each Federal agency, in taking such actions, shall avoid harm to the natural and cultural resources that are protected by an MPA.

6.11 INFORMATION QUALITY ACT

Pursuant to NOAA guidelines implementing Section 515 of Public Law 106-554 (the Data Quality Act), all information products released to the public must first undergo a Pre-Dissemination Review to ensure and maximize the quality, objectivity, utility, and integrity of the information (including statistical information) disseminated by or for federal agencies. The following sections address these requirements.

6.11.1 Utility

The information presented in this document is helpful to the intended users (the affected public) by presenting a clear description of the purpose and need of a proposed action, the measures proposed, and the impacts of those measures. This document is the principal means by which the information contained herein is available to the public. The information provided in this document is based on the most recent available information from the relevant data sources. The development of this document and the decisions made by NMFS to propose an action are the result of a multi-stage public process. This document is available in several formats, including printed publication and CD-ROM, upon request.

6.11.2 Integrity

Prior to dissemination, information associated with an action, independent of the specific intended distribution mechanism, is safeguarded from improper access, modification, or destruction, to a degree commensurate with the risk and magnitude of harm that could result from the loss, misuse, or unauthorized access to or modification of such information. All electronic information disseminated by NMFS adheres to the standards set out in Appendix III, "Security of Automated Information Resources," of Office of Management and Budget (OMB) Circular A-130; the Computer Security Act; and the Government Information Security Act. All confidential information (e.g., dealer purchase reports) is safeguarded pursuant to the Privacy Act; Titles 13, 15, and 22 of the U.S.C. (confidentiality of census, business, and financial information); the Confidentiality of Statistics provisions of the MSA; and NAO 216-100, Protection of Confidential Fisheries Statistics.

6.11.3 Objectivity

For purposes of the Pre-Dissemination Review, this document is considered to be a "Natural Resource Plan." Accordingly, the document adheres to the published standards of the MSA; Operational Guidelines of the FMP Process; EFH Guidelines; National Standard Guidelines; and NAO 216-6, Environmental Review Procedures for Implementing NEPA.

This document uses information of known quality from sources acceptable to the relevant scientific and technical communities. Stock status (including estimates of biomass and fishing mortality) are based on either assessments subject to peer-review through Stock Assessment Review Committees or on updates of those assessments prepared by scientists of the SWFSC. Landing information is based on information collected through the SWFSC Commercial Fisheries database. In addition to these sources, other information is presented that has been accepted and published in peer-reviewed journals or by scientific organizations.

Despite current data limitations, the measures proposed for this action were selected based upon the best scientific information available. The analyses conducted in support of the proposed action were conducted using information from the most recent complete calendar years, from 2006 through 2011. The data used in the analyses provide the best available information on the landings of the relevant species in the SWFSC region.

The supporting science and analyses, upon which the policy choices are based, have been documented. All supporting materials, information, data, and analyses within this document have been, to the maximum extent practicable, properly referenced according to commonly accepted standards for scientific literature to ensure transparency.

The review process used in preparation of this document involved staff from the SWFSC and the Southwest Regional Office. The SWFSC's technical review was conducted by senior level scientists with specialties in population dynamics, stock assessment methods, demersal resources, population biology, and the social sciences. All stock assessment data used in this document has gone through the Stock Assessment Workshop/Stock Assessment Review Committee review process. Review was conducted by those with expertise in fisheries management and policy, habitat conservation, protected species, and compliance with the applicable law.

6.12 PAPERWORK REDUCTION ACT

The purpose of the Paperwork Reduction Act is to reduce the paperwork burden on the public. The director of the OMB has the authority to manage information collection and record keeping requirements in order to reduce paperwork burdens. This authority includes the establishment of guidelines and policies, and the approval of information collection requests. The Act applies to specific public information collection requests conducted by the SWFSC for research. However, the SWFSC has determined that the research considered in this EA does not make specific requests for information from the public; and, therefore, the Paperwork Reduction Act does not apply to this EA.

6.13 THE MARINE PROTECTION, RESEARCH AND SANCTUARIES ACT

The Marine Protection, Research and Sanctuaries Act (MPRSA) (16 U.S.C. 1431) prohibits all ocean dumping, except that allowed by permits, in any ocean waters under U.S. jurisdiction, by any U.S. vessel, or by any vessel sailing from a U.S. port. MPRSA authorizes the Secretary of Commerce (through NOAA) to coordinate a research and monitoring program with the EPA and the U.S. Coast Guard (USCG). The MPRSA established nine regional marine research boards for the purpose of developing comprehensive marine research plans, considering water quality and ecosystem conditions and research and monitoring priorities and objectives in each region. It also launched a national coastal water quality monitoring program that directs the EPA and NOAA together to implement a long-term program to collect and analyze scientific data on the environmental quality of coastal ecosystems, including ambient water quality, health and quality of living resources, sources of environmental degradation, and data on trends. Results of these actions are used to provide the information required to devise and execute effective programs under the Clean Water Act and Coastal Zone Management Act (CZMA).

The MPRSA authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities as national marine sanctuaries. The primary objective is to protect marine resources, such as coral reefs, sunken historical vessels or unique habitats.

Section 304(d) requires interagency consultation between the NOAA Office of National Marine Sanctuaries and federal agencies taking actions that are "likely to destroy, cause the loss of, or injure a sanctuary resource." The SWFSC will use this EA as a sanctuary resource statement to initiate consultation with the Office of National Marine Sanctuaries.

6.14 COASTAL ZONE MANAGEMENT ACT

The principal objective of the CZMA is to encourage and assist states in developing coastal management programs, to coordinate state activities, and to safeguard regional and national interest in the coastal zone. Section 307(c) of the CZMA requires federal activity affecting the land or water uses or natural resources of a state's coastal zone to be consistent with that state's approved coastal management program, to the maximum extent practicable. NMFS will provide a copy of this Draft EA and a consistency determination to the state coastal management agency in every state with a federally-approved coastal management program whose coastal uses or resources are affected by these fisheries research activities. Each state has sixty days in which to agree or disagree with the determination regarding consistency with that state's

approved coastal management program. If a state fails to respond within sixty days, the state's agreement may be presumed.

6.15 PACIFIC INTERNATIONAL CONVENTIONS AND TREATIES

The SWFSC participates in international forums for the assessment of the status of some stocks in accordance with the relevant rules of international law. NMFS, working through the SWFSC, conducts research to support U.S. commitments to international fisheries management, including provision of stock assessment and management advice for the conventions and treaties outlined below.

The Tunas Convention Act of 1950 (16 U.S.C. 951-961; Act of September 7, 1950, as amended) addresses and codifies the obligations of the U.S. under the Inter-American Tropical Tuna Commission (IATTC) and authorizes the Secretary of Commerce to issue regulations for implementing recommendations of the Commission. The act permits limiting the size and quantity of catches and limiting or prohibiting incidental catch of regulated species.

The IATTC was established in 1949 to monitor the long-term conservation and sustainable use of tunas, billfish, dolphins, turtles, non-target finfish, sharks, and others) that may be affected either directly or indirectly by fishing operations. In 2003, the Convention's scope was broadened, and is now known as the Antigua Convention. The Antigua Convention applies to waters of the Pacific Ocean including areas off California, Oregon and Washington, and encompasses significant U.S. fisheries, such as the troll fishery targeting albacore. The IATTC is currently made up of 21 nations and fishing entities. The Secretary of Commerce has directed NMFS, via the SWFSC, to conduct research and provide scientific input into stock assessments and conservation and management recommendations for target and non-target stocks in the convention area.

The Multilateral Fisheries Treaty entered into force in 1987, and has been extended through 2013. The Treaty sets the operational terms and conditions for the U.S. tuna purse seine fleet to fish in a vast area of the Central and Western Pacific Ocean, including waters under the jurisdiction of the Pacific Island Parties. As stipulated under the Treaty, the U.S., working through NMFS, conducts research and provides scientific data necessary for stock assessments and management advice.

The Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean was established in 2004. The objective is to ensure, through effective management, the long-term conservation and sustainable use of highly migratory fish stocks. This is in accordance with the 1982 United Nations Convention on the Law of the Sea and the 1995 United Nations Fish Stocks Agreement. The Convention establishes a Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean. NMFS, working through the SWFSC, conducts research and provides scientific data to the Commission, an obligation under the Convention.

The Western and Central Pacific Fisheries Commission (WCPFC) is an international organization organized to ensure the long-term conservation and sustainable use of highly migratory fish stocks (i.e. tunas, billfish, and marlin) in the western and central Pacific Ocean. WCPFC is made up of 25 member nations and several participating territories and cooperating nations, who have an interest in the management of high seas fisheries in the western Pacific Ocean. Through the WCPFC, the U.S. is directly engaged in the development of fisheries management measures to manage and conserve bigeye, yellowfin, and albacore tunas, and to minimize impacts on the non-associated and dependent species, such as sea turtles and seabirds. As a WCPFC Member, the U.S. has directed NMFS, via the SWFSC, to conduct research and provide scientific data for the management of high seas fisheries, a stipulation set by the Commission.

The International Scientific Committee for Tuna and Tuna-like Species (ISC) in the North Pacific Ocean was established in 1995 for the purpose of enhancing scientific research and cooperation for conservation

and rational utilization of tuna and tuna-like species of the North Pacific Ocean. Through a Memorandum of Understanding, the ISC provides scientific support for the work of the Northern Committee of the WCPFC. As a Member, the U.S. supports its obligations to the Committee through scientific research conducted by NMFS and the SWFSC.

6.16 ANTARCTIC TREATY SYSTEM

The Antarctic treaty system began in 1961, and designated the area as a scientific preserve. The system refers to a collection of related acts and conventions developed since. Some of the related conventions of the Antarctic Treaty include the Antarctic Conservation Act of 1978, the Antarctic Protection Act of 1990, and the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) (1980). NMFS, through the SWFSC activities, conducts fisheries research within Antarctic waters to meet designated international obligations stipulated under the Antarctic Treaty and codified through US law and regulations.

6.17 ANTARCTIC CONSERVATION ACT

The Antarctic Conservation Act (ACA) of 1978 (Public Law [PL] 95-541), as amended by the Antarctic Science, Tourism, and Conservation Act of 1996 (PL 104-227) and the regulations issued under it, was enacted by the U.S. to implement protocol on environmental protection and meet its obligations under the Antarctic Treaty. The goal of the ACA is to conserve and protect the native mammals, birds, plants, and invertebrates of Antarctica and the ecosystem upon which they depend. The ACA applies to land and fast ice south of 60 degrees south latitude and to: U.S. citizens in Antarctica; certain persons in Antarctica who participate in U.S. government activities; U.S. corporations or other legal entities that organize expeditions into the Antarctic; and U.S. persons wherever located, or foreign persons while in the U.S., who handle certain Antarctic animals and plants.

The ACA governs the taking of fauna and flora; entry into protected areas; introduction of nonnative species; material management and waste disposal; and use of designated pollutants. Section 670.4 prohibits, unless authorized by permit, to:

(a) *take native mammal, bird or plants;*

(b) *engage in harmful interference of native mammals, birds, or plants;*

(c) *enter specially designated areas;*

(d) *possession, sale, export, and import of native mammals, birds, and plant; or*

(e) *introduction of non-indigenous animals and plants into Antarctica.*

Section 671.4 prohibits, unless authorized by permit, to:

(a) *use or release any banned substance in Antarctica;*

(b) *use or release any designated pollutant in Antarctica;*

(c) *release any waste in Antarctica.*

An ACA permit is required in addition to any permit issued under other applicable acts (*e.g.*, the MMPA of 1972, ESA of 1973, MBTA, and the CCAMLR).

6.18 CONVENTION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

The CCAMLR, part of the Antarctic Treaty System, came into force in 1982 as an international treaty between twenty five nations with the goal of preserving the stability and species diversity of the entire Antarctic marine ecosystem. The treaty was established primarily in response to concerns that increased

krill catches in the Southern Ocean could lead to adverse impacts on bird, seal, and fish populations, which are highly dependent on krill for food. Apart from seals south of 60°S and whales, which are covered by the Convention for the Conservation of Antarctic Seals and the International Convention for Regulation of Whaling, CCAMLR applies to all marine living resources between the Antarctic continent in the south and the Antarctic Polar Front in the north (about 50°S).

While the treaty does not prohibit the reasonable harvest of marine resources by members, it does implement a "precautionary" approach aimed at minimizing risk associated with unsustainable harvest practices and high levels of uncertainty. To this end, CCAMLR's Scientific Committee utilizes information, datasets, and relevant scientific techniques to develop and adopt conservation measures and catch levels for harvest species based on data and scientific advice. However, the extensive size and harsh nature of the Southern Ocean make it extremely challenging for member nations to enforce CCAMLR conservation measures.

Each member engaged in research or harvesting activities in relation to the marine living resources are allowed membership in the commission, a group of members tasked with implementing CCAMLR's management objectives. As a member for the commission, the U.S. is obligated to provide, to the greatest extent possible "statistical, biological and other data as the Commission and Scientific Committee may require in the exercise of their functions." In order to meet this obligation, the U.S., through NMFS and the SWFSC, conducts biological research and collects fisheries data for the Southern Ocean.

6.19 ANTARCTIC MARINE LIVING RESOURCES CONVENTION ACT

The Antarctic Marine Living Resources Convention Act (AMLRCA) of 1984 (PL 98-623) addresses and codifies the obligations of the CCAMLR. AMLRCA provides the legislative authority to establish the U.S. Antarctic Marine Living Resources (AMLR) program and authorizes the Secretary of Commerce, under 16 U.S.C. § 2441 [a] [B] to "design and conduct the program of directed scientific research…supplemental to and coordinated with the United States Antarctic Program" to support the purposes of carrying out the policies and objectives of CCAMLR. In addition, AMLRCA prohibits any person under the jurisdiction of the U.S. from engaging in harvesting activities that violate CCAMLR or its associated conservation measures. The act gives the U.S. authority to enforce CCAMLR's conservation standards on its nationals and vessels on the high seas within the area south of the Antarctic Convergence.

The Secretary of Commerce has directed NMFS, via the SWFSC, to manage and operate the AMLR Program. Working through the Department of State, the AMLR Program supports U.S. participation in both the CCAMLR Commission and the Scientific Committee by collecting scientific data and monitoring commercial fisheries activities. To this end, the primary objective of the AMLR research component is to collect the information necessary to assess the effects of marine resource harvesting activities on the target, dependent, and related species and populations of the Antarctic marine ecosystem. The AMLR program has several long term field studies and marine surveys in the Southern Ocean focused on collecting the scientific data necessary to achieve this goal. In addition, the Act requires adequate monitoring of the U.S. commercial fleet in the Antarctic, with results presented to, and used by, CCAMLR for managing fisheries resources. The data and results collected and presented by the U.S. AMLR Program form a basis for which many fisheries management decisions are made by CCAMLR and are the reason for SWFSC's research activities in Antarctic waters.

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Appendix A

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1. Trawl Nets

A trawl is a funnel-shaped net towed behind a boat to capture fish. The codend, or 'bag,' is the fine-meshed portion of the net most distant from the towing vessel where fish and other organisms larger than the mesh size are retained. In contrast to commercial fishery operations, which generally use larger mesh to capture marketable fish, research trawls often use smaller mesh to enable estimates of the size and age distributions of fish in a particular area. The body of a trawl net is generally constructed of relatively coarse mesh that functions to gather schooling fish so that they can be collected in the codend. The opening of the net, called the 'mouth', is extended horizontally by large panels of wide mesh called 'wings.' The mouth of the net is held open by hydrodynamic force exerted on the trawl doors attached to the wings of the net. As the net is towed through the water, the force of the water spreads the trawl doors horizontally apart.

The trawl net is usually deployed over the stern of the vessel, and attached with two cables, or 'warps,' to winches on the deck of the vessel. The cables are played out until the net reaches the fishing depth. Commercial trawl vessels travel at speeds between two and five knots while towing the net for time periods up to several hours. The duration of the tow depends on the purpose of the trawl, the catch rate, and the target species. At the end of the tow the net is retrieved and the contents of the codend are emptied onto the deck. For research purposes, the speed and duration of the tow and the characteristics of the net must be standardized to allow meaningful comparisons of data collected at different times and locations. Active acoustic devices incorporated into the research vessel and the trawl gear monitor the position and status of the net, speed of the tow, and other variables important to the research design.

Most SWFSC research trawling activities utilize 'pelagic' trawls, which are designed to operate at various depths within the water column. Because pelagic trawl nets are not designed to contact the seafloor, they do not have bobbins or roller gear, which are often used to protect the foot rope of a 'bottom' trawl net as it is dragged along the bottom.

Trawls thought to have the greatest potential for interactions with protected species

Trawl nets with the greatest potential for interactions with marine mammals and consequently the only nets with historical takes of marine mammals during SWFSC surveys include the Nordic 264 trawl, manufactured by Net Systems Inc. (Bainbridge Island, WA), and the modified Cobb mid-water trawl. One of the main factors that contributes to the likelihood of marine mammal takes with these two nets is their large mouth size. The NETS Nordic 264 trawl and the modified Cobb mid-water trawl have total effective mouth areas of 380m^2 and 80m^2 respectively, both of which are significantly larger in size relative to the mouth openings of other nets used by the SWFSC. For comparison, the IKMT net (Isaacs-Kidd Mid-water Trawl) has a mouth size opening that is less than 9m^2.

NETS Nordic 264: Several SWFSC research programs utilize a Nordic 264 two-warp rope trawl, manufactured by Net Systems Inc. (Bainbridge Island, WA). The forward portion of this large two-warp rope trawl is constructed of a series of ropes that function to gather fish into the body of the net. The effective mouth opening of the Nordic 264 is approximately 380 m^2, spread by a pair of 3.0 m (9.8 ft) Lite trawl doors (Churnside et al. 2009). For surface trawls, used to capture fish at or near the surface of the water, clusters of polyfoam buoys are attached to each wing tip of the headrope and additional polyfoam

floats are clipped onto the center of the headrope. Mesh sizes range from 162.6 cm in the throat of the trawl, to 8.9 cm in the codend (Churnside et al. 2009). For certain research activities, a liner may be sewn into the codend to minimize the loss of small fish.

SWFSC's La Jolla Laboratory uses a Nordic 264 pelagic rope trawl to sample adult coastal pelagic fish species during cruises along the U.S. west coast. The primary objective of these cruises is to measure population dynamics of Pacific sardine (*Sardinops sagax*) in order to set management goals for the coastwide U.S. fishery. The Nordic 264 is also used in salmon (*Oncorhychus spp.*) research by the SWFSC Santa Cruz lab (Dotson et al. 2010). During Coastal Pelagic Species surveys, the Nordic 264 two-warp rope trawl is fished during night time hours in order to collect information on sardines, anchovy, Jack and Pacific mackerels, hake, and other species. The trawl is fished at depth for 30 minutes at a time at a speed of 2-4 knots.

Modified-Cobb: A modified-Cobb midwater trawl net is used for SWFSC Juvenile Rockfish Surveys. The net has a headrope length of 26.2 m (86 ft), a mouth of 80 m2, and uses a 3/8-inch codend liner to catch juvenile rockfish. The net is towed for periods of approximately 15 minutes at depth at a speed of approximately 2.0 to 2.5 knots. The target headrope depth is 30 meters for the vast majority of stations, but 10 meters for some of the more nearshore (shallow) stations. There are historical and infrequently occupied depth-stratified stations that are also sampled to 100 meters depth. The fishing depth is monitored using an electronic net monitoring system, and is adjusted by varying the length of trawl line connecting the net to the boat.

Mitigation measures implemented in NETS Nordic 264 and modified-Cobb trawls: Potential for interactions with protected species, such as marine mammals, is often greatest during the deployment and retrieval of the trawl, when the net is at or near the surface of the water. During retrieval of the net, protected species may become entangled in the net while attempting to feed from the codend as it floats near the surface of the water. Recently, considerable effort has been given to developing excluder devices that allow marine mammals to escape from the net while allowing retention of the target species (e.g. Dotson *et al*. 2010). Marine mammal excluder devices (MMEDs) generally consist of a large aluminum grate positioned in the intermediate portion of the net forward of the codend and below an "escape panel" constructed into the upper net panel above the grate. The angled aluminum grate is intended to guide marine mammals through the escape panel and prevent them from being caught in the codend (Dotson *et al*. 2010). MMEDs are currently deployed on all surveys using Nordic 264 nets. The Nordic 264 rope trawl is intended to fish at the surface, while the Cobb trawl is typically fishing at 30 meters headrope depth, thus it is rarely at the surface aside from the deployment and retrieval stages. The SWFSC is developing MMEDs for use with modified-Cobb gear but they have not been fully tested yet. These devices are anticipated to be ready for incorporation into modified-Cobb trawl protocols within a few years. However, implementation of MMEDs on modified cobb trawls is contingent on testing that indicates catch rates of target species are not compromised by use of the MMED.

In addition, two to four acoustic 'pingers' are attached to several places on the headrope and footrope to deter marine mammals from the net. Pingers are manufactured by STM Products, model DDD-03H. Pingers remain operational at depths between 10m and 200m. Tones range from 100 microseconds to seconds in duration, with variable frequency of 5 to 500 kHz, and maximum sound pressure levels of 176 dB RMS re 1 micropascal at 1m at 30-80 kHz. Acoustic pingers have been shown to effectively deter

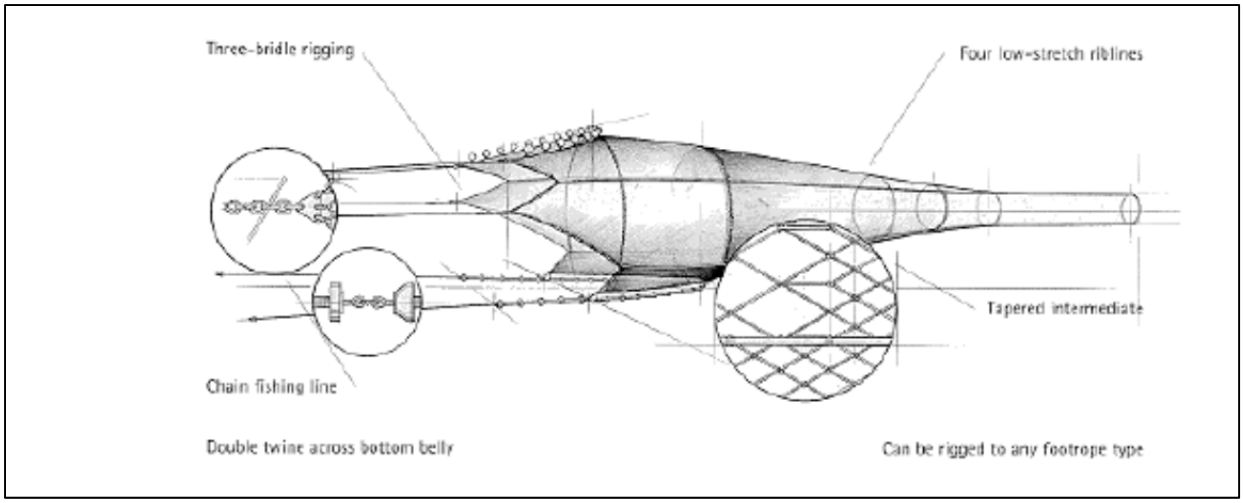
several species of small cetaceans from becoming entangled in gillnets. While their effectiveness is unproven on trawls, pingers are believed to represent a mitigation measure worth pursuing given their effectiveness when used with other gear types.

(Dotson et al. 2010)

Figure A-1 Marine Mammal Excluder Device installed in Nordic 264 pelagic trawl net.

Trawls with relatively low potential for interactions and no historical interaction with protected species

In addition to the nets described above, SWFSC uses the two-warp NET Systems Hard-Bottom Snapper Trawl to capture fish at or near the seafloor as part of Antarctic survey activities. The lower edge of the bottom trawl net opening is normally protected by a thick footrope ballasted with heavy rubber discs or bobbins, often called 'roller gear' or 'tire gear,' while the upper edge of the trawl net opening is the 'headrope.' Floatation devices attached to the headrope hold the net open vertically as it is towed through the water. Bottom trawl nets used for commercial purposes can be up to 100 meters (328.1 ft) wide. The AMLR bottom trawl net has a headrope length of 28.0 m (92.0 ft) and a footrope length of 38.9 m (127.6 ft) (Stauffer 2004).



(Net Systems Inc., Bainbridge Island, WA)

Figure A-2 Schematic Diagram of the NET Systems Hard Bottom Snapper Trawl.

SWFSC surveys in all of the research areas utilize various small, fine-mesh, towed nets designed to sample small fish and pelagic invertebrates. The Oozeki net is a newly designed frame trawl with a 5 m^2 mouth area used for quantitative sampling of larval and juvenile pelagic fishes (Figure A-3). Towing depth of the net is easily controlled by adjusting the warp length, and the net samples a large size range of juvenile fishes and micronekton (Oozeki et al. 2004). Micronekton is a term used for a large variety of free-swimming organisms, including small or juvenile fish as well as crustaceans and cephalopods, that are larger than current-drifting plankton but not quite large enough to swim against substantial currents. Similar to the Oozeki net, the IKMT net (Isaacs-Kidd Mid-water Trawl) is used to collect deep water biological specimens larger than those taken by standard plankton nets. The net is attached to a wide, V-shaped, rigid diving vane that keeps the mouth of the net open and maintains the net at depth for extended periods (Yasook et al. 2007). The IKMT is a long, round net approximately 6.5 m (21.3 ft) long, with a series of hoops decreasing in size from the mouth of the net to the codend, which maintain the shape of the net during towing (Yasook et al. 2007). The Tucker Trawl is a medium-sized single-warp net used to study pelagic fish and zooplankton. The Tucker trawl usually consists of a series of nets that can be opened and closed sequentially without retrieving the net from the fishing depth. Similarly the MOCNESS, or Multiple Opening/Closing Net and Environmental Sensing System, is based on the Tucker Trawl principle where a stepping motor is used to sequentially control the opening and closing of the nets. The MOCNESS uses underwater and shipboard electronics for controlling the device. The electronics system continuously monitors the functioning of the nets, frame angle, horizontal velocity, vertical velocity, volume filtered, and selected environmental parameters, such as salinity and temperature. The MOCNESS is used for specialized zooplankton surveys. There has never been an interaction with a protected species for any of the gear types described in this paragraph during SWFSC research activity.

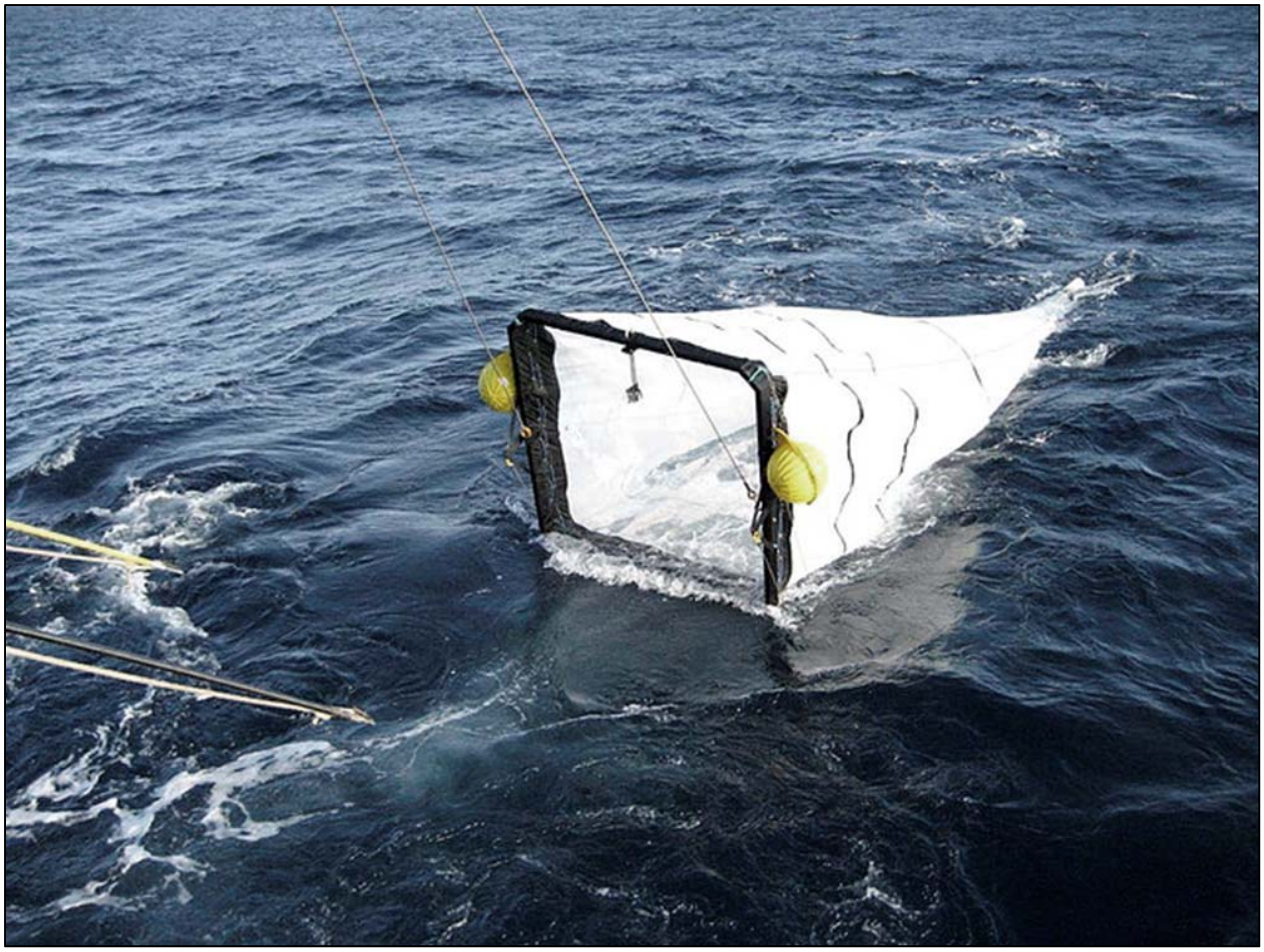


Figure A-3 Oozeki trawl at the surface as it is deployed from the vessel.

2. Longline

Longline vessels fish with baited hooks attached to a mainline or 'groundline'. The length of the longline and the number of hooks depend on the species targeted, the size of the vessel, and the purpose of the fishing activity. A commercial longline can be over 100 kilometers long and can have thousands of hooks attached, however longlines used for research surveys are usually shorter. The longline gear used for SWFSC research surveys for Highly Migratory Species, thresher sharks, and swordfish typically use 200-400 hooks attached to a steel or monofilament mainline from 2 to 12 miles in length. Hooks are attached to the mainline by another thinner line called a 'gangion'. The length of the gangion and the distance between gangions depends on the purpose of the fishing activity. For SWFSC research the gangions are 10 to 36 feet in length and are attached to the mainline at intervals of 50 to 100 feet. Buoys are used to keep pelagic longline gear suspended near the surface of the water, and flag buoys (or 'high flyers') equipped with radar reflectors, radio transmitters, and/or flashing lights are attached to each end of the mainline to enable the crew to find the line for retrieval (Figure A-4).

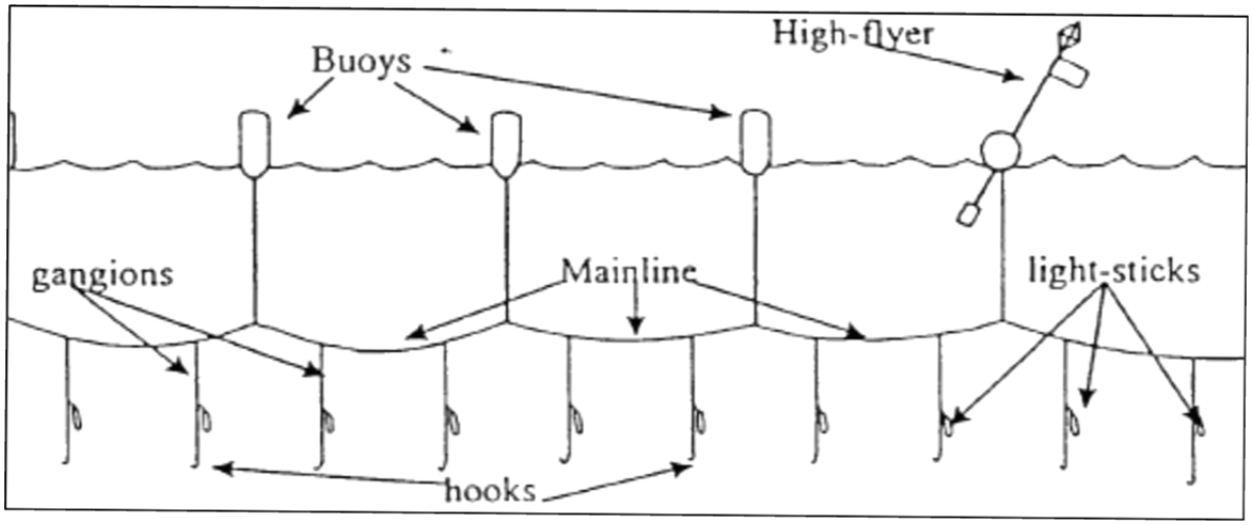


Figure A-4 Schematic example of pelagic longline gear.

In contrast to the pelagic longline gear used for surveys of Highly Migratory Species and Coastal Pelagic Species, bottom (or 'demersal') longline gear may be used to survey species in deeper water, including sablefish. Bottom longlines use fixed hooks strung along a weighted groundline. Bottom longlines used for commercial fishing can be up to several miles long, but those used for SWFSC research related to reproductive life history of sablefish off the coasts of California and Washington use shorter lines with approximately 75 hooks per line. The hooks are baited with squid and set at depths of between 1180 to 1480 feet (360 to 450 meters). Like pelagic longline gear, flag buoys (or 'high flyers') are attached to each end of the groundline to enable the crew to find the line for retrieval. The flag buoys used for bottom longline gear use long buoy lines to allow the weighted groundline to rest on the seafloor while the attached buoys float on the surface to enable retrieval of the gear.

The time period between deployment and retrieval of the longline gear is the 'soak time.' Soak time is an important parameter for calculating fishing effort. For commercial fisheries the goal is to optimize the soak time in order to maximize catch of the target species while minimizing the bycatch rate, and minimizing damage to target species caught on the hooks that may result from predation by sharks or other predators. Soak time can also be an important factor for controlling longline interactions with protected species. Marine mammals, turtles, and other protected species may be attracted to bait, or to fish caught on the longline hooks. Protected species may become caught on longline hooks or entangled in the longline while attempting to feed on the catch before the longline is retrieved.

Birds may be attracted to the baited longline hooks, particularly while the longline gear is being deployed from the vessel. Birds may get caught on the hooks, or entangled in the gangions while trying to feed on the bait. Birds may also interact with longline gear as the gear is retrieved.

3. Swordfish deep-set buoy gear

Swordfish deep-set buoy gear is used to capture and tag swordfish (*Xiphias gladius*) off the coast of Southern California and includes a buoy flotation system (i.e., a strike-indicator float/flag, a large, non-

compressible buoy and a float affixed with a radar reflector). A set of “gear” consists of 250-400 m 500 pound (lb) mainline monofilament rigged with a 1-2 kilogram (kg) drop sinker to orient the mainline and terminal fishing gear vertically in the water column. Unlike longline gear which typically uses a long monofilament mainline suspended horizontally near the surface of the water, deep-set buoy gear does not involve the use of a horizontal mainline. Two monofilament gangions branch from the vertically oriented mainline at 250-400 m and are constructed of 400 lb monofilament leader containing a crimped 14/0 circle hook baited with either squid or mackerel.

The gear is set at a target depth below the thermocline (Figure A-5), at depths of 250-400m, with fishing occurring only during daylight hours, which theoretically constrains the potential for interactions with many non-target species. Deep-set buoy gear research is conducted in the water column below the thermocline. The conditions at this depth consist of relatively cold, oxygen-poor waters that are inhospitable to most pelagic species, which are not physiologically equipped to continuously inhabit the water column at such depth.

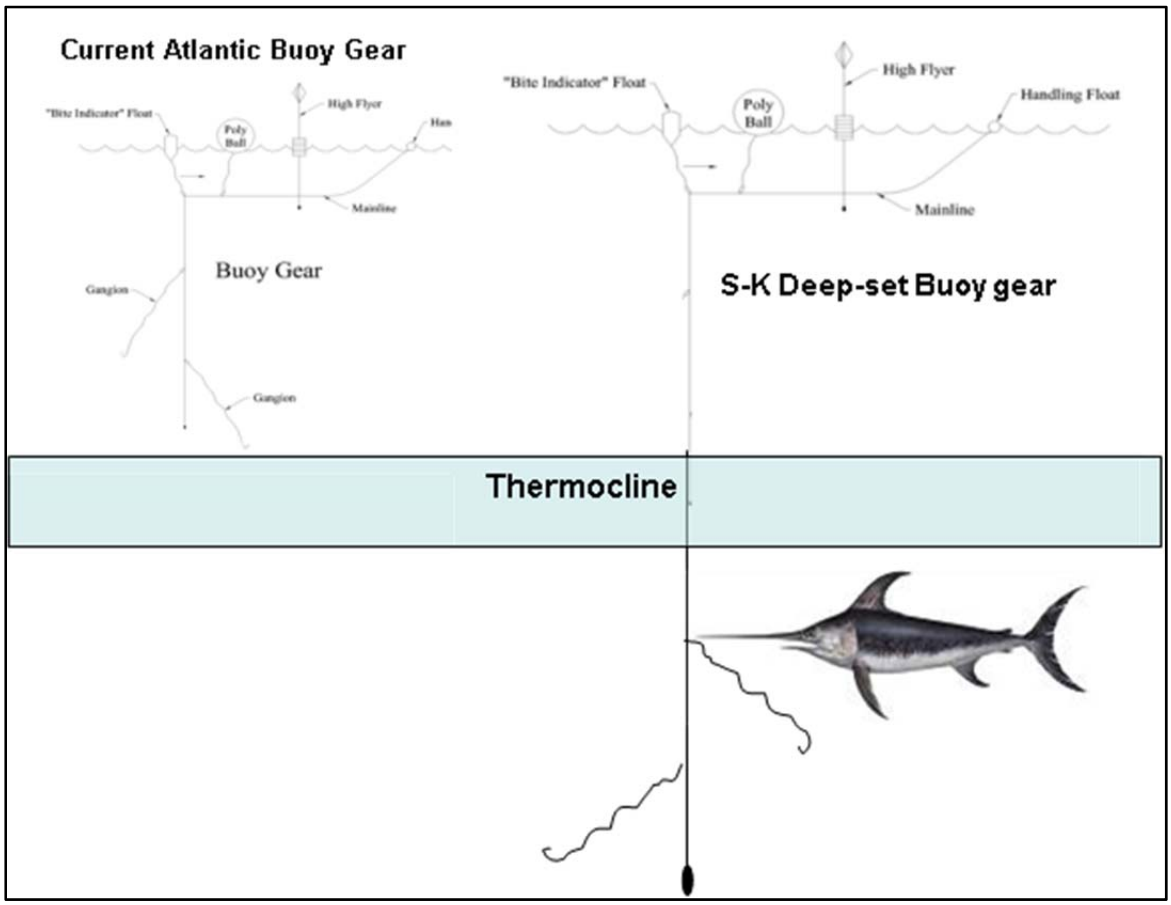


Figure A-5 Schematic of the Atlantic shallow-set buoy gear and swordfish deep-set buoy gear.

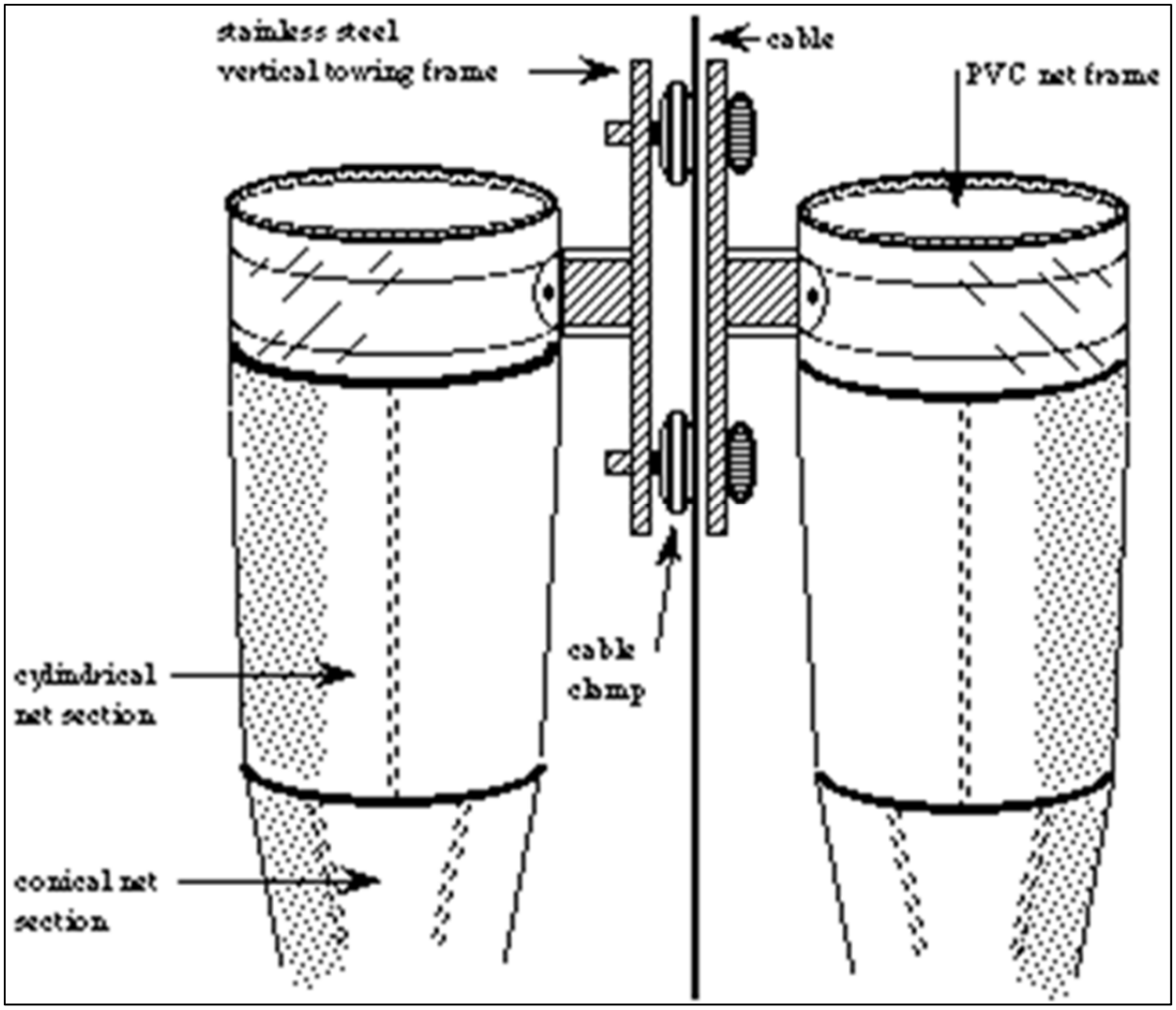
The buoys are deployed in a restricted spatial grid such that all of the indicator buoys can be continuously monitored from the vessel (within a maximum 4 nm grid area). When an indicator flag rises, the buoy set is immediately tended and the animal caught is either released or tagged and released in order to increase

post-hooking survivorship of all animals. In addition, slack in the fishing line is minimized in order to maintain a vertical profile and keep hooks at or below 250 m depth to minimize potential for marine mammal interactions. Circle hooks are used, which have been shown in other hook-and-line fisheries to increase post-hooking survivorship with selected non-target species.

4. Various plankton nets (Bongo / Pairovet, Manta)

SWFSC research activities include the use of several plankton sampling nets that employ very small mesh to sample plankton and fish eggs from various parts of the water column. Plankton sampling nets usually consist of fine mesh attached to a weighted frame. The frame spreads the mouth of the net to cover a known surface area. The Bongo nets used for CalCOFI surveys have openings 71 cm in diameter and employ a 505 µm mesh. The nets are 3 meters in length with a 1.5 m cylindrical section coupled to a 1.5 m conical portion that tapers to a detachable codend constructed of 333 µm or 0.505 µm nylon mesh (Figure A-6).

The bongo nets are towed through the water at an oblique angle to sample plankton over a range of depths. During each plankton tow, the bongo nets are deployed to a depth of approximately 210 m and are then retrieved at a controlled rate so that the volume of water sampled is uniform across the range of depths. In shallow areas, sampling protocol is adjusted to prevent contact between the bongo nets and the seafloor. A collecting bucket, attached to the cod-end of the net, is used to contain the plankton sample. When the net is retrieved, the collecting bucket can be detached and easily transported to a laboratory. Some bongo nets can be opened and closed using remote control to enable the collection of samples from particular depth ranges. A group of depth-specific bongo net samples can be used to establish the vertical distribution of zooplankton species in the water column at a site. Bongo nets are generally used to collect zooplankton for research purposes, and are not used for commercial harvest.



(Aquatic Research Instruments 2011)

Figure A-6 Bongo net diagram.

The Pairovet is a bongo-type device consisting of two nets. The Pairovet frame was designed to facilitate comparison of nets constructed of various materials and to provide replicate observations when using similar nets. The frame is constructed of 6061-T6 aluminum with stainless steel fittings. The nets are nylon mesh attached to the frame with adjustable stainless steel strapping.

Manta nets are towed horizontally at the surface of the water to sample neuston (organisms living at or near the water surface). The frame of the Manta net is supported at the ocean surface by aquaplanes (wings) that provide lift as the net is towed horizontally through the water (Figure A-7). To ensure repeatability between samples, the towing speed, angle of the wire, and tow duration must be carefully controlled. The Manta nets used for CalCOFI surveys employ 505 µm nylon mesh in the body of the net and 303 µm mesh in the codend. The frame has a mouth area of 0.1333 m^2. For CalCOFI surveys, the Manta net is towed for periods of 15 minutes at a speed of approximately 2.0 knots.

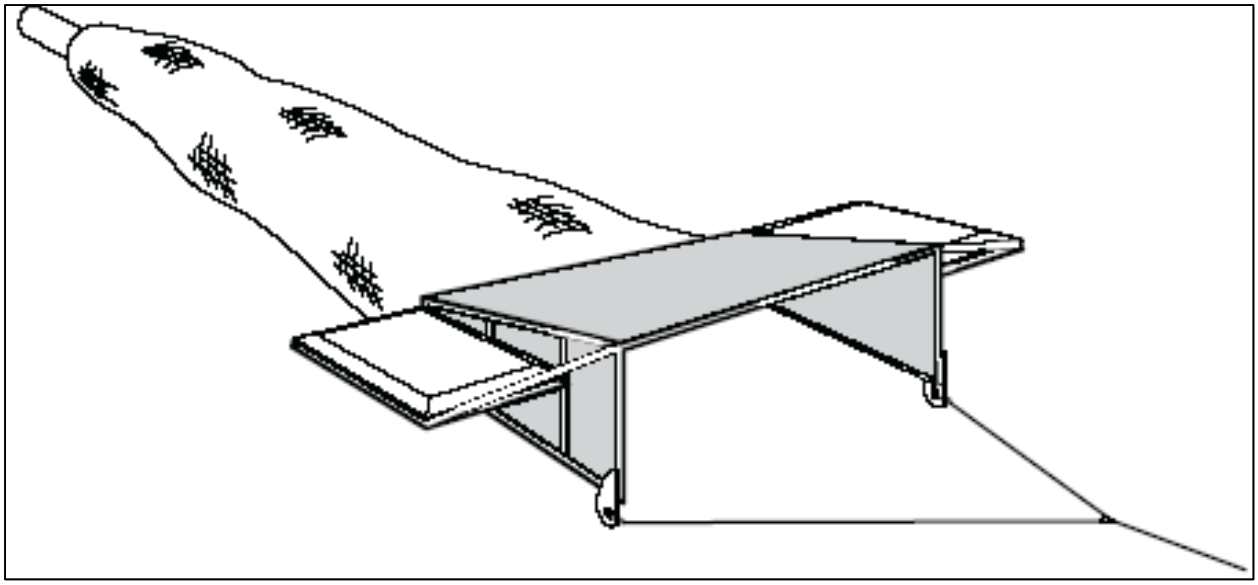
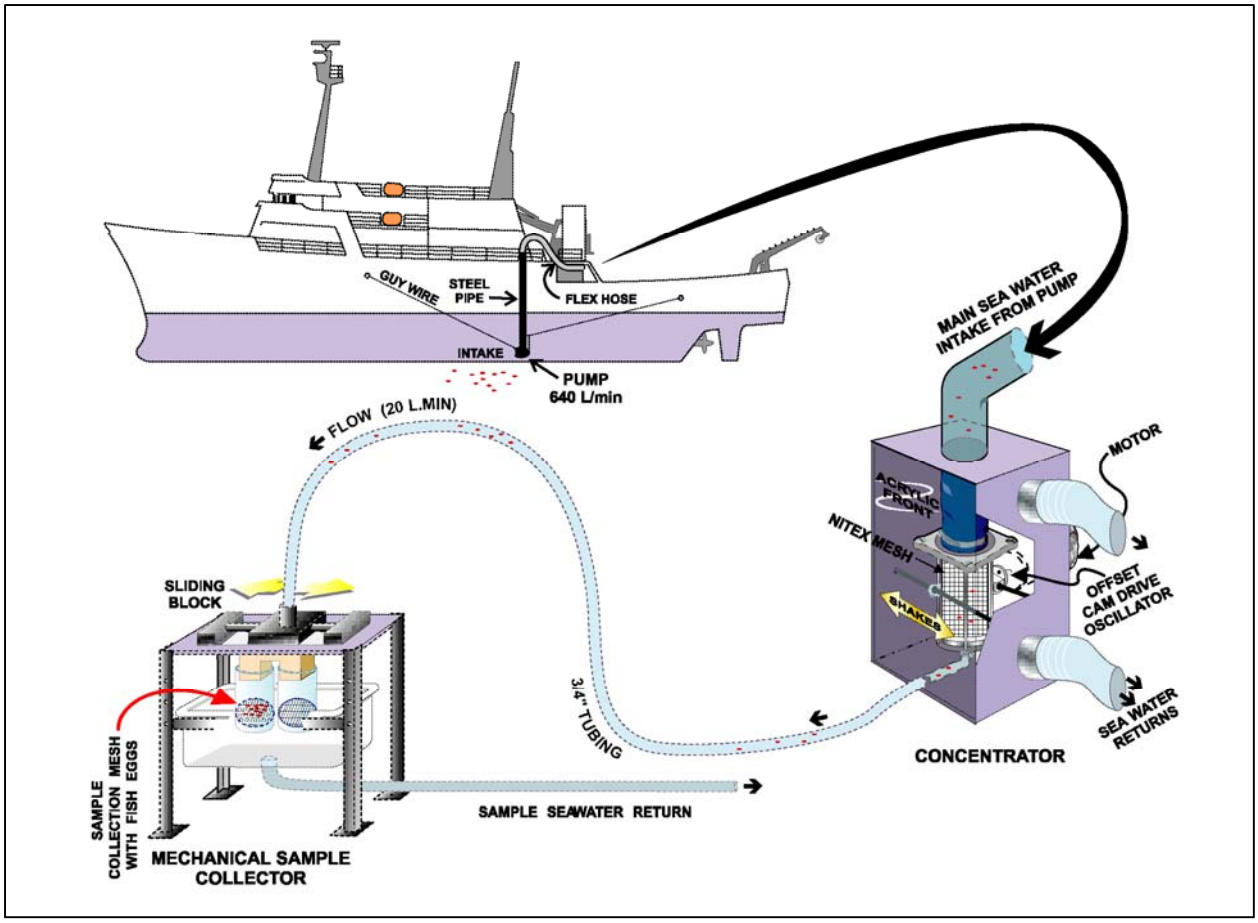


Figure A-7 Conceptual diagram of a Manta net.

5. Continuous Underway Fish Egg Sampler (CUFES)

The Continuous Underway Fish egg sampler (CUFES) is used to collect pelagic fish eggs from the water column while the vessel is underway. The CUFES device consists of a water intake approximately three meters below the surface of the water connected to a high capacity pump capable of pumping approximately 640 liters of water per minute through the device. Particles in the bulk water stream are concentrated by an oscillating mesh. Samples are transferred to a collecting device at a rate of approximately 20 liters per minute, while the bulk water is discharged overboard (Figure A-8). Samples are collected and preserved on mesh net over sequential sampling intervals. Ancillary data including temperature, salinity, chlorophyll-*a* fluorescence, time and location are also collected automatically. The fish eggs within each sequential sample are identified and counted, and the preserved sample is cataloged for future reference.



(from: http://cufes.ucsd.edu/graf/egg-pump.pdf)

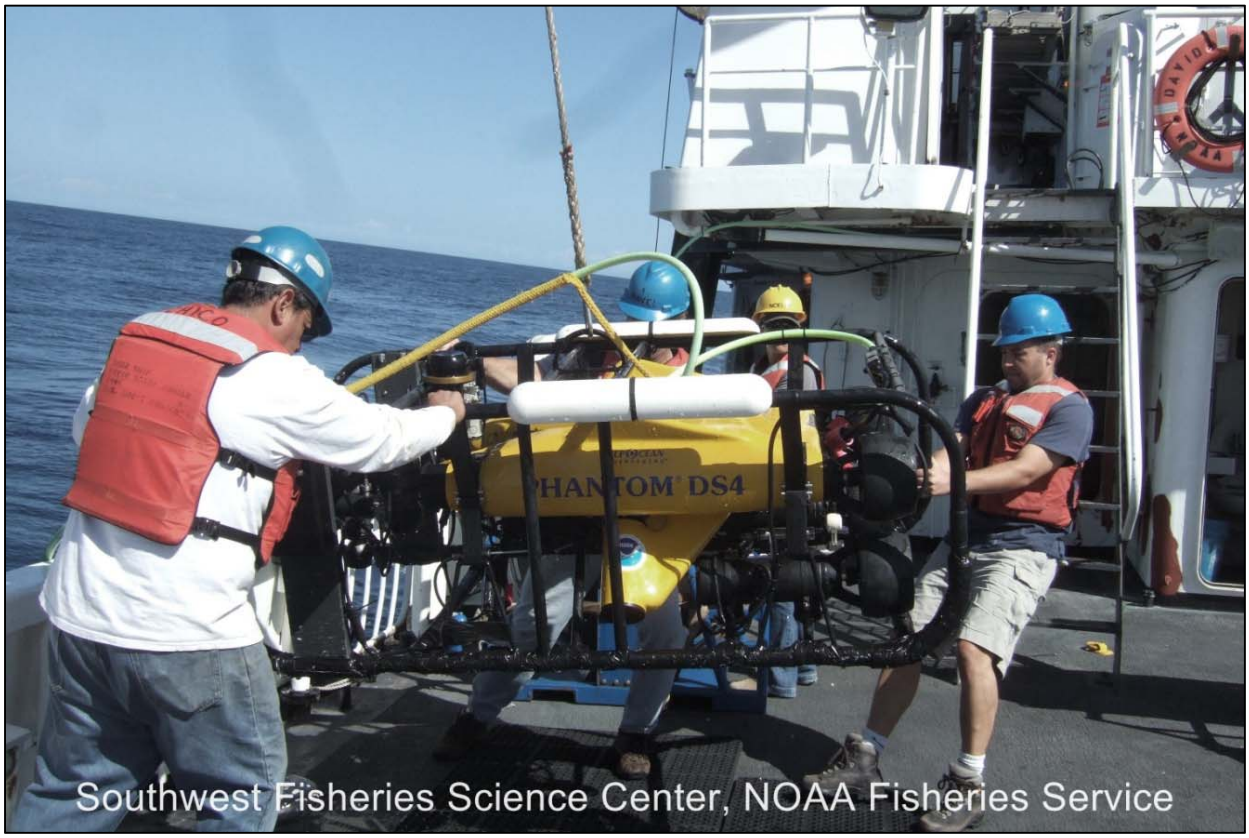
Figure A-8 Schematic diagram of the Continuous Underway Fish Egg Sampler (CUFES).

Continuous sampling from a ship moving at full speed is an effective technique for assessing the spatiotemporal aggregation of fish eggs in surface water and the CUFES is designed for this purpose. The CUFES data are used to estimate spawning habitat distribution and spawning biomass, which are important parameters upon which fisheries management decisions may be based. The CUFES device is used in the California Current research area during both CalCOFI research surveys and Coastal Pelagic Species research surveys off of the coast of California within the U.S. EEZ.

6. Still and video camera images taken from an ROV

The SWFSC maintains and deploys two remotely operated vehicles (ROVs). The ROVs are used to quantify fish and shellfish, photograph fish for identification, and provide views of the bottom habitat for habitat-type classification studies. Still and video camera images are used to monitor populations of the endangered white abalone, and also for assessment of southern California rockfish assemblages and ground-truthing of sonar surveys of groundfish habitats as part of the Collaborative Optically-assisted Acoustic Survey Technique (COAST) program. Precise georeferenced data from ROV platforms also

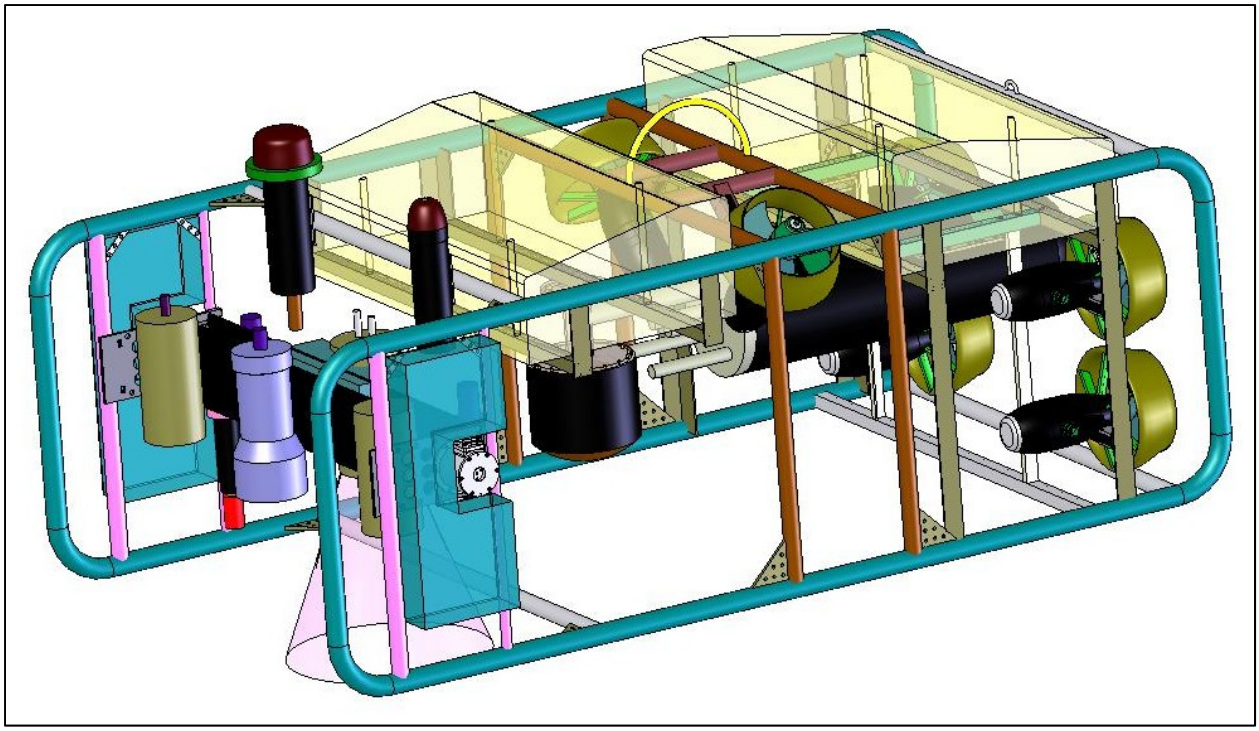
enables SCUBA divers to utilize bottom time more effectively for collection of brood stock and other specimens.



(SWFSC)

Figure A-9 The SWFSC Phantom DS4 remotely operated vehicle (ROV), 'Sebastes'.

Since 1999 SWFSC has operated a Phantom DS4 ROV to collect video and still camera images (Figure A-9). The Phantom DS4 platform is driven horizontally by four ½ horsepower thrusters, and vertically by two ¼ horsepower thrusters. The Phantom DS4 can operate at a maximum depth of 600 meters. Standard instrumentation on the ROV includes a directional hydrophone, a CTD (see section 12) , a differential Global Positioning System (dGPS), pitch and roll sensors, still cameras, and video cameras; some additional instrumentation can be added to the platform as needed. The ROV platform also includes a reference laser system to facilitate *in situ* specimen measurements and to determine the distance of the ROV platform from underwater objects.



(SWFSC)

Figure A-10 High-Definition High-Voltage remotely operated vehicle.

The SWFSC Benthic Resources Group has also recently designed and constructed a custom high-definition high-voltage (HDHV) remotely operated vehicle (ROV) for surveying groundfish and benthic invertebrates in deepwater environments (Figure A-10). The HDHV ROV is powered by six 300-volt brushless DC thrusters. The DC thrusters are efficient and quiet to maximize bottom time while minimizing behavioral disturbance to target species. The HDHV ROV platform is equipped with video and still cameras, an illumination system, scanning sonar, CTD, a dissolved oxygen sensor, laser range-finding and laser caliper systems, and the capability to process data while underway to facilitate real-time georeferenced collection of oceanographic data.

7. Active Acoustic Sources used in SWFSC Fisheries Surveys

A wide range of active acoustic sources are used in SWFSC fisheries surveys for remotely sensing bathymetric, oceanographic, and biological features of the environment, Most of these sources involve relatively high frequency, directional, and brief repeated signals tuned to provide sufficient focus and resolution on specific objects. Tables showing important characteristics of these sources for each of the primary operational research vessels conducting fisheries surveys in the SWFSC are given below in Tables A-1 through A-3, followed by descriptions of some of the primary general categories of sources, including all those for which acoustic takes of marine mammals are calculated.

Table A-1 Operating characteristics of active acoustic sources operated from the *R/V* Shimada

Active Acoustic System (product name and #)	Operating Frequencies	Maximum Source Level in dB/1µPa (referenced to 1m)	Single ping duration (ms) and repetition rate (Hz)	Orientation/ Directionality	Nominal Beamwidth (degrees)
Simrad EK500 and EK60 Narrow Beam Scientific Echo Sounders	18, 38, 70, 120, 200, 333 kHz (or a subset). Primary frequencies are 38, 70, 120 and 200 kHz.	224 dB	Variable. Most common setting is 1 ms duration and 0.5 Hz repetition rate.	Downward looking	7°
Simrad ME70 Multi-Beam Echo Sounder	70-120 kHz	205 dB	0.06 to 5 ms, 1-4 Hz	Primarily Downward Looking	130°
Teledyne RD Instruments Acoustic Doppler Current Profiler (ADCP), Ocean Surveyor	75 kHz	224 dB	0.2 Hz rep rate	Downward looking	30°
Simrad ITI Catch Monitoring System	27-33 kHz	214 dB	0.05-0.5 Hz rep rate	Downward looking	40°
Simrad FS70 Third Wire Net Sonde	120 kHz	Unknown, maximum transmit power is 1 kW	Variable	Downward looking	40°

Table A-2 Operating characteristics of active acoustic sources operated from the R/V McArthur

Active Acoustic System (product name and #)	Operating Frequencies	Maximum Source Level in dB/1µPa (referenced to 1m)	Single ping duration (ms) and repetition rate (Hz)	Orientation/ Directionality	Nominal Beamwidth (degrees)
Simrad EK500 and EK60 Narrow Beam Scientific Echo	18, 38, 70, 120, 200, 333 kHz (or a subset). Primary frequencies 38, 70,	224 dB	Variable. Most common setting is 1 ms duration and	Downward looking	7°

Sounders	120 and 200 kHz.		0.5 Hz repetition rate.		

Table A-3 Operating characteristics of active acoustic sources operated from the *R/V* Lasker

Active Acoustic System (product name and #)	Operating Frequencies	Maximum Source Level in dB/1µPa (referenced to 1m)	Single ping duration (ms) and repetition rate (Hz)	Orientation/ Directionality	Nominal Beamwidth (degrees)
Simrad EK500 and EK60 Narrow Beam Scientific Echo Sounders	18, 38, 70, 120, 200, 333 kHz (or a subset). Primary frequencies are 38, 70, 120 and 200 kHz.	224 dB	Variable. Most common setting is 1 ms duration and 0.5 Hz repetition rate.	Downward looking	7°
Simrad ME70 Multi-Beam Echo Sounder	70-120 kHz	205 dB	0.06 to 5 ms, 1-4 Hz	Primarily Downward Looking	130°
Simrad MS70 Multi-Beam Sonar	75-112 kHz	206 dB	2 to 10 ms, 1-2 Hz	Primarily Side-Looking	60°
Simrad SX90 Narrow Beam Sonar	20-30 kHz	219 dB	Variable	Omni-Directional	4-5° (variable for tilt angles from 0 to 45° from horizontal)
Teledyne RD Instruments Acoustic Doppler Current Profiler (ADCP), Ocean Surveyor	75 kHz	224 dB	0.2 Hz rep rate	Downward looking	30°
Simrad ITI Catch Monitoring System	27-33 kHz	214 dB	0.05-0.5 Hz rep rate	Downward looking	40°
Simrad FS70 Third Wire Net Sonde	120 kHz	Unknown, maximum transmit power is 1 kW	Variable	Downward looking	40°

8. Multi-frequency Narrow Beam Scientific Echo Sounders (Simrad EK500 and EK60 Systems - 18, 38, 70, 120, 200, 333 kHz)

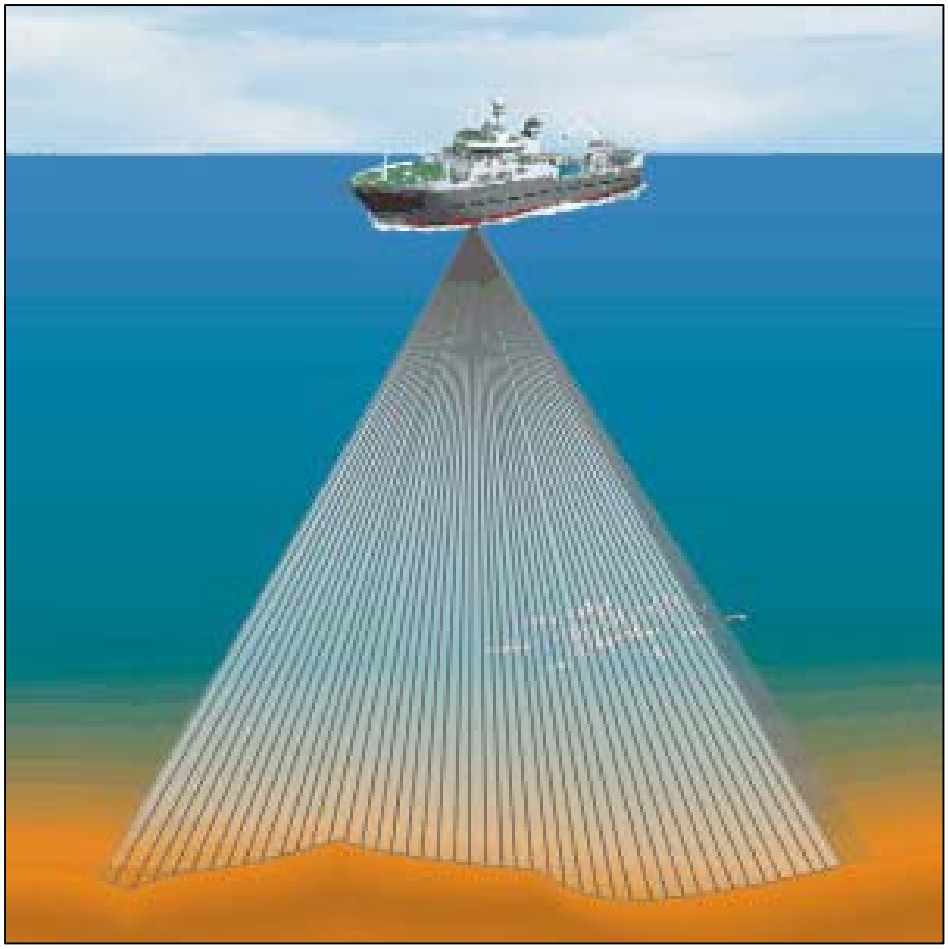
Similar to multibeam echosounders, multi-frequency split-beam sensors are deployed from NOAA survey vessels to acoustically map the distributions and estimate the abundances and biomasses of many types of fish; characterize their biotic and abiotic environments; investigate ecological linkages; and gather information about their schooling behavior, migration patterns, and avoidance reactions to the survey vessel. The use of multiple frequencies allows coverage of a broad range of marine acoustic survey activity, ranging from studies of small plankton to large fish schools in a variety of environments from shallow coastal waters to deep ocean basins. Simultaneous use of several discrete echosounder frequencies facilitates accurate estimates of the size of individual fish, and can also be used for species identification based on differences in frequency-dependent acoustic backscattering between species. The SWFSC uses devices that transmit and receive at six frequencies ranging from 18 to 333 kHz.

9. Single Frequency Omnidirectional Sonars (Simrad SX-90)

Low frequency, high-resolution, long range fishery sonars including the SX-90 operate with user selectable frequencies between 20 and 30 kHz providing longer range and prevent interference from other vessels. These sources provide an omnidirectional imaging around the source with three different vertical beamwidths, single or dual vertical view and 180° tiltable vertical views are available. At 30 kHz operating frequency, the vertical beamwidth is less than 7 degrees. This beam can be electronically tilted from +10 to -80 degrees, which results in differential transmitting beam patterns. The cylindrical multi-element transducer allows the omnidirectional sonar beam to be electronically tilted down to -60 degrees, allowing automatic tracking of schools of fish within the whole water volume around the vessel. The signal processing and beamforming is performed in a fast digital signal processing system using the full dynamic range of the signals.

10. Multi-beam echosounder (Simrad ME70) and sonar (Simrad MS70)

Multibeam echosounders and sonars work by transmitting acoustic pulses into the water then measuring the time required for the pulses to reflect and return to the receiver and the angle of the reflected signal. The depth and position of the reflecting surface can be determined from this information, provided that the speed of sound in water can be accurately calculated for the entire signal path.



(from Simrad – www.simrad.com)

Figure A-11 Conceptual image of a multi-beam echosounder

The use of multiple acoustic 'beams' allows coverage of a greater area compared to single beam sonar. The sensor arrays for multibeam echosounders and sonars are usually mounted on the keel of the vessel and have the ability to look horizontally in the water column as well as straight down. Multibeam echosounders and sonars are used for mapping seafloor bathymetry, estimating fish biomass, characterizing fish schools, and studying fish behavior. The multibeam echosounders used by SWFSC are mounted to the hull of the research vessels and emit frequencies in the 70-120 kHz range.

11. ADCP

An Acoustic Doppler Current Profiler, or ADCP, is a type of sonar used for measuring water current velocities simultaneously at a range of depths. In the past, current depth profile measurements required the use of long strings of current meters. ADCP enables measurements of current velocities across an entire water column, replacing the long strings of current meters. An ADCP anchored to the seafloor can measure current speed not just at the bottom, but also at equal intervals all the way up to the surface (WHOI 2011). An ADCP instrument can also be mounted to a mooring, or to the bottom of a boat.

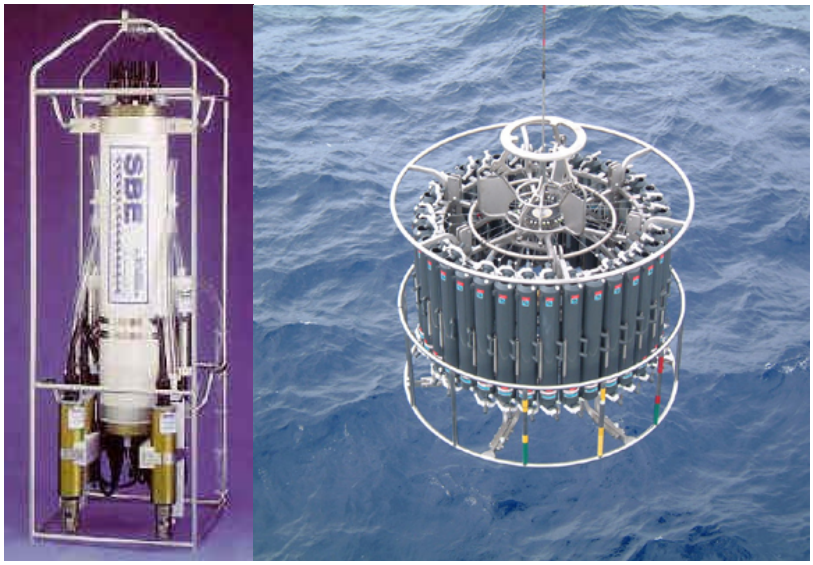
The ADCP measures water currents with sound, using the Doppler Effect. A sound wave has a higher frequency when it moves towards the sensor (blue shift) than when it moves away (red shift). The ADCP works by transmitting "pings" of sound at a constant frequency into the water. As the sound waves travel, they ricochet off particles suspended in the moving water, and reflect back to the instrument (WHOI 2011). Due to the Doppler Effect, sound waves bounced back from a particle moving away from the profiler have a slightly lowered frequency when they return. Particles moving toward the instrument send back higher frequency waves. The difference in frequency between the waves the profiler sends out and the waves it receives is called the Doppler shift. The instrument uses this shift to calculate how fast the particle and the water around it are moving. Sound waves that hit particles far from the profiler take longer to come back than waves that strike close by. By measuring the time it takes for the waves to return to the sensor, and the Doppler shift, the profiler can measure current speed at many different depths with each series of pings (WHOI 2011).

ADCPs operate at frequencies between 75 and 300 kHz. High frequency pings yield more precise data, but low frequency pings travel farther in the water. Thus, a compromise must be made between the distance that the profiler can measure and the precision of the measurements (WHOI 2011).

ADCPs that are bottom-mounted need an anchor to keep them on the bottom, batteries, and a data logger. Vessel-mounted instruments need a vessel with power, a shipboard computer to receive the data, and a GPS navigation system so the ship's movements can be subtracted from the current velocity data (WHOI 2011).

12. CTD

‘CTD’ is an acronym for Conductivity, Temperature, and Depth. A CTD profiler measures these parameters, and is the primary research tool for determining chemical and physical properties of seawater. A shipboard CTD is made up of a set of small probes attached to a large (1 to 2 m in diameter) metal rosette wheel. The rosette is lowered through the water column on a cable, and CTD data are observed in real time via a conducting cable connecting the CTD to a computer on the ship. The rosette also holds a series of sampling bottles that can be triggered to close at different depths in order to collect a suite of water samples that can be used to determine additional properties of the water over the depth of the CTD cast. A standard CTD cast, depending on water depth, requires two to five hours to complete (WHOI 2011). The data from a suite of samples collected at different depths are often called a depth profile, and are plotted with the value of the variable of interest on the x-axis and the water depth on the y-axis. Depth profiles for different variables can be compared in order to glean information about physical, chemical, and biological processes occurring in the water column.



(Sea-Bird Electronics, Bellevue WA)

Figure A-12 Sea-Bird 911 plus CTD profiler on a sampling rosette.

Conductivity is measured as a proxy for salinity, or the concentration of salts dissolved in the seawater. Salinity is expressed in 'practical salinity units' (psu) which represent the sum of the concentrations of several different ions. Salinity is calculated from measurements of conductivity. Salinity influences the types of organisms that live in a body of water, as well as physical properties of the water. For instance, salinity influences the density and freezing point of seawater.

Temperature is generally measured using a high-sensitivity thermistor protected inside a thin walled stainless steel tube. The resistance across the thermistor is measured as the CTD profiler is lowered through the water column to give a continuous profile of the water temperature at all water depths.

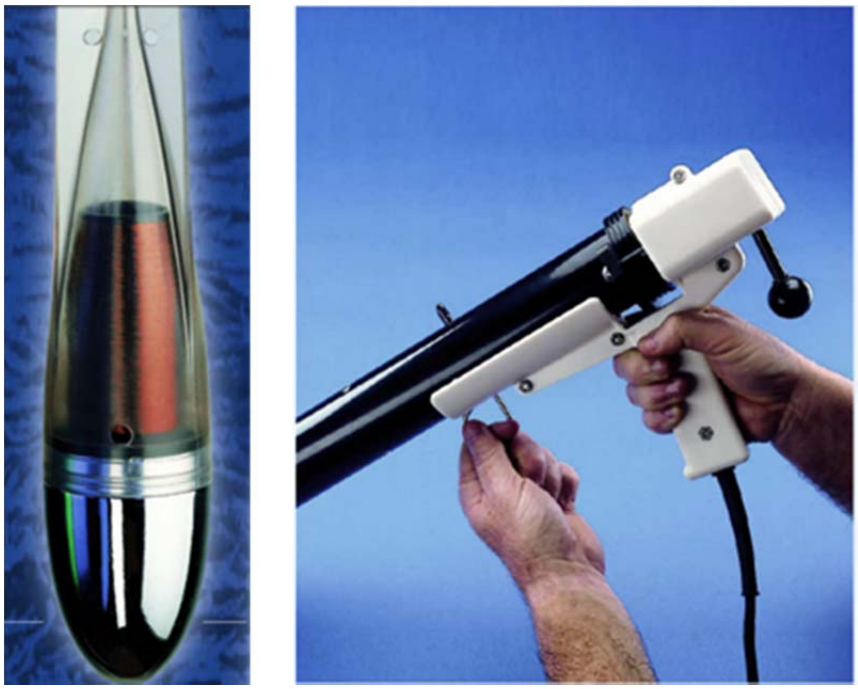
The depth of the CTD sensor array is continuously monitored using a very sensitive electronic pressure sensor. Salinity, temperature, and depth data measured by the CTD instrument are essential for characterization of seawater properties.

SWFSC also uses Lockheed Martin Sippican's Expendable Bathythermographs (XBT) to provide ocean temperature versus depth profiles. A standard XBT/XSV system consists of an expendable probe, a data processing/recording system, and a launcher. An electrical connection between the probe and the processor/recorder is made when the canister containing the probe is placed within the launcher and the launcher breech door is closed. Following launch, wire dereels from the probe as it descends vertically through the water. Simultaneously, wire dereels from a spool within the probe canister, compensating for any movement of the ship and allowing the probe to freefall from the sea surface unaffected by ship motion or sea state.

The XBT probes consist of a metal weight surrounding a temperature probe, attached to a copper wire that conducts the signal to the vessel. The copper wire is protected within a plastic housing (Figure A-13). Probes are generally launched from the leeward side of the vessel and as far aft as possible. Launching

from these locations helps obtain high reliability and minimizes the chances that the fine copper probe wire will come in contact with the ship's hull which may cause spikes in the data or a catastrophic wire break. A portable shipboard data acquisition system records, processes, and interprets the data the probes collect.

XBT drops occur at predetermined times along with surface chlorophyll sampling. Opportunistic drops may also occur. Typically, three XBT drops are made per survey day. XBT drops may be repeated if the displayed profile does not show a well-defined mixed layer and thermocline, which typically occurs at 15°C in the eastern tropical Pacific Ocean and 10°C in the California Current.



(Lockheed Martin Sippican Inc.)

Figure A-13 Expendable XBT probe on the left; LM-3A Hand-Held Launcher on the right

Deep Blue probes are preferred, as they survey to a depth of 760 m and take approximately 2 minutes per drop. Probes are launched using a Hand-Held Launcher (Figure A-13). As the XBT probes are expendable, they are not retrieved and are left on the seafloor after data collection.

13. SWFSC Vessels used for Survey Activities

NMFS employs NOAA-operated research vessels, chartered vessels, and vessels operated by cooperating agencies and institutions to conduct research, depending on the survey and type of research.

The *David Starr Jordan*, a NOAA fisheries survey vessel formerly home-ported in San Diego, was decommissioned in August 2011. Her replacement, the NOAA Ship *Reuben Lasker* will come online in 2013 but will not be considered fully operational until 2014. In the meantime, surveys are conducted aboard other NOAA ships (*MacArthur II*, *Miller Freeman*, *Shimada*), UNOLS vessels (*New Horizon*) and

various charter vessels. Several small boats are located in Santa Cruz and La Jolla and deployed as far away as the Eastern Tropical Pacific and Antarctica.

NOAA-Operated Research Vessels

McArthur II

The R/V *McArthur II* was converted from a T-AGOS surveillance vessel when NOAA acquired it from the U.S. Navy in 2002. The *McArthur II* is home-ported in Newport, Oregon and shared between the west coast National Marine Sanctuaries and NMFS. Approximately half of her time is used to support Protected Resource Division marine mammal surveys. The ship is 68.3 m (224 ft.) in length with a 15 ft. draft. It can cruise at 11 knots with two 800 hp General Electic diesel motors and two 2.6 m (8.5 ft.) propellers. The deck has two oceanographic winches, an A-Frame, and a J-Frame. The *McArthur I*I can accommodate up to 15 scientists in a crew of 37. The ship conducts oceanic research and assessment throughout the eastern Pacific, engaging in chemical, meteorological, and biological sampling on a large scale.

Figure A-13 NOAA Ship R/V *McArthur II*

Bell M. Shimada

The R/V *Bell M. Shimada* is home-ported in Newport, Oregon and shared between the Northwest Fisheries Science Center (NWFSC) and the SWFSC. Shakedown cruises were conducted in 2010 and operational surveys began for 2011. The *Bell M. Shimada* is one of the most technologically-advanced fisheries vessels in the world. Many of the advances are focused on making the boat quieter and reducing disturbance to marine life. The vessel is 68.3 m (209 ft.) in length with a diesel electric drive system with two 1,508 hp propulsion motors and one 4.3 m (14.1 ft.) propeller. The deck has an oceanographic winch, two stern trawl winches, and two A-Frame winches. The ship can cruise at 12 knots. The *Bell M. Shimada* can accommodate a total of 39 crewmembers, including 15 scientists. The technologies on the boat offer scientists the ability to monitor fish populations without altering their behavior, allowing accurate data collection.

Figure A-14 NOAA Ship R/V *Bell M. Shimada*

Miller Freeman

The R/V *Miller Freeman* is home-ported in Newport, Oregon and shared between the Alaska Fisheries Science Center, NWFSC, and SWFSC. The ship is currently laid up awaiting funding for a mid-life overhaul. At 65.5 m (215 ft.) long, the *Miller Freeman* is one of the largest research trawlers in the United States and is capable of operating in any waters in the world. The vessel can cruise at 11 knots with one 2,200hp General Motors diesel engine and one 3 m (10.1 ft.) propeller. On the deck are two cranes, two A-Frames, including a large stern gantry, and eight winches. The ship can accommodate up to 45 people, including up to 11 scientists.

Figure A-15 NOAA Ship R/V *Miller Freeman*

David Starr Jordan

The R/V *David Starr Jordan* was commissioned and home-ported in San Diego from 1965 to 2009. For 44-years she worked exclusively on SWFSC surveys before being decommissioned in 2010. Although it no longer belongs to NOAA, many of the surveys mentioned in this report were done on this vessel. The *David Starr Jordan* is currently owned by Stabbert Maritime. She is a 52.1 m (171 ft.) steel-hulled, purpose-built research vessel powered by two White Superior diesel engines with a total of 1068 horsepower. The *David Starr Jordan* uses two propellers to achieve a sustained cruising speed of 10.0 knots. The deck equipment features five winches, two cranes, one J-frame, and a gantry. Each of the winches serves a specialized function ranging from trawling to hydrographic surveys. The ship has a flying bridge observation station, a helicopter flight deck, a bow observation chamber, and deck space for two portable lab containers. The *David Starr Jordan* can accommodate a crew of 33 people, including up to 15 scientists. The NOAA Ship R/V *Reuben Lasker* (Figure A-17) has been designated as the *David Starr Jordan*'s replacement. The vessel is currently being designed and constructed at Marinette Marine in Wisconsin and will be delivered to the West Coast in 2013 for outfitting, crew training and shakedown cruises.

Figure A-16 Former NOAA Ship R/V *David Starr Jordan*

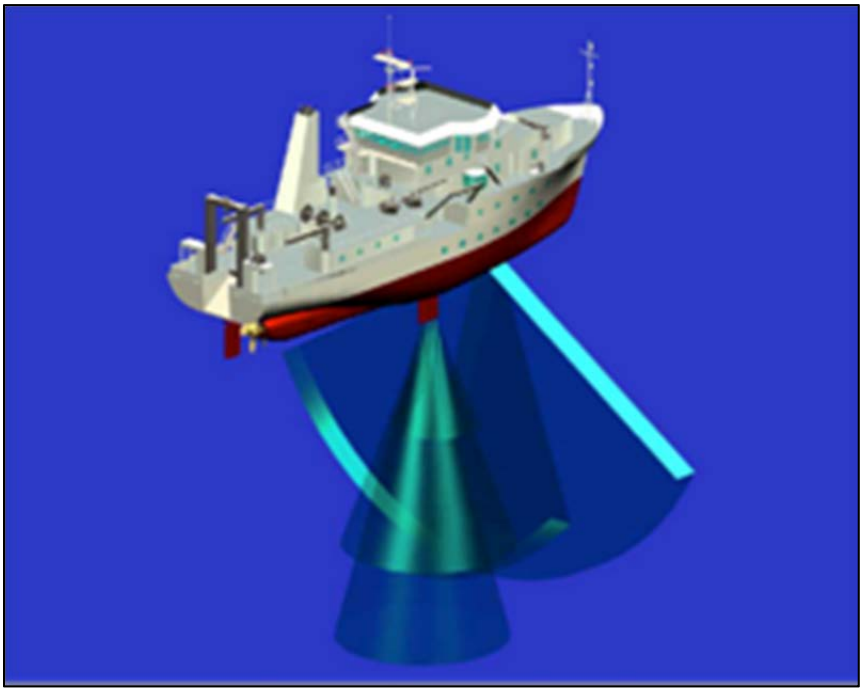


Figure A-17 Illustration of the new NOAA Ship R/V *Reuben Lasker*

The SWFSC also deploys the trailerable 33-foot R/V *Holliday* off the coast of Southern California. This high-tech vessel is equipped with an array of acoustic and optical sensors and can be used to support AUV and ROV operations. Other small boats include instrumented 5 m Zodiacs used in the Antarctic, Boston Whalers used by the turtle group, a 19-foot instrumented aluminum skiff, and several small boats located at the Santa Cruz lab.

Figure A-18 R/V *Holliday*

UNOLS and university vessels available to SWFSC

In addition to NOAA-operated research vessels, research activities may be conducted from vessels owned and operated by cooperating agencies and institutions. A wide range of research vessels are used, ranging from small open boats to modern trawlers and longliners. The sizes of the vessels used for research, engine types, cruising speeds, etc. vary depending upon the location and requirements of the research for which the vessel is used. Some of the most commonly chartered are described below.

New Horizon

The R/V *New Horizon* is part of the University-National Oceanographic Laboratory System (UNOLS) fleet, and owned by the Scripps Institution of Oceanography. The vessel is 51.2 m (170 ft.) in length, and has 2 diesel 850 hp Caterpillar engines and two Heimdal controllable-pitch propellers. One permanent crane, three winches, an A-Frame, and an inverted J-Frame style hydro boom are on the deck. The *New Horizon* was used for three seasons of the CalCOFI surveys: fall, spring, and summer, as well as a Cowcod survey.

Figure A-19 R/V *New Horizon*

Coral Sea

The R/V *Coral Sea* is owned by Humboldt State University and is 27.4 m (90 ft.) in length. It uses a 500 hp engine and 4 bladed propellers to cruise at 10 knots. Deck equipment includes one A-Frame, one crane, and two winches. This ship can accommodate up to 39 scientists and 5 crew members. The *Coral Sea* has been chartered for the PacOOS Northern California surveys to conduct monthly (weather permitting) plankton and oceanographic observations along a line of stations off Arcata in northern California using funds supplied by the SWFSC.

Figure A-20 R/V *Coral Sea*

Point Sur

The R/V *Point Sur* is part of the University-National Oceanographic Laboratory System fleet, and operated by the Moss Landing Marine Laboratories. The vessel is 41 m (135 ft.) in length, and can cruise at 9.5 knots. It has two Caterpillar diesel engines with 565hp each and two propellers. The ship can accommodate up to 21 people including 11 scientists for multi-day journeys, or up to 40 scientists for day trips. The deck equipment includes a trawl winch, a hydro winch, a CTD winch, two cranes and an A-Frame. The *Point Sur* has been used in the PacOOS surveys in central California. It is also used by Monterey Bay Aquarium Research Institute and University of California Santa Cruz to conduct sampling on CalCOFI lines 66 and 60 using funds supplied by SWFSC.

Figure A-21 R/V *Point Sur*

Charter vessels used by SWFSC:

Yuzhmorgeologiya

The R/V *Yuzhmorgeologiya* is a Russian ice class ship, owned by CGGE International, capable of stable operations in extreme conditions. It had been chartered for 15-years by AERD to conduct its Antarctic surveys. In 2010, the government pulled the vessel from competitive bidding on a charter renewal and indicated that it will be unavailable for an indefinite period. The ship is 104.5 m (342.8 ft.) in length and has two 3500hp engines to cruise at 10 knots. The deck has an A-Frame, two J-Frames, four cranes, and several winches: 2 trawl, 4 geophysical, one air gun, and two others. This charted vessel can accommodate 30 guests. The *Yuzhmorgeologiya* is used in the AMLR Program surveys.

Figure A-22 **R/V *Yuzhmorgeologiya***

Moana Wave

The R/V *Moana Wave* is a research vessel owned and chartered out by Stabbert Maritime. The ship is 64 m (210 ft.) in length, and has two Cat 398 engines with 850hp each and one propeller to keep a cruising speed of 10 knots. Deck machinery includes an A-Frame gantry, two hydraulic cranes, and two winches. The vessel boasts 4,479 square feet of working deck space. The *Moana Wave* was chartered by AERD to conduct their 2010 and 2011 Antarctic surveys.

Figure A-23 R/V *Moana Wave*

F/V Frosti

F/V *Frosti* is a 130-foot trawler registered in Canada that has been used to conduct portions of the coastwide sardine survey, the juvenile rockfish survey and the juvenile salmon survey.

Figure A-24 F/V *Frosti*

La Mer

The *La Mer* (which stands for Los Angeles Marine Environmental Research) was commissioned to be built by the city of Los Angeles for collecting water quality samples and various other biological samplings. The vessel is 25.6 m (84 ft.) in length with a displacement of 56 tons. Its two diesel engines run at 764bhp each. The ship can accommodate up to 8 persons, including scientists. On the deck are A-Frames, oceanographic winches, and sea cranes. The *La Mer* has been used on nearshore ichthyoplankton surveys in the California Current.

Aircraft used by SWFSC:

A NOAA-owned Twin Otter (currently based in Monterey, California) and various charter aircraft have been used by SWFSC to conduct surveys of coastal harbor porpoise, and several species of oceanic dolphins and whales, marine turtles, and pinnipeds.

Figure A-25 Aircraft used for SWFSC research

Other observation platforms developed and used by SWFSC:

Underwater Autonomous Vehicles (UAVs)

Light-Weight Instrumented Buoys

Unmanned Aerial Vehicles (UAVs)

Moored Instrument Arrays

Miniaturized Echosounders

Figure A-26 Other observation platforms developed and used by SWFSC.

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Appendix B

Spatial and Temporal Distribution of SWFSC Fisheries Research Effort by Gear Type in the California Current Research Area (CCRA)

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Spatial and Temporal Distribution of SWFSC Fisheries Research Effort by Gear Type in the California Current Research Area (CCRA)

This appendix provides a synopsis of SWFSC fisheries research effort by gear type and by season in the California Current Research Area. Descriptions of the research effort in the Eastern Tropical Pacific Research Area and the Antarctic Research Area are provided in Table 2.2-1. This appendix provides information about the spatio-temporal distribution of research effort in the California Current Research Area to complement the information provided in Table 2.2-1.

Table B-1 SWFSC Research Effort by Gear Type in the CCRA by Season

Gear type	Surveys	Gear Description	Sampling Events	Effort
Spring (March-May)				
Pelagic trawling	California Cooperative Oceanic Fisheries Investigations (CalCOFI)	Fine-mesh, small, towed nets designed to sample larval fish and pelagic invertebrates (Oozeki, IKMT, MOCNESS, and Tucker nets)	Selected stations (<100)	20-60 minute duration tows at 2-3 knots (kts)
	Coastal Pelagic Species (CPS) This survey is conducted either in April-May or in June-July but not both in the same year; only listed in spring season	NETS Nordic 264 two-warp rope trawl	50	30 minute tows at 2-3 kts
	Juvenile Rockfish Survey (JRS) This survey is conducted either in May to mid-June; only listed in spring season	Modified Cobb midwater trawl	150	15 minute tows at 2 kts
Bottom longline	Reproductive life history analysis of sablefish (Sablefish)	Small commercial bottom longline	6-9 sets	75 hooks per set
Plankton tows	CalCOFI, CSP, JRS Pacific Coast Ocean Observing System (PaCOOS)-North CA	Various plankton nets (Bongo, CalVET, Pairovet, and Manta)	255	10-20 minute tows at 1.5-2.5 kts or vertical deployment
CTD and rosette water sampler	CalCOFI, CSP, JRS, PacOOS-North	Vertical deployment to various depths	305	Vertical deployment
Continuous Underway Fish Egg Sampler (CUFES)	CalCOFI CSP	Surface to 3 m depth	Continuous sampling	Continuous sampling
Multi-frequency single-beam active acoustics	CalCOFI, CSP, JRS	18, 38, 70, 120, 200, and 333 kHz	Continuous use	Continuous use
Multibeam Acoustics	CalCOFI CSP	Simrad ME-70 and MS-70	Continuous use	Continuous use

Gear type	Surveys	Gear Description	Sampling Events	Effort
Summer (June-August)				
Pelagic trawling	CalCOFI, Marine Mammal Surveys (MMS)	Oozeki, IKMT, MOCNESS, and Tucker nets	Selected stations (<100)	20-60 minute duration tows at 2-3 kts
	Juvenile Salmon Survey (JSS)	NETS Nordic 264 two-warp rope trawl	50	30 minute tows at 2-3 kts
Pelagic longline	Highly Migratory Species Survey (HMS)	2-12 mile mainline with 10-36 ft gangions, 50-100 ft apart, 9/0 J hooks for blue and mako sharks; 16/0 and 18/0 offset, stainless circle hooks for swordfish.	60 sets	200-400 hooks per set, 2-4 hr soak (12,000-24,000 hooks per survey)
Bottom longline	Sablefish	Small commercial bottom longline	6-9 sets	75 hooks per set
Deep set buoy gear	Swordfish tagging	Modified swordfish buoy gear	150-300 sets	Two hooks per set, fishing at 250-400 m depth with continual surveillance for quick retrieval
CTD and rosette water sampler	CalCOFI, JSS, PacOOS-Central, PacOOS-North, HMS, MMS	Vertical deployment to various depths	300	Vertical deployment
Continuous Underway Fish Egg Sampler (CUFES)	CalCOFI	Surface to 3 m depth	Continuous sampling	Continuous sampling
Multi-frequency single-beam active acoustics	CalCOFI, JSS, HMS, MMS	18, 38, 70, 120, 200, and 333 kHz	Continuous use	Continuous use
Multibeam Acoustics	CalCOFI	Simrad ME-70 and MS-70	Continuous use	Continuous use

Gear type	Surveys	Gear Description	Sampling Events	Effort
Fall (September-November)				
Pelagic Trawling	CalCOFI, Habitat Surveys (HS) This survey only conducted opportunistically as ship time is available; listed only in the fall.	Oozeki, IKMT, MOCNESS, and Tucker nets	Selected stations (<150)	20-60 minute duration tows at 2-3 kts
	HS	NETS Nordic 264 two-warp rope trawl	10	30 minute tows at 2-3 kts
Pelagic longline	Thresher Shark Survey (TSS), HS	1-2 mile mainline set at 12 ft deep with 10-15 ft gangions, 50-100 ft apart, 13/0 offset circle hooks	60 sets	200-400 hooks per set, 2-4 hr soak (8,000-16,000 hooks per survey) + 4,000-8,000 hooks for HS
Bottom longline	Sablefish	Small commercial bottom longline	6-9 sets	75 hooks per set
Deep set buoy gear	Swordfish tagging	Modified swordfish buoy gear	150-300 sets	Two hooks per set, fishing at 250-400 m depth with continual surveillance for quick retrieval
Plankton tows	CalCOFI, JSS, PacOOS-Central, PacOOS-North, HS	Various plankton nets	300	10-20 minute tows at 1.5-2.5 kts or vertical deployment
CTD and rosette water sampler	CalCOFI, JSS, PacOOS-Central, PacOOS-North, HS	Vertical deployment to various depths	300	Vertical deployment
Continuous Underway Fish Egg Sampler (CUFES)	CalCOFI	Surface to 3 m depth	Continuous sampling	Continuous sampling
Multi-frequency single-beam active acoustics	CalCOFI, TSS	18, 38, 70, 120, 200, and 333 kHz	Continuous use	Continuous use
Multibeam Acoustics	CalCOFI	Simrad ME-70 and MS-70	Continuous use	Continuous use
Submersibles	HS	Manned and Remotely Operated Vessels with video cameras	10	60-240 minute deployment each

Gear type	Surveys	Gear Description	Sampling Events	Effort
Winter (December-February)				
Pelagic trawling	CalCOFI	Oozeki, IKMT, MOCNESS, and Tucker nets	Selected stations (<100)	20-60 minute duration tows at 2-3 kts
Bottom longline	Sablefish	Small commercial bottom longline	6-9 sets	75 hooks per set
Plankton tows	CalCOFI, PacOOS-North	Various plankton nets	130	10-20 minute tows at 1.5-2.5 kts or vertical deployment
CTD and rosette water sampler	CalCOFI, PacOOS-North	Vertical deployment to various depths	130	Vertical deployment
Continuous Underway Fish Egg Sampler (CUFES)	CalCOFI	Surface to 3 m depth	Continuous sampling	Continuous sampling
Multi-frequency single-beam active acoustics	CalCOFI	18, 38, 70, 120, 200, and 333 kHz	Continuous use	Continuous use
Multibeam Acoustics	CalCOFI	Simrad ME-70 and MS-70	Continuous use	Continuous use

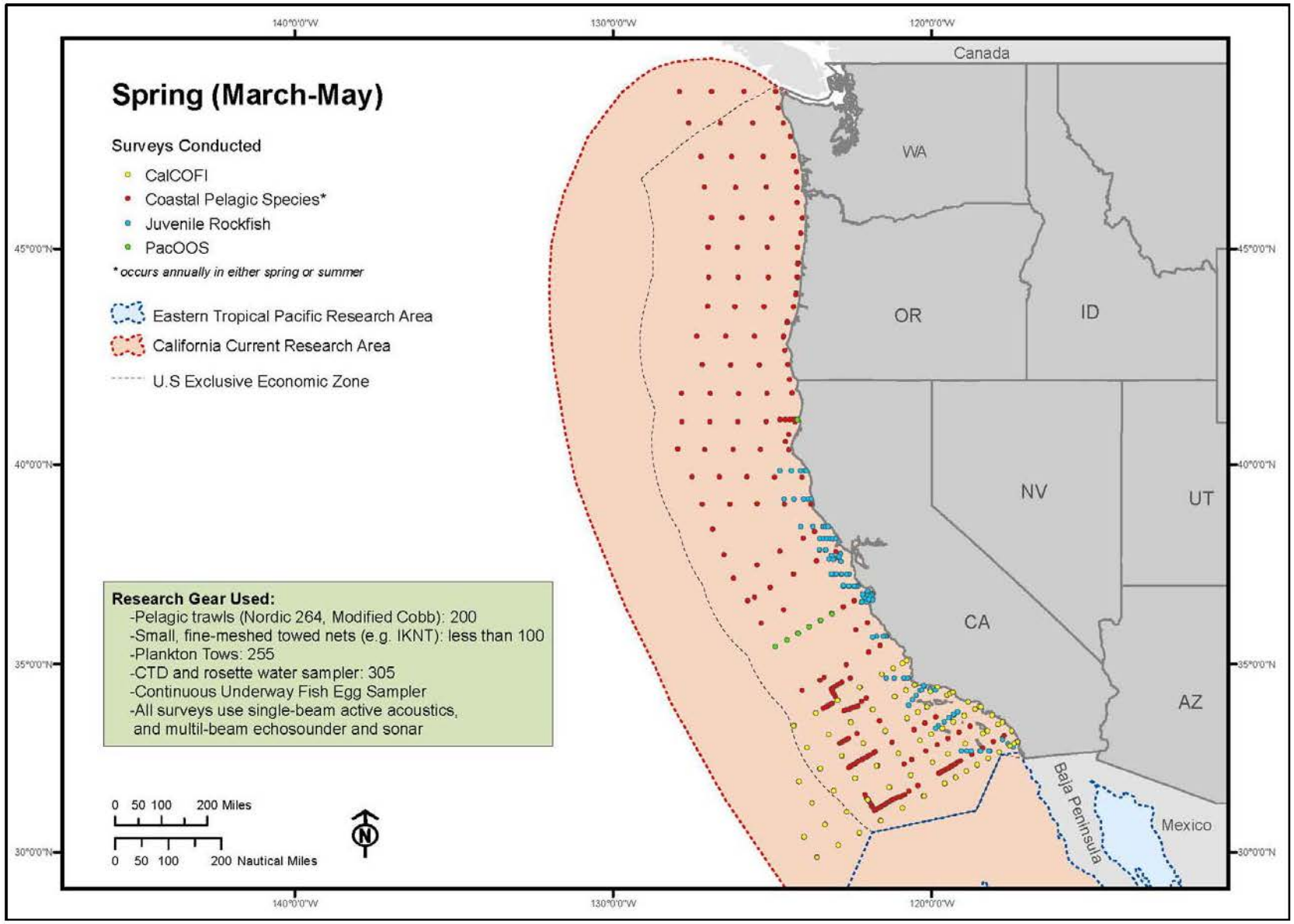

Figure B-1 Distribution of SWFSC research effort in the CCRA in spring.

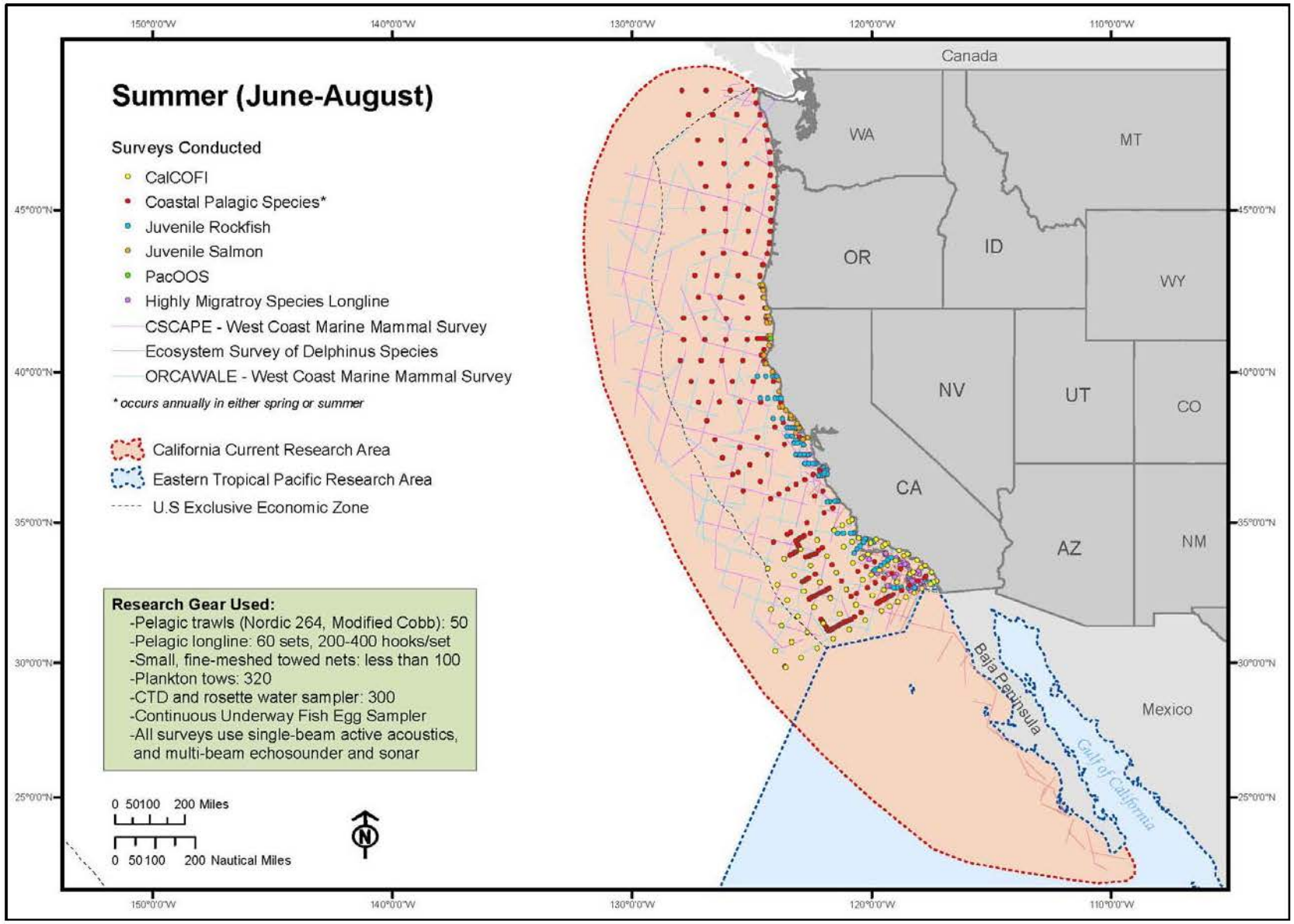

Figure B-2 Distribution of SWFSC research effort in the CCRA in summer

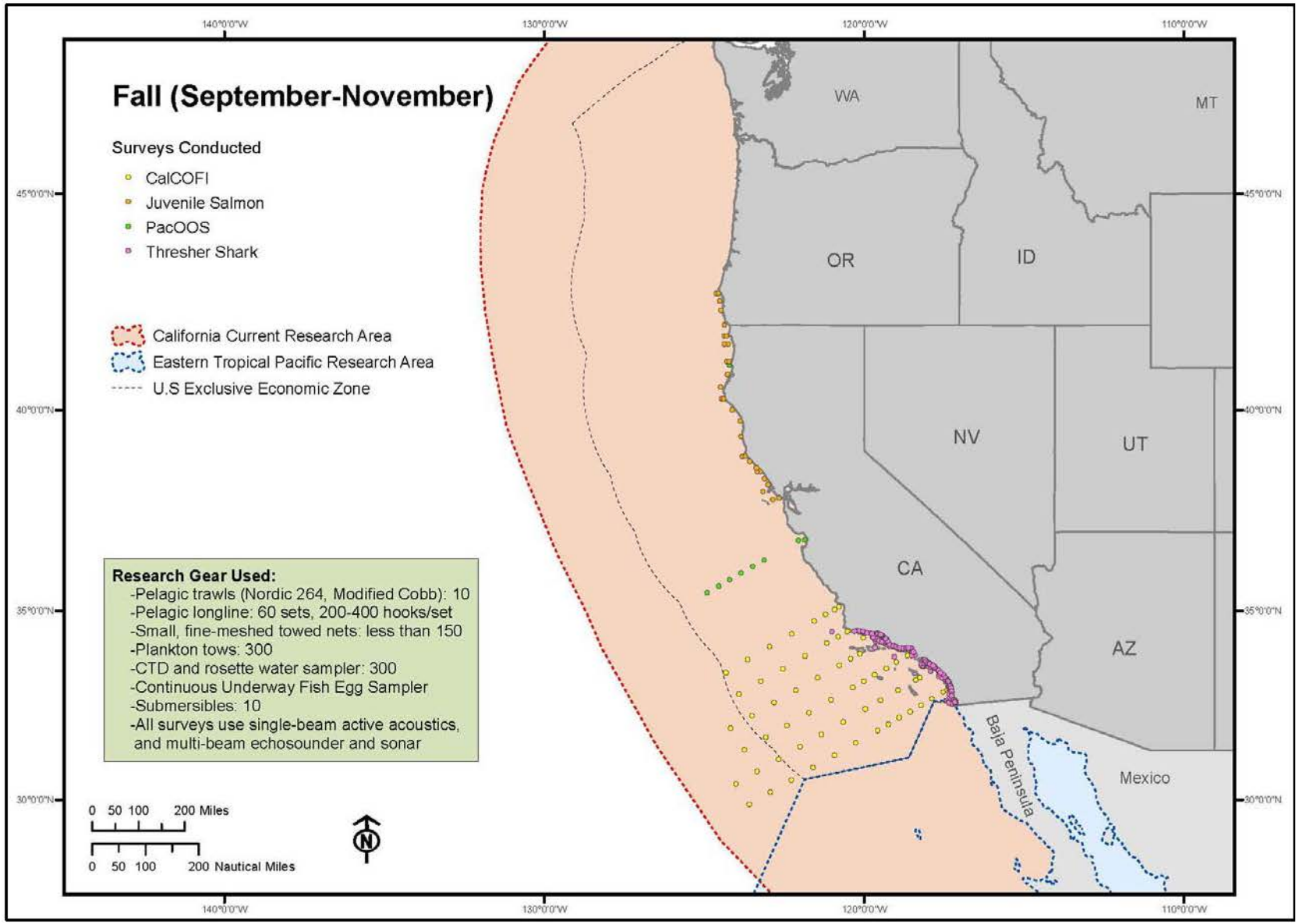

Figure B-3 Distribution of SWFSC research effort in the CCRA in fall

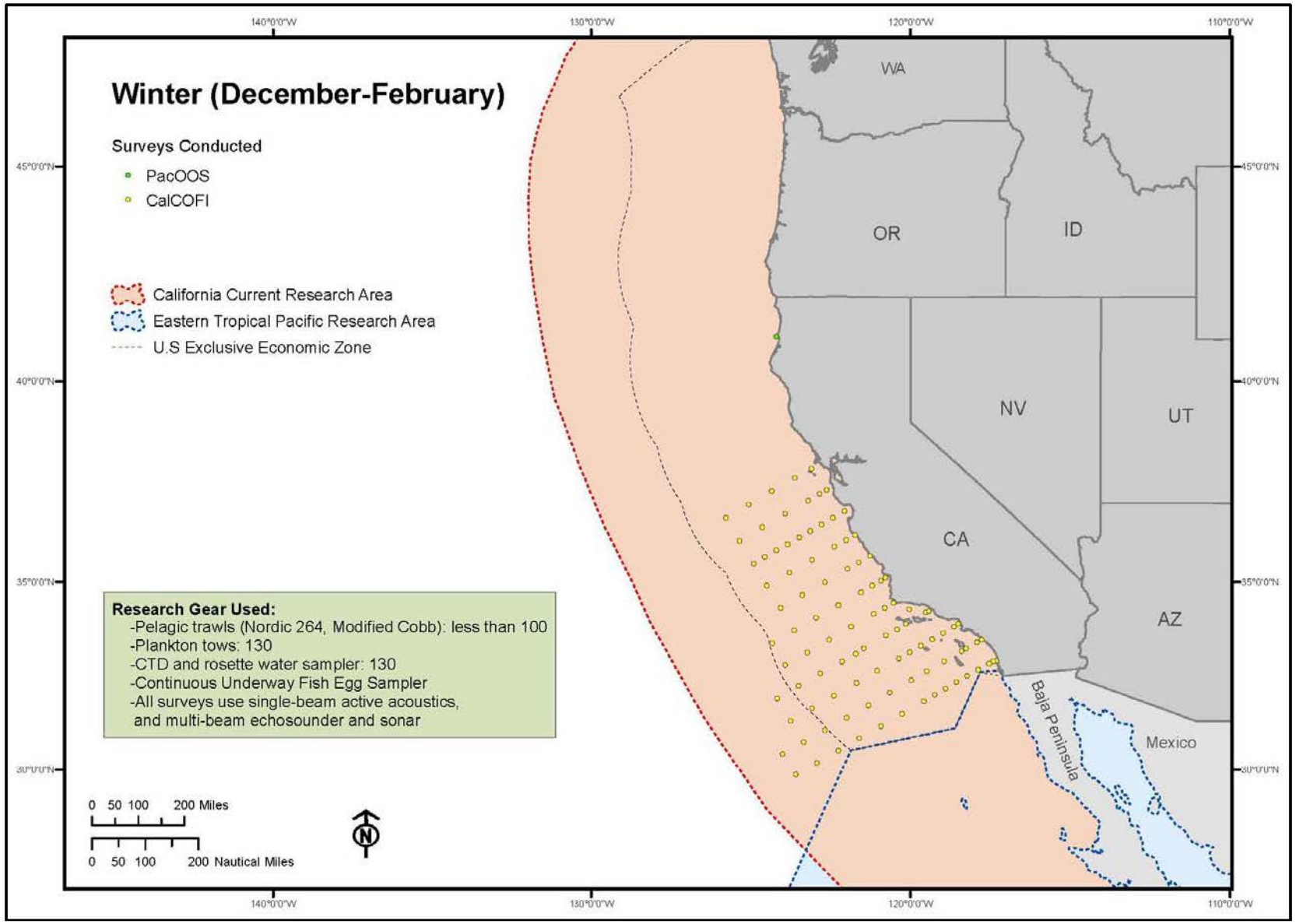

Figure B-4 Distribution of SWFSC research effort in the CCRA in winter

Appendix C

REQUEST FOR
RULEMAKING and LETTERS OF AUTHORIZATION UNDER SECTION 101(a)(5)(A) OF THE MARINE MAMMAL PROTECTION ACT
(SWFSC LOA Application)

REQUEST FOR

RULEMAKING and LETTERS OF AUTHORIZATION UNDER SECTION

101(a)(5)(A) OF THE MARINE MAMMAL PROTECTION ACT

FOR THE TAKE OF MARINE MAMMALS

INCIDENTAL TO FISHERIES AND ECOSYSTEM RESEARCH ACTIVITIES

CONDUCTED BY

NOAA FISHERIES SOUTHWEST FISHERIES SCIENCE CENTER

WITHIN THE

CALIFORNIA CURRENT ECOSYSTEM, EASTERN TROPICAL PACIFIC

ECOSYSTEM, AND ANTARCTIC ECOSYSTEM

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1. **DETAILED DESCRIPTION OF THE SPECIFIC ACTIVITY OR CLASS OF ACTIVITIES THAT CAN BE EXPECTED TO RESULT IN INCIDENTAL TAKING OF MARINE MAMMALS**

This application, submitted to the National Marine Fisheries Service (NMFS) Office of Protected Resources, requests rulemaking and subsequent letters of authorization under the Marine Mammal Protection Act (MMPA) of 1972 for the incidental take of marine mammals during fisheries surveys and related research activities conducted by the Southwest Fisheries Science Center (SWFSC), National Marine Fisheries Service (NMFS), NOAA. Management of certain protected species falls under the jurisdiction of the NMFS under the MMPA and Endangered Species Act (ESA). Mechanisms exist under both the ESA and MMPA to assess the effect of incidental takings and to authorize appropriate levels of take.

The Federal government has a trust responsibility to protect living marine resources in waters of the United States (U.S.), also referred to as federal waters. These waters generally lie 3 to 200 nautical miles (nm) from the shoreline [those waters 3-12 nm offshore comprise territorial waters and those 12 to 200 nm offshore comprise the Exclusive Economic Zone (EEZ)]. The U.S. government has also entered into a number of international agreements and treaties related to the management of living marine resources in international waters outside of the U.S. EEZ (i.e., the high seas). To carry out its responsibilities over federal and international waters, Congress has enacted several statutes authorizing certain federal agencies to administer programs to manage and protect living marine resources. Among these federal agencies, NOAA has the primary responsibility for protecting marine finfish and shellfish species and their habitats. Within NOAA, the NMFS has been delegated primary responsibility for the science-based management, conservation, and protection of living marine resources.

Within the area covered by this MMPA application to incidentally take marine mammals, NMFS manages finfish and shellfish harvest under the provisions of several major statutes, including the Magnuson-Stevens Fishery Conservation and Management Act (MSA)[1], the Tuna Conventions Act, the ESA, the International Dolphin Conservation Program Act, and the Antarctic Marine Living Resources Convention Act. Accomplishing the requirements of these statutes requires the close interaction of numerous entities in a sometimes complex fishery management process. In the Southwest, the entities involved are a NMFS Regional Fisheries Science Center; NMFS Regional Office; NMFS Offices of Protected Resources, Sustainable Fisheries and Science and Technology; a Fisheries Management Council; a Fisheries Commission; and five International Fisheries Management Organizations.

1.1 Fisheries Science Centers

Six Regional Fisheries Science Centers direct and coordinate the collection of scientific information needed to inform fisheries management decisions[2]. Each Fisheries Science Center is a distinct entity and is the scientific focal point for a particular region (Figure 1.1). The Southwest Fisheries Science Center (SWFSC) conducts research and provides scientific advice

[1] 16 U.S.C. §§ 1801-1884, (MSA 2007).

[2] The six Regional Fisheries Science Centers are: 1) Northeast, 2) Southeast, 3) Southwest, 4) Northwest, 5) Alaska, and 6) Pacific Islands.

to manage fisheries and conserve protected species along the U.S. west coast, throughout the eastern tropical Pacific Ocean, and in the Southern Ocean off Antarctica (Figure 1.2). SWFSC provides scientific information to support the Pacific Fishery Management Council and other domestic and international fisheries management organizations.

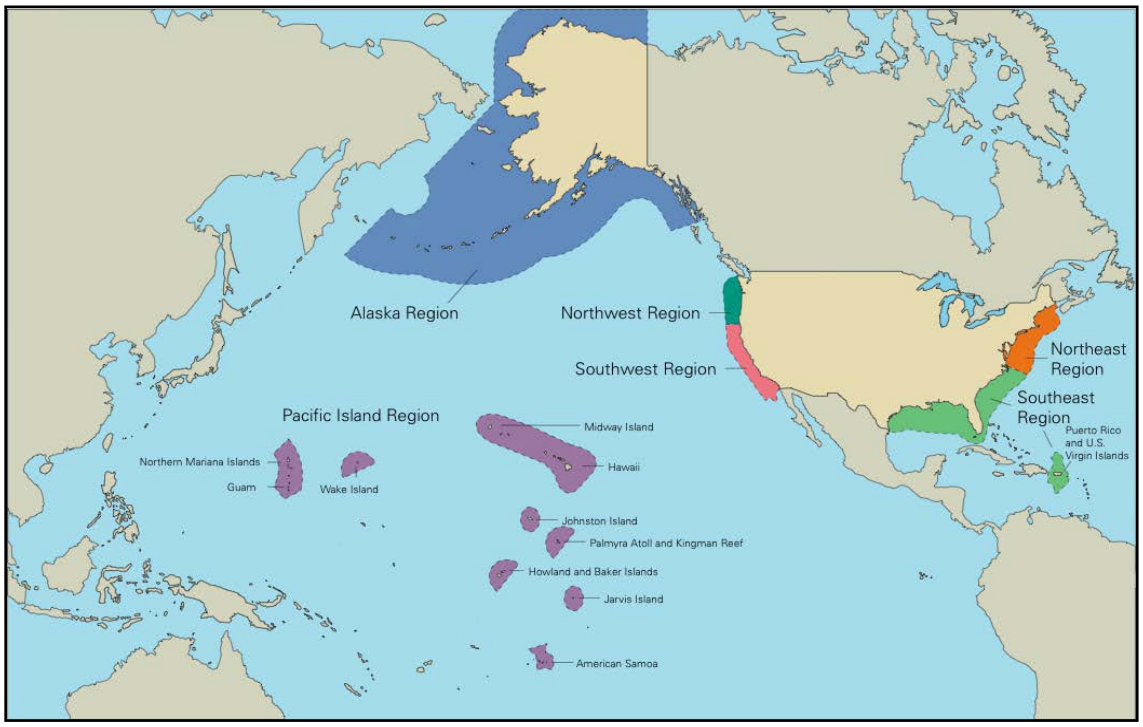

Figure 1.1 NMFS's Fisheries Science Center Regions.

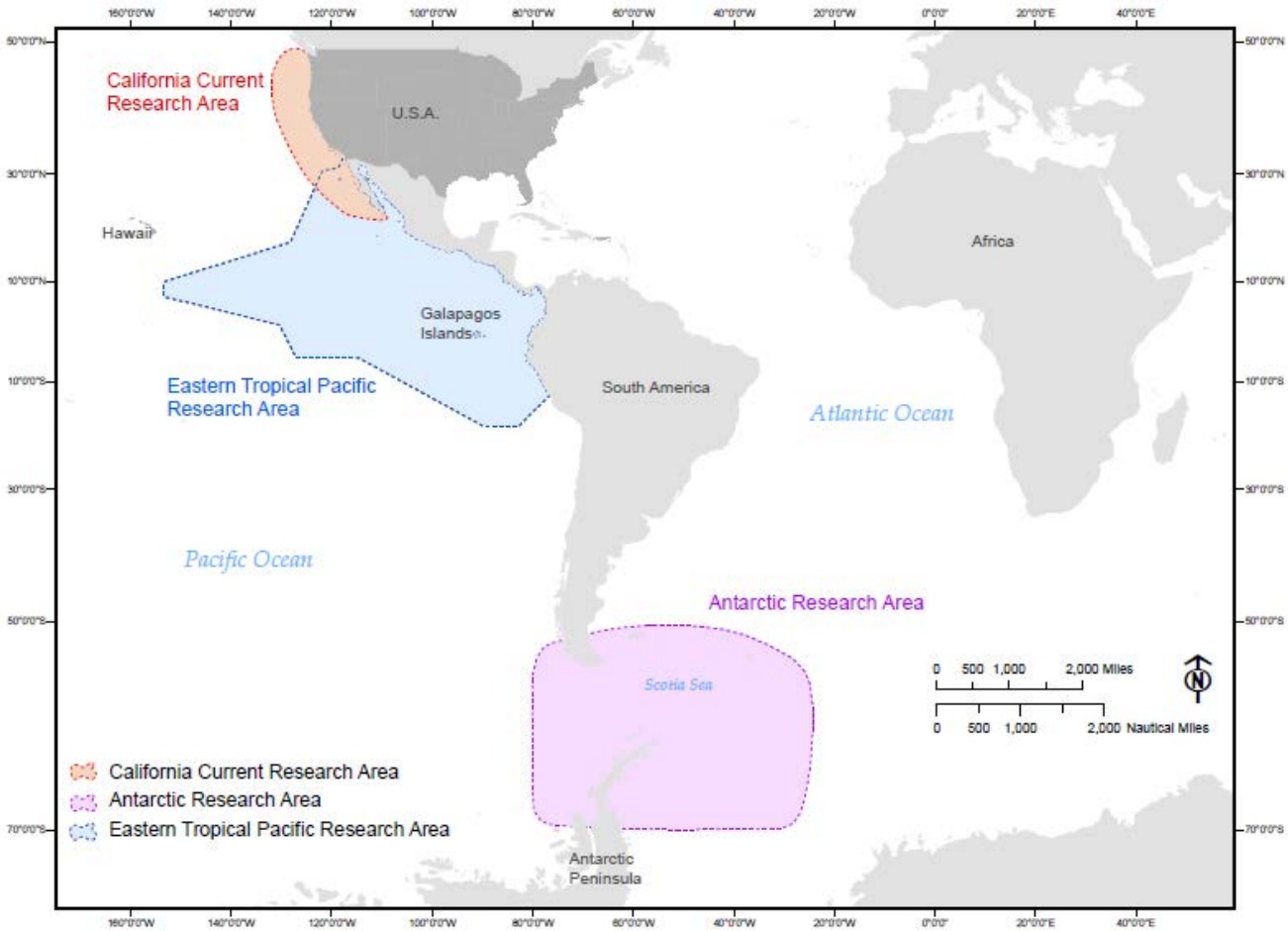

Figure 1.2 SWFSC research areas.

1.2 Role of Fisheries Research in Federal and Regional Fisheries Management

The SWFSC provides scientific information and advice to assist with the development of FMPs prepared by the Pacific Fishery Management Council (PFMC), Western Pacific Regional Fishery Management Council (WPRFMC), and a variety of federal and non-federal entities. The councils, which include fishing industry representatives, fishers, scientists, government agency representatives, federal appointees, and others, are designed to provide all resource users and managers a voice in the fisheries management process. Under the MSA, the Councils are charged with developing Fishery Management Plans (FMPs) and management measures for the fisheries occurring within the EEZ adjacent to their constituent states. Data collected by Fisheries Science Centers are often used to inform FMPs, as well as to inform other policies and decisions promulgated by the Fishery Management Councils. Such policies and decisions sometimes affect areas that span the jurisdictions of several Fishery Management Councils, and make use of data provided by multiple Fisheries Science Centers.

Fisheries managers use a variety of techniques to manage trust resources, a principal one being the development of FMPs. FMPs are used to articulate fishery goals as well as the methods used to achieve those goals, and their development is specifically mandated under the MSA.

In addition to providing information to domestic fisheries management councils, the SWFSC provides scientific advice to support numerous international fisheries councils, commissions, and conventions including the Western and Central Pacific Fisheries Commission, International Scientific Committee for Tuna and Tuna-like Species, Inter-American Tropical Tuna Commission and the Convention for the Conservation of Antarctic Marine Living Resources. Research conducted by the SWFSC has also been critical in the development and successful implementation of ecosystem-based management in Antarctica in order to fulfill the conservation objectives of the Antarctic Treaty.

1.3 SWFSC Research Divisions

The SWFSC is the research arm of NMFS in the Southwest Region. The SWFSC plans, develops, and manages a multidisciplinary program of basic and applied research to inform management of the region's marine and anadromous fish and invertebrate populations to ensure they remain at sustainable and healthy levels. Responsibilities include maintaining healthy fish stocks for commercial and recreational fishing; sustaining ecosystem services; and coordinating with domestic and international organizations to implement fishery agreements and treaties.

The SWFSC research efforts are divided among five research divisions that are tasked with different roles in collecting scientific information on living marine resources and the ecosystems that sustain them. The SWFSC headquarters is located in La Jolla, California. The Fisheries Ecology Division is based in Santa Cruz, California, adjacent to UC Santa Cruz's Long Marine Laboratory, and the Environmental Research Division is based in Pacific Grove, California. The SWFSC operates two field stations in California located in Arcata and Granite Canyon. On the Antarctic Peninsula, the SWFSC’s Antarctic Ecosystem Research Division maintains two field stations located at Cape Shirreff on Livingston Island and at Copacabana in Admiralty Bay on King George Island.

1.3.1 Fisheries Resources Division

The SWFSC Fisheries Resources Division (FRD) develops the scientific foundation for the conservation and management of marine resources in the California Current and Eastern Tropical Pacific Ocean. The division conducts seagoing surveys, genetic and morphometric research to define stock structure, life history studies to estimate production of eggs and larvae and adult vital rates, engineering work to develop advanced survey technologies, oceanographic studies to define critical habitat and population response to climate change, quantitative population assessments, and economic studies to define the value of fisheries and alternative management options. The division responds to the information needs of the PFMC’s Coastal Pelagic Species FMP, Highly Migratory Species FMP and Groundfish FMP. FRD scientists also participate on international working groups and provide scientific advice to the ISC, IATTC and WCPFC.

1.3.2 Fisheries Ecology Division

The Fisheries Ecology Division (FED) conducts research on the ecology of groundfish, economic analysis of fishery data, Pacific salmon studies (including 10 endangered salmon and steelhead runs), and coastal habitat issues affecting the San Francisco Bay and the Gulf of Farallones. Results from FED research are used by the PFMC to manage fisheries, and by NMFS

to manage threatened and endangered species. FED scientists study causes of variability in abundance and health of fish populations, analyze ecological relationships in marine communities, and study the economics of exploiting and protecting natural resources. They also assess the stocks of species targeted by various fisheries, and assist in evaluating potential impacts of human activities on threatened or endangered species.

1.3.3 Antarctic Ecosystem Research Division

The Antarctic Ecosystem Research Division (AERD) manages the U.S. Antarctic Marine Living Resources Program (AMLR), which provides information for U.S. policy on the management and conservation of Antarctic living resources and supports U.S. participation in international efforts to protect the Antarctic and its marine life. Research is directed toward gathering ecological and biological information to quantify the functional relationships between finfish and krill, their environment and their predators; to develop an ecosystem approach to ensure sustained harvesting of krill, fish and crabs; and to protect predator populations of seals, penguins, and pelagic seabirds resident in the Southern Ocean surrounding Antarctica.

1.3.4 Protected Resources Division

The Protected Resources Division (PRD) promotes and conducts research that contributes to the conservation and management of U.S. and international populations of marine mammals and their designated critical habitats. Provisions of the MMPA and the ESA guide the division's activities, which include monitoring the abundance of pinniped and cetacean stocks and sea turtles, assessing and helping to minimize the effect of fishing operations and other human activities on these populations, determining stock structure and population dynamics, and conducting research on "dolphin-safe" tuna fishing methods. Research efforts span the entire migratory range of marine mammal and turtle populations. PRD monitors the life history, condition and health of populations, performs regular abundance estimates, advances studies of marine mammal acoustics, and strives to interpret these results in an ecosystem context. To do this, ecosystem data are collected to characterize habitat and its variation over time and on distribution and abundance of prey fishes and squids, seabirds, and marine turtles further characterize the ecosystem in which marine mammals and other protected species live.

1.3.5 Environmental Research Division

The Environmental Research Division (ERD) conducts a flexible research program to assess, understand, and predict climate and environmental variability and its impacts on marine fish populations and ecosystems. ERD provides science-based, globally integrated, fisheries-relevant environmental data, products, and information to meet the research and management needs of the SWFSC, NMFS, and NOAA.

1.4 SWFSC Fisheries Research Activities

Following is a summary of activities conducted by the SWFSC that have the potential to take marine mammals incidental to fisheries and ecosystem research activities. The SWFSC is requesting rulemaking and subsequent Letters of Authorization for the proposed activities. The descriptions below include the location, time of year the surveys occur and gear used. Additional information and detail for each survey and its associated mitigation measures for marine mammals are in Table 1.1 and Appendix A. In general, all SWFSC surveys are set in an ecological context. That is, the Center conducts concurrent hydrographic, oceanographic, and meteorologic sampling in addition to the marine resource surveys.

A component of SWFSC fisheries research is conducted cooperatively with commercial fisheries to address questions of mutual interest, often utilizing commercial vessels as research platforms. Because SWFSC staff are present for all components of its fisheries research activities, it does not distinguish in this application between research activities that are or are not considered cooperative. However, for clarity the following surveys are conducted cooperatively with commercial fisheries: ROV habitat surveys for rockfish and white abalone, adult rockfish, thresher shark longline survey, HMS longline survey, sablefish life history survey and deep-set buoy gear for swordfish tagging.

1.4.1 Surveys conducted in the California Current Ecosystem (CCE)

Coastal Pelagic Species Surveys (e.g. Sardine surveys). This survey is conducted annually in the spring (April-May) or the summer (June-July) and extends from San Diego, CA, to Cape Flattery, WA; it is broken into southern and northern portions on two survey vessels. The southern portion is done in conjunction with the spring or summer CalCOFI survey. Possible marine mammal takes during these conjoined CalCOFI/Sardine surveys are the direct result of trawl operations for the sardine component of the survey. Results of the sardine survey inform the annual assessment of sardine and the corresponding harvest guidelines. It is conducted on either two NOAA ships or a NOAA ship and a charter vessel. The survey requires about 70 survey days per year (Table 1.1).

The protocol for the sardine survey includes deploying a NETS Nordic 264 two-warp rope trawl in the upper 10 m of the water column at night in order to sample adult sardines (*Sardinops sagax*). Estimates of daily fecundity are derived from the samples and combined with estimates of daily egg production to produce an estimate of spawning stock biomass. Additional protocols for this survey are similar to the CalCOFI surveys described below.

The NETS Nordic 264 rope trawl is deployed for 30-minute tows at the target depth at 3 knots during dark hours when sardines are dispersed and near the surface. Directed trawling during daytime on sardine schools deeper in the water column is ineffective. Marine mammals may be caught infrequently while using these nets. Mitigation measures include attachment of a marine mammal excluder device in the net mesh, attachment of acoustic pingers, and a move-on rule to minimize chances for gear to be deployed with marine mammals within 1 nm (see section 13 below for additional information on mitigation and monitoring).

Juvenile Salmon Survey. This survey is conducted annually in June and September and extends from central CA to southern OR and complements similar surveys conducted by the NWFSC. This survey measures ocean survival of juvenile salmon (Coho; *Oncorhynchus kisutch* and Chinook; *Oncorhynchus tshawytscha*) and produces early estimates of adult salmon returns. The juvenile salmon survey is usually conducted on a charter vessel and requires about 30 survey days.

The protocols for this survey include deployment of a two-warp NETS Nordic 264 rope trawl for 30-minute tows at the target depth during daylight hours at 15-30 m depth. It should be noted that the deployment protocol for this trawl is different than the sardine surveys, such that these tows are conducted during the day and deeper in the water column. Depending on vessel

capabilities, additional operations may include multi-frequency active acoustics, CTD profiles, Bongo plankton tows, and single-warp Tucker mid-water trawls.

Juvenile Rockfish Survey. This survey is conducted annually from May to mid-June and extends from southern CA to WA; it targets the pelagic phase of juvenile rockfish. Results of this survey inform assessments of several rockfish populations. It is either conducted on a NOAA ship or a charter vessel and requires about 45 survey days.

The protocols for this survey include underway multi-frequency active acoustics, two-warp midwater trawls, various plankton tows, and CTD profiles at fixed stations. The trawl is conducted using a Modified-Cobb mid-water trawl deployed for 15-minute tows at 2 knots during the dark hours at 15-30 m depth.

CalCOFI Survey - Winter. This survey is conducted annually during January and February and extends from San Diego to San Francisco; it captures early spawning hake and some rockfish. It is usually conducted on a NOAA ship and requires about 25 survey days; all four of the CalCOFI surveys require about 90 days total.

The survey describes the physical and biological characteristics of the southern portion of the California Current epipelagic habitat. Protocols include multi-frequency single-beam active acoustics (18, 38, 70, 120 and 200 kHz) (Table 1.1). These surveys also include a Continuous Underwater Fish Egg Sampler (CUFES), various plankton nets (Bongo, Pairovet, Manta, and PRPOOS), CTD with an array of vertically profiling instruments and bottles to collect water samples at discrete depths, marine mammal and bird observations, meteorological observations using a wide-range of passive sensors, trawls for sampling mesopelagic organisms at selected stations. See Appendix A and the CalCOFI website http://www.calcofi.org/ for additional information.

CalCOFI Survey - Spring. This survey is conducted annually in April. It also extends from San Diego to San Francisco and captures spring spawning (e.g., anchovy, sardine, jack mackerel, and several hundred others). In general, the Center uses a NOAA ship to conduct the survey.

The purpose of the survey and the protocol are the same as for the Winter CalCOFI Survey above. See Appendix A and the CalCOFI website http://www.calcofi.org/ for additional information.

CalCOFI Survey - Summer. This survey is conducted annually in July in the Southern California Bight solely on a Scripps Institution of Oceanography (SIO) University-National Oceanographic Laboratory System (UNOLS) vessel. The survey describes the physical and biological characteristics of the southern portion of the California Current epipelagic habitat. Protocols are the same as for the winter and spring CalCOFI surveys. See Appendix A and the CalCOFI website http://www.calcofi.org/ for additional information.

CalCOFI Survey - Fall. This survey is conducted annually in October in the Southern California Bight usually on a SIO (UNOLS) vessel. The survey describes the physical and biological characteristics of the southern portion of the California Current epipelagic habitat.

Protocols are the same as other CalCOFI surveys. See Appendix A and the CalCOFI website http://www.calcofi.org/ for additional information.

PaCOOS Central CA (MBARI). This survey is conducted annually in July and October. It incorporates the plankton and oceanographic surveys of CalCOFI survey line 66, extending offshore from the Monterey Bay Aquarium Research Institute (MBARI), and line 60, extending offshore from San Francisco Bay. It is usually conducted on Moss Landing Marine Laboratories Research Vessel (R/V) *Point Sur* and lasts about 6 survey days.

Protocols include the use of various plankton nets (Bongo, California Vertical Egg Tow (CalVET), Manta, Pairvet), CTD with an array of vertically profiling instruments and bottles to collect water samples at discrete depths, marine mammal and bird observations, and meteorological observations using a wide-range of passive sensors.

PaCOOS North CA Humboldt State University (HSU). This is monthly plankton and oceanographic surveys of a single line of stations off the university in northern CA. It is usually conducted on HSU R/V *Coral Sea* and takes about 12 survey days.

Protocols include the use of various plankton nets (Bongo, CalVET, Manta), CTD with an array of vertically profiling instruments and water samples at discrete depths, marine mammal and bird observations, and meteorological observations using a wide-range of passive sensors.

Highly Migratory Species (HMS) Survey. This survey is conducted annually from June - July and extends from southern to central CA; it targets blue sharks, shortfin Mako sharks and swordfish and other highly migratory species. Historically it has been conducted on a NOAA ship but in recent years it has been conducted on a charter vessel and requires about 30 survey days.

Protocols include deployment of a pelagic longline at fixed stations with 2-4 hour soak times. Length of the mainline is 2-4 miles with 200-400 hooks spaced 50-100 feet apart, 18 foot long gangions and 9/0 J-type hooks. When targeting swordfish, the mainline may be up to 12 miles in length with 36 foot long gangions and 16/0 circle-type hooks and soak times may last up to 8 hours. Typical bait used is whole mackerel or market squid. Depending on vessel capabilities, additional protocols may include multi-frequency active acoustics, CTD profiles, and Bongo plankton tows.

Thresher Shark Survey. This survey is conducted annually in September. It targets thresher shark pupping areas from the Southern California Bight up to Central California and is usually conducted on charter vessel requiring about 20 survey days.

The protocols for this survey include deployment of an anchored longline at fixed stations with 2-4 hour soak times. Length of the mainline is 2-4 miles with 200-400 hooks spaced 50-100 feet apart, 12 foot long gangions and 16/0 circle-type hooks. Typical bait used is whole mackerel or market squid. Depending on vessel capabilities, additional protocols may include the use of multi-frequency active acoustics, CTD profiling systems, and Bongo plankton tows.

Survey to Research Reproductive Life History Analysis of Sablefish. This survey to research reproductive life history analysis of sablefish is conducted monthly each year near Bodega Bay off the Central California coast. The primary objective of the survey is to collect adult sablefish for reproductive studies using small scale bottom longline gear.

The gear is essentially a small scale longline with 75 hooks per line that are baited with squid and set at or near the bottom, usually at depths between 360 and 450m. Two to three sets are made per trip over the course of 30 days per year.

Swordfish Tagging Deep-Set Buoy Survey. The Swordfish tagging deep-set buoy survey is conducted annually June-November in the Southern California Bight region of the CCE. The survey's main objective is to investigate the use of this gear to capture swordfish while minimizing bycatch of non-target species. Approximately 300-600 sets are made annually.

The gear includes a buoy flotation system (i.e., a strike-indicator float/flag, a large, non-compressible buoy and a float affixed with a radar reflector). A set of "gear" consists of 250-400 m 500 pound (lb) mainline monofilament rigged with a 1-2 kilogram (kg) drop sinker to orient the mainline and terminal fishing gear vertically in the water column. Unlike longline gear which typically uses a long monofilament mainline suspended horizontally near the surface of the water, deep-set buoy gear does not involve the use of a horizontal mainline. Two monofilament gangions branch from the vertically oriented mainline at 250-400 m and are constructed of 400 lb monofilament leader containing a crimped 14/0 circle hook baited with either squid or mackerel.

The buoys are deployed in a restricted spatial grid such that all of the indicator buoys can be continuously monitored from the vessel (within a maximum 4 nm grid area). When an indicator flag rises, the buoy set is immediately tended and the animal caught is either released or tagged and released in order to increase post-hooking survivorship of all target and non-target animals.

Marine Mammal Ecosystem Surveys. This survey is conducted annually during August to December. These are large-scale surveys requiring substantial blocks of continuous time on two NOAA ships and about 60-120 survey days (Table 1.1). Results inform status assessments of marine mammal populations. Surveys rotate among geographic areas and include STAR (eastern tropical Pacific), ORCAWALE (west coast EEZ), HICEAS (Pacific Islands), and SPLASH (northern Pacific).

Protocols include line transect surveys of marine mammals and seabirds. For marine mammals, observations are made of schools or aggregations of animals. For a subset of observations, survey effort is suspended and aggregations are approached for estimation of aggregation size and species composition. Directed research permits are obtained for marine mammal and seabird surveys as required; currently this work is authorized under MMPA/ESA permit 14097.

Additional protocols include the use of multi-frequency active acoustics (38, 70, 120 and 200 kHz) (Table 1.1), 2.5 m^2 single-warp Isaacs Kidd Midwater Trawl (IKMT) with 1 mm mesh net for sampling macro-zooplankton, 3 m^2 dip net with 2 mm mesh net for sampling flying fish,

CTD with an array of vertically profiling instruments and bottles to collect water samples at discrete depths, and meteorological observations using a wide-range of passive sensors.

White Abalone Survey. This survey utilizes still and video camera observations using a remotely operated vehicle (ROV) to monitor population recovery of deep-water habitat for endangered white abalone. It is usually conducted on a charter vessel for about 25 survey days. The surveys are confined to offshore banks and island margins, 30-150 m depth, in the Southern California Bight. Since 2002, over 1,000 ROV transects have been conducted along the entire U.S. west coast. The average and maximum speed of the ROV was 0.49 and 2.43 kts, respectively. The tether that connects the ROV to the ship is 0.75 inches in diameter, and is securely attached to a stainless steel cable and down-weight to minimize slack in the tether and to prevent any loops.

Collaborative Optical Acoustical Survey Technology (COAST) Survey. These are multi-frequency acoustic and ROV optical surveys of offshore banks conducted in collaboration with charter boat fishing industry to monitor the recovery of rockfish. The COAST surveys are usually conducted on a NOAA ship augmented by a charter vessel and require about 40 survey days. The surveys are confined to offshore banks reported by fishermen as known rockfish habitat. Protocols include the use of multi-frequency active acoustics (38, 70, 120 and 200 kHz) and still and video camera observations using an ROV (Table 1.1 and Appendix A).

Habitat Surveys. The focus of these surveys include adult rockfish essential fish habitat and habitat use of a variety of other species. They are usually conducted on a NOAA ship for about 50 survey days. The protocols include visual observations from ships and submersibles.

Small Boats. Numerous field operations use small boats including for attaching tags to fish. These operations require about 75 survey days.

1.4.2 Surveys conducted in the Eastern Tropical Pacific (ETP)

Marine Mammal Ecosystem Surveys. These surveys are conducted annually during August to December. They are authorized under the MMPA (MMPA/ESA permit 14097); the Center is requesting an LOA for the incidental take of marine mammals associated with ecosystem sampling. As discussed previously for the marine mammal surveys in the CCE, these are large-scale surveys requiring substantial blocks of continuous time on two NOAA ships and about 60-120 survey days (Table 1.1). Results inform status assessments of marine mammal populations. Surveys rotate among geographic areas and include STAR (eastern tropical Pacific), ORCAWALE (west coast EEZ), HICEAS (Pacific Islands), and SPLASH (northern Pacific).

The protocols for these surveys include line transect surveys of marine mammals and seabirds. The marine mammal component of the surveys focuses on observations of schools or aggregations of animals. For a subset of observations survey effort is suspended and aggregations are approached for estimation of aggregation size and species composition. As noted above, MMPA and ESA research permits are obtained for these surveys, as required.

Additional protocols include the use of multi-frequency active acoustics (38, 70, 120 and 200 kHz) (Table 1.1), 2.5 m^2 single-warp Isaacs Kidd Midwater Trawl (IKMT) with 1 mm mesh net for sampling macro-zooplankton, 3 m^2 dip net with 2 mm mesh net for sampling flying fish,

CTD with an array of vertically profiling instruments and bottles to collect water samples at specific depths, and meteorological observations using a wide-range of passive sensors.

Highly Migratory Species (HMS) Surveys. To date, these surveys have not been conducted in the ETP; however, the SWFSC believes they will likely occur during the period 2014-2019. They may be conducted up to 30 days annually during June-July. In addition to deployment of longline gear, protocols include the use of multi-frequency active acoustics (38, 70, 120, 200 and 333 kHz) (Table 1.1).

1.4.3 Surveys conducted in the Antarctic Marine Living Resources area (AMLR)

Antarctic Survey. These surveys are conducted annually during January through March or in August and include the extended area around the South Shetland and South Orkney archipelagos in the Scotia Sea, the eastern section of the Bellingshausen Sea, and the northwestern section of the Weddell Sea. They are usually conducted on a charter vessel and required about 70 survey days.

Shipboard surveys are designed to map the distribution of Antarctic krill relative to the distributions of krill predators (including penguins, pinnipeds, and flying birds) as well as estimate krill biomass within the survey area. The physical and biological environment is also characterized. Protocols include the use of 2.5 m^2 single-warp Isaacs Kidd Midwater Trawl (IKMT) with 505 micron mesh net, multi-frequency active acoustics (38, 70, 120 and 200 kHz), CTD with an array of vertically profiling instruments and water samples at discrete depths, marine mammal and bird observations, and meteorological observations using a wide-range of passive sensors.

The SWFSC is currently investigating use of 4 m^2 single-warp Tucker Midwater Trawl with two 505 micron mesh nets and one 5 mm mesh net for use on these surveys.

Every 2-3 years a bottom trawl is used to assess benthic invertebrates and fish on the continental shelf. Gear used is a towed camera array and a two-warp NET Systems Hard-Bottom Snapper Trawl.

Table 1.1. Summary description of surveys conducted on NOAA vessels and NOAA-chartered vessels for SWFSC.

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
California Current Research Area								
Survey Using Trawl Gear								
Coastal Pelagic Species (CPS) Survey (aka Sardine Survey)	One or two ship survey. Results of survey inform the annual assessment of sardines and the corresponding harvest guideline. Consists of southern and northern portions conducted on two survey vessels. When possible, preference has been for a two-ship survey. The southern portion is done in conjunction with the spring or summer CalCOFI Survey. Protocols similar to CalCOFI with the addition of mid-water trawls conducted near the surface at night to sample adult sardines.	United States (U.S.) West Coast Exclusive Economic Zone (EEZ)	Annually or biennially, April-May or July-August 70 DAS (~35DAS/vessel)	NOAA ship, Charter vessel One or two ship survey	NETS Nordic 264 two-warp rope trawl	Towed near-surface, primarily at night Tow speed: 2-4 knots (kts) Duration: 30 min at intended depth	50 tows	Acoustic pingers, development of marine mammal excluder devices (MMEDs), visual monitoring (limited on night trawl), “move-on” rule.
					Various plankton nets (Bongo, Pairovet, Manta)	Tow speed: 1.5- 2.5 kts for Bongo and Manta; 0 for Pairovet Duration: 10-20 min	75 tows	
					Conductivity Temperature Depth (CTD) and rosette water sampler	Tow speed: 0 Duration: 20-120 min	75 casts	
					Continuous Underway Fish Egg Sampler (CUFES)		Continuous	
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200 kilohertz (kHz)	Continuous	
					Multi-beam echosounder (Simrad ME70) and sonar (Simrad MS70)		Continuous	
Juvenile Rockfish Survey	Targets pelagic phase of juvenile rockfish with nighttime tows. Results of survey inform assessments of several rockfish populations and may soon be used in assessments of Central California salmon productivity.	West Coast EEZ	Annually, May-mid-June 45 DAS	NOAA ship, Charter vessel	Modified Cobb Midwater Trawl	Tow speed: 2 kts Duration: 15 min at intended depth	150 tows	Acoustic pingers, development of marine mammal excluder devices (MMEDs), visual monitoring, “move-on” rule.
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 5-120 min	250 casts	
					Various plankton nets (Bongo and Tucker)	Tow speed: 1.5- 2.5 kts Duration: 20-60 min	50 tows	

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200, 333 kHz	Continuous	
Juvenile Salmon Survey	Measures ocean survival of juvenile salmon and produces early estimate of adult returns. Protocols include surface-water trawls, active acoustics, oceanographic and meteorological measurements. Tissue samples are collected for genetic analysis.	Central CA to southern OR	Annually, June and September 30 DAS total for two surveys	Charter vessel	NETS Nordic 264 two-warp rope trawl	Towed at 15-30 meters (m) deep during daytime Tow speed: 2-4 kts Duration: 30 min at intended depth	50 tows	Acoustic pingers, development of marine mammal excluder devices (MMEDs), visual monitoring, "move-on" rule.
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 20-120 min	50 casts	
					Various plankton nets (Bongo and Tucker)	Tow speed: 1.5- 2.5 kts Duration: 20-60 min	50 tows	
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200, 333 kHz	Continuous	
Surveys Using Longline Gear								
Highly Migratory Species (HMS) Survey	This survey targets blue sharks, shortfin mako sharks, and other HMS as a basis for stock assessments and support for HMS Fishery Management Plans. Information is also obtained about their biology, distribution, movements, stock structure and status, and potential vulnerability to fishing pressure. Surveys involve catching sharks on longline gear, measuring, attaching various tags, and releasing them alive.	Southern to central CA	Annually, June-July 30 DAS	NOAA ship, Charter vessel	Pelagic longline	Mainline length: 2-4 mile set 50 to 75 feet for mako and blue sharks; 300 to 600 feet for swordfish. Gangion length: 10-15 ft. ; 36 ft for swordfish Gangionspacing: 50-100 ft. apart. Hook size and type: 9/0 J hooks for blue and mako sharks; 16/0 and 18/0 offset, stainless circle hooks for swordfish. Soak time: 2-4 hr for most species, up to 8 hr for swordfish	60 sets	Visual monitoring, "move-on" rule, operational adjustments to avoid take.
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 30 min	60 casts	
					Bongo plankton tows	Tow speed: 1.5 kts Duration: 20 min	60 tows	
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200, 333 kHz	Continuous	

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Reproductive Life History Analysis of Sablefish	This survey is conducted to collect adult sablefish for reproduction studies. Surveys involve catching sablefish on longline gear.	Central California (near Bodega Bay)	Monthly (One day per month), 30 DAS	Charter vessel	Small scale longline	75 hooks per line, baited with squid, set at or near the bottom, usually at depths of 360-450m	2-3 sets per trip	"move on" rule if a marine mammal is encountered
Thresher Shark Survey	This survey is conducted to support stock assessment and management of thresher sharks, which are subject to commercial and recreational fisheries. Surveys involve catching sharks on longline gear, measuring and taking tissue samples, attaching various tags, and releasing them alive.	Primarily Southern CA Bight, possibly as far north as Monterey, CA	Annually, September 20 DAS	Charter vessel	Anchored longline	Mainline length: 1-2 mile set at 12 ft. deep Gangion length: 10-15 ft. Gangionspacing: 50-100 ft. apart. Hook size and type:13/0 offset circle hooks for thresher sharks Soak time: 2-4 hr	40 sets	Visual monitoring, "move-on" rule, operational adjustments to avoid take. Use of circle hooks and finfish bait to minimize protected species bycatch and magnitude of injury associated with hooking events.
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 30 min	40 casts	
					Bongo plankton tows	Tow speed: 1.5 kts Duration: 20 min	60 tows	
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200, 333 kHz	Continuous	

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Surveys Using Trawl and /or Longline Gear								
Habitat Surveys (adult rockfish, swordfish)	Surveys include adult rockfish, EFH, habitat use by swordfish	California Current LME	Opportunistically as funds and ship time are available 50 DAS	NOAA ship, Charter	NETS Nordic 264 two-warp rope trawl	Towed near-surface at night Tow speed: 2-3 kts Duration: 30 min at intended depth	10 tows	Visual monitoring, "move-on" rule, acoustic pingers, and MMEDs
					Pelagic longline	Mainline length: 2-12 mile set to 600 feet depending on target species. Gangion length: 36 ft. Gangionspacing: 50-100 ft. apart Hook size and type:16/0 and 18/0 offset, stainless circle hooks for swordfish Soak time: up to 8 hr	20 sets	Visual monitoring, operational adjustments to avoid take. Use of circle hooks and finfish bait to minimize protected species bycatch and magnitude of injury associated with hooking events.
					Bongo plankton tows	Tow speed: 1.5 kts Duration: 20 min	100 tows	
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 30 min	100 casts	
					Oozeki, IKMT, MOCNESS, Tucker nets	Tow speed: 2-3 kts Duration: 20-60 min	50 tows	
					Manned Submersible	1-3 hour dives	10 dives	

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Surveys Using Other Gear								
California Cooperative Oceanic Fisheries Investigation (CalCOFI) **Winter, Spring, Summer and Fall Surveys**	CalCOFI is a partnership of NMFS, California Department of Fish and Game, and Scripps Institution of Oceanography. The survey series was started in 1949 to describe the pelagic ecology of the California Current and its influence on the population dynamics of west coast sardine stocks. Several hundred taxa of marine fishes and zooplankton are monitored along with aspects of their physical and biological environment. Sampling protocols include transects to assess the distribution and abundance of marine mammals and seabirds	San Diego to San Francisco	Four surveys annually in January-February, April, July and October 90 DAS total for four surveys	NOAA ships and University-National Oceanographic Laboratory System fleet (Scripps Institution of Oceanography)	Various plankton nets (Bongo, Pairovet, Manta, PRPOOS)	Tow speed: 1.5- 2.5 knots (kts) for Bongo and Manta; 0 for Pairovet Duration: 10-20 minutes (min)	75-113 stations per survey; 340 samples total	Visual Monitoring
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 20-120 min	340 casts total	
					Various small, towed, fine-mesh nets designed to sample larval and juvenile fish and small pelagic invertebrates (Matsuda-Oozeki-Hu trawl net [MOHT], Isaacs-Kidd Mid-water Trawl[IKMT], MOCNESS, Tucker)	Tow speed: 2-3 kts Duration: 20-60 min	35-85 tows total	
					CUFES		Continuous	
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200 kHz	Continuous	
					Multi-beam echosounder (Simrad ME70) and sonar (Simrad MS70)		Continuous	
Collaborative Optical Acoustical Survey Technology (COAST) Survey	ROV and acoustic surveys of offshore banks designed to monitor recovery of rockfish. Conducted in collaboration with the charter boat fishing industry.	Southern and Central California	Opportunistically as funds and ship time are available 40 DAS	NOAA ship, Charter vessel	Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200, 333 kHz	Continuous	
					Still and video camera images taken from an ROV			

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Marine Mammal and Ecosystem Assessment Surveys	One or two ship surveys are conducted to assess all marine mammal species in west coast EEZ, or to focus on the distribution and ecology of a selected group of species. Protocols include sampling of various ecosystem components.	California Current Large Marine Ecosystem (LME)	Tri-annually (July - Dec) 60-120 DAS total for three surveys	NOAA ship One or two ship survey	Bongo plankton tows	Tow speed: 1.5 kts Duration: 20 min	60 tows	
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 30 min	40 casts	
					Oozeki, IKMT, MOCNESS, Tucker nets	Tow speed: 2-3 kts Duration: 20-60 min	60 tows	
					Expendable bathythermographs (XBTs)		80-240 units	
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200, 333 kHz	Continuous	
Pacific Coast Ocean Observing System (PacOOS) Central CA	Extension of CalCOFI observation protocols to CalCOFI lines off Monterey Bay and San Francisco during summer and fall surveys when the CalCOFI sampling grid is confined to the Southern California Bight. Surveys conducted in conjunction with Monterey Bay Aquarium Research Institute, UC Santa Cruz, and Navy Post-Graduate School	Central CA, fixed survey lines off Monterey and San Francisco Bays	Annually, July and October 6 DAS total for two surveys	Research Vessel (R/V) Point Sur	Various plankton nets (Bongo, CalVET, Pairovet, Manta)	Tow speed: 1.5- 2.5 kts for Bongo and Manta; 0 for Californai Vertical Egg Tow (CalVET) and Pairovet Duration: 10-20 min	40 tows	
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 20-120 min	40 casts	
PacOOS North CA	Extension of CalCOFI observation protocols to a sampling line off Eureka CA. Surveys conducted in conjunction with Humboldt State University.	Northern CA, fixed survey lines off Eureka	Monthly 12 DAS total for 12 surveys	R/V Coral Sea	Various plankton nets (Bongo, CalVET, Pairovet, Manta)	Tow speed: 1.5- 2.5 kts for Bongo and Manta; 0 for CalVET and Pairovet Duration: 10-20 min	100 tows	
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 20-120 min	100 casts	
Swordfish Tagging using Deep-set Buoy Gear	Investigate the use of deep-set buoy gear to capture and tag swordfish without generating significant bycatch interactions	Southern California Bight	Annually, June-November	PIER research vessel *R/V Malolo*, cooperative commercial fishing vessels	Modified swordfish buoy gear to target pelagic swordfish at depths of 250-400 meters during daylight hours	250-400 m mainline monofilament with a buoy flotation system and a 1-2 kilogram (kg) drop sinker. Two monofilament gangions would branch from the mainline at 250-400	300 - 600 sets per year	Minimize slack in the fishing line to maintain a vertical profile and use a high speed electric reel to reduce the time that baits are within the upper water column and minimize potential for marine mammal interactions. Use circle hooks to increase

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
						m and would contain a crimped 14/0 circle hook baited with either squid or mackerel. A single set of gear consists of two baited hooks soaked on average for a 4 hour period.		post-hooking survivorship of non-target species. Visually monitor all of the indicator buoys from the vessel. When an indicator flag rises, the buoy set would immediately be tended and the animal caught would either be released or tagged and released in order to increase post-hooking survivorship of all animals.
White Abalone Survey	Remotely Operated Vessel (ROV) surveys of endangered white abalone to monitor population recovery. Surveys confined to offshore banks, island and continental margins, 30-150 m. depth.	Southern CA Bight	Opportunistically as funds and ship time are available 25 DAS	Charter vessel	Still and video camera images taken from an ROV	Tether connecting ROV to the ship is 0.75 inches diameter Avg. speed: 0.49 kts Max. speed: 2.43 kts	100 transects/yr	Slow operating speed minimizes risk of striking a marine mammal. The tether is securely attached to a steel cable and down-weight to minimize slack and prevent loops that might lead to entanglement risk.
Eastern Tropical Pacific Research Area								
Surveys Using Longline Gear								
HMS Survey	New survey planned for the future to monitor HMS abundance and distribution. Conditional on funding.	Eastern Tropical Pacific Ocean	Annually, June-July 30 DAS	NOAA Ship, Charter vessel	Pelagic longline	Mainline length: 2-4 mile set 50 to 75 feet for mako and blue sharks; 300 to 600 feet for swordfish. Gangion length: 10-15 ft. ; 36 ft for swordfish Gangionspacing: 50-100 ft. apart. Hook size and type: 9/0 J hooks for blue and mako sharks; 16/0 and 18/0 offset, stainless circle hooks for swordfish. Soak time: 2-4 hr; up to 8 hr for swordfish	60 sets	Visual monitoring, “move-on” rule, operational adjustments to avoid take.
					Bongo plankton tows	Tow speed: 1.5 kts Duration: 20 min	60 tows	
					CTD profiler and rosette	Tow speed: 0 kts	60 casts	

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
					water sampler	Duration: 20-120 min		
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200, 333 kHz	Continuous	
Surveys Using Other Gear								
Marine Mammal and Ecosystem Assessment Surveys	Multi-year cetacean and ecosystem assessment study designed to monitor the recovery of several dolphin stocks that were depleted by the yellowfin tuna purse-seine fishery in the ETP Ocean. Protocols include sampling of various ecosystem components.	Eastern Tropical Pacific Ocean	Tri-annually (Jul – Dec) 240 DAS total for three surveys	NOAA ships Two ship survey	Bongo plankton tows	Tow speed: 1.5 kts Duration: 20 min	500 tows	
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 30 min	500 casts	
					Oozeki, IKMT, MOCNESS, Tucker nets	Tow speed: 2-3 kts Duration: 20-60 min	50-125 tows	
					Multi-frequency single-beam active acoustics	18, 38, 70, 120, 200, 333 kHz	Continuous	
					XBTs		720 units	
Antarctic Research Area								
Antarctic Survey	Shipboard surveys monitor the abundance and distribution of krill for stock assessments and studies of the foraging ecology of krill predators including penguins and pinnipeds. Protocols include marine mammal and seabird observations. Every 2-3 years these protocols are augmented with a bottom trawl and towed camera array used to sample benthic invertebrates and fish. Results of the survey inform fish stock assessments and benthic habitat descriptions.	Scotia Sea sector of the Southern Ocean, including the continental shelf adjacent to the Antarctic Peninsula, and the South Shetland, South Orkney, South Sandwich and South Georgia archipelagos	Annually, January-March or Annually, July-October Bottom trawl conducted every 2-3 years 70 DAS	Charter (RVIB Nathaniel B. Palmer)	Oozeki, IKMT, MOCNESS, Tucker nets	Tow speed: 2-3 kts Duration: 20-60 min	200 tows	
					Multi-frequency active acoustics	38, 70, 120 and 200 kHz	Continuous	
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 45 min	200 casts	
					Video camera tows	Tow speed: <3 kts Duration: <65 min	50 tows	
					Two-warp NET Hard-Bottom Snapper Trawl	Tow speed: 2-3 kts Duration: 30 min	100 tows	

2. THE DATE(S) AND DURATION OF SUCH ACTIVITY AND THE SPECIFIC GEOGRAPHICAL REGION WHERE IT WILL OCCUR

2.1 Dates and Duration of Activities

Table 1.1 is a summary of regularly occurring SWFSC surveys conducted on NOAA owned and chartered vessels. These surveys are likely to continue during the next five years, although not necessarily every year.

Some cooperative research projects last multiple years or may continue with modifications. Other projects only last one year and are not continued. Therefore, not all of the projects summarized in Table 1.1 are likely to continue in the future. Actual projects that will occur from 2014 through 2019 depend on competitive grant processes and congressional funding levels for the SWFSC, which are inherently uncertain.

- While some surveys are consistently conducted every year (Table 1.1), they are often based on randomized sampling designs so the exact location of survey effort varies year to year in the same general area.
- Some surveys are only conducted every two or three years or when funding is available. Timing of the surveys is a key element of their design but sea and atmospheric conditions as well as ship contingencies often dictate what can happen on any given day or whether scheduled surveys actually occur so there is variability inherent in even the most consistently conducted surveys.
- In addition, the cooperative research program is designed to provide flexibility on a yearly basis in order to address issues as they arise.

Most cooperative research projects go through an annual competitive selection process to determine which projects should be funded based on proposals developed by many independent researchers and fishing industry participants. Because the need for different kinds of fisheries information changes over time and overall funding levels vary with annual congressional appropriations, the priorities for funding different kinds of projects change regularly, which makes it difficult to know what will be funded in the next several years.

2.2 Geographic Region Where the Activity Will Occur

SWFSC research is conducted in three geographic areas that correspond to the California Current Ecosystem (CCE), Eastern Tropical Pacific (ETP), and Antarctic marine living resources (AMLR) ecosystem (Figures 2.1, 2.2, 2.3).

2.2.1 California Current Ecosystem

The SWFSC conducts research surveys in the CCE, both inside and outside of the Large Marine Ecosystem (LME) boundaries. The California Current LME has a surface area of about 2.2 million km² and is bordered by the U.S. and Mexico. The California Current moves south along the western coast of North America, beginning off southern British Columbia, flowing southward past Washington, Oregon and California, and ending off southern Baja California (Bograd et al. 2010). The California Current is part of the North Pacific Gyre and brings cool waters southward. Additionally, extensive upwelling of colder sub-surface waters supports large populations of whales, seabirds and important fisheries along the west coast of the U.S. (Sherman and Hempel 2009). The California Current LME includes coastal areas where SWFSC

conducts research surveys for rockfish, coastal pelagics and numerous other species. However the SWFSC also conducts research that extends into deeper waters beyond the California Current LME boundary.

On the shoreward side of the California Current, the California Current Front (CCF) separates cold, low-salinity upwelled waters from the warmer saltier waters close to shore. Offshore frontal filaments transport the frontal water across the entire LME. In winter, the Davidson Current Front forms along the boundary between inshore subtropical waters and colder offshore temperate and subarctic waters (Sherman and Hempel 2009).

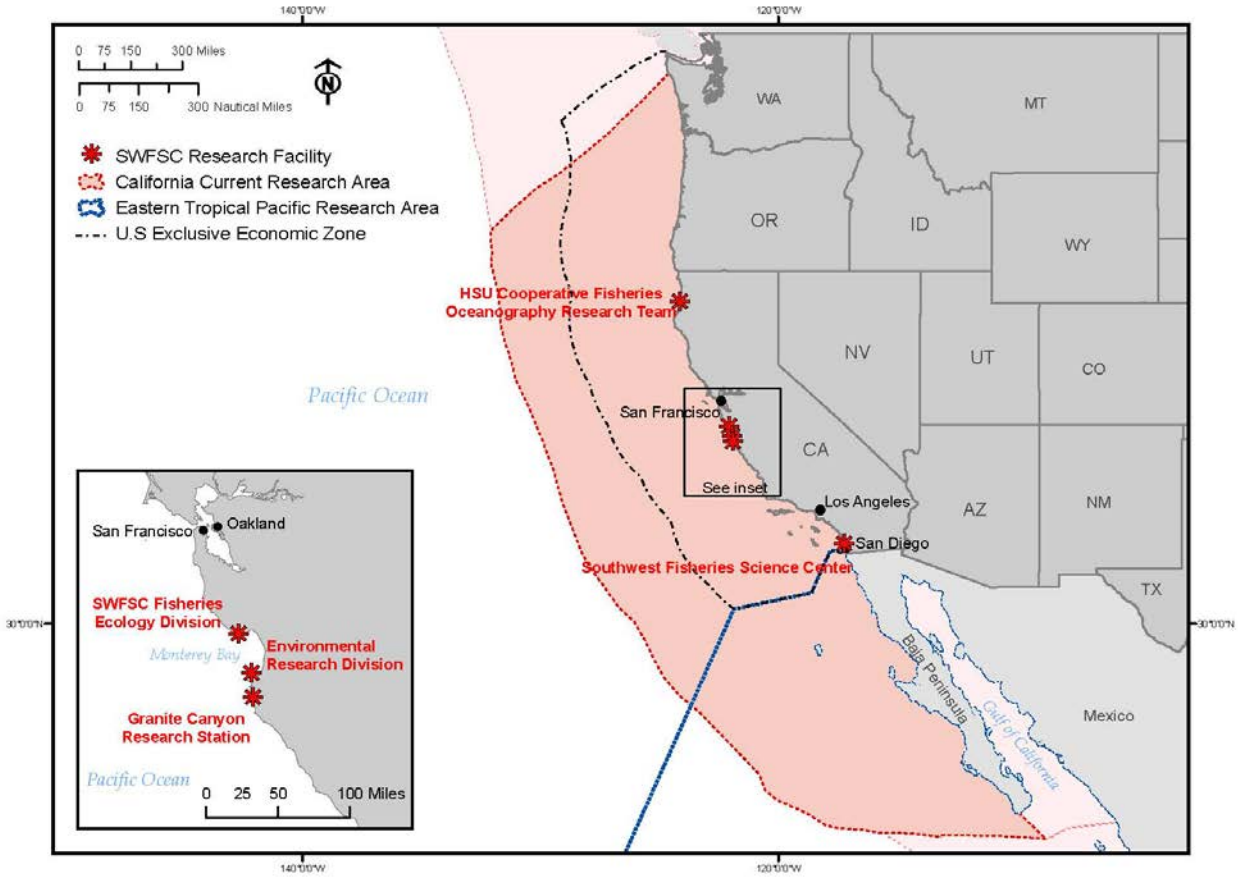

Figure 2.1 California Current Ecosystem (CCE) research area and facilities.

2.2.2 Eastern Tropical Pacific

The eastern tropical portion of the Pacific Ocean extends from San Diego west to Hawaii and south to Peru. Located between the subtropical gyres of the North and South Pacific, this area is one of the most productive tropical oceans in the world. Cool, low-salinity eastern boundary current waters flow into the ETP from the north and south, while warm, high-salinity subtropical surface waters flow into the ETP after being subducted into the thermocline primarily in the southern Subtropical Convergence. As a result of upwelling, the surface layer has relatively cool temperatures, high salinity, and high nutrient concentrations along the equator, coastal Peru and Baja California, and at the Costa Rica Dome. Nutrient-rich thermocline waters lie close to the

surface along the countercurrent thermocline ridge between the North Equatorial Countercurrent and the North Equatorial Current. Deep and bottom waters formed in the Antarctic and North Atlantic are relatively homogeneous in the ETP (Fiedler and Lavın 2006).

The SWFSC's ETPRA spans the boundaries of several LMEs, including the California Current LME, the Gulf of California (Sea of Cortez) LME, the Pacific-Central American Coastal LME, and the Humboldt Current LME. The Research Area also includes a large portion of the offshore ETP Ocean outside of coastal LME boundaries (Sherman and Hempel 2009).

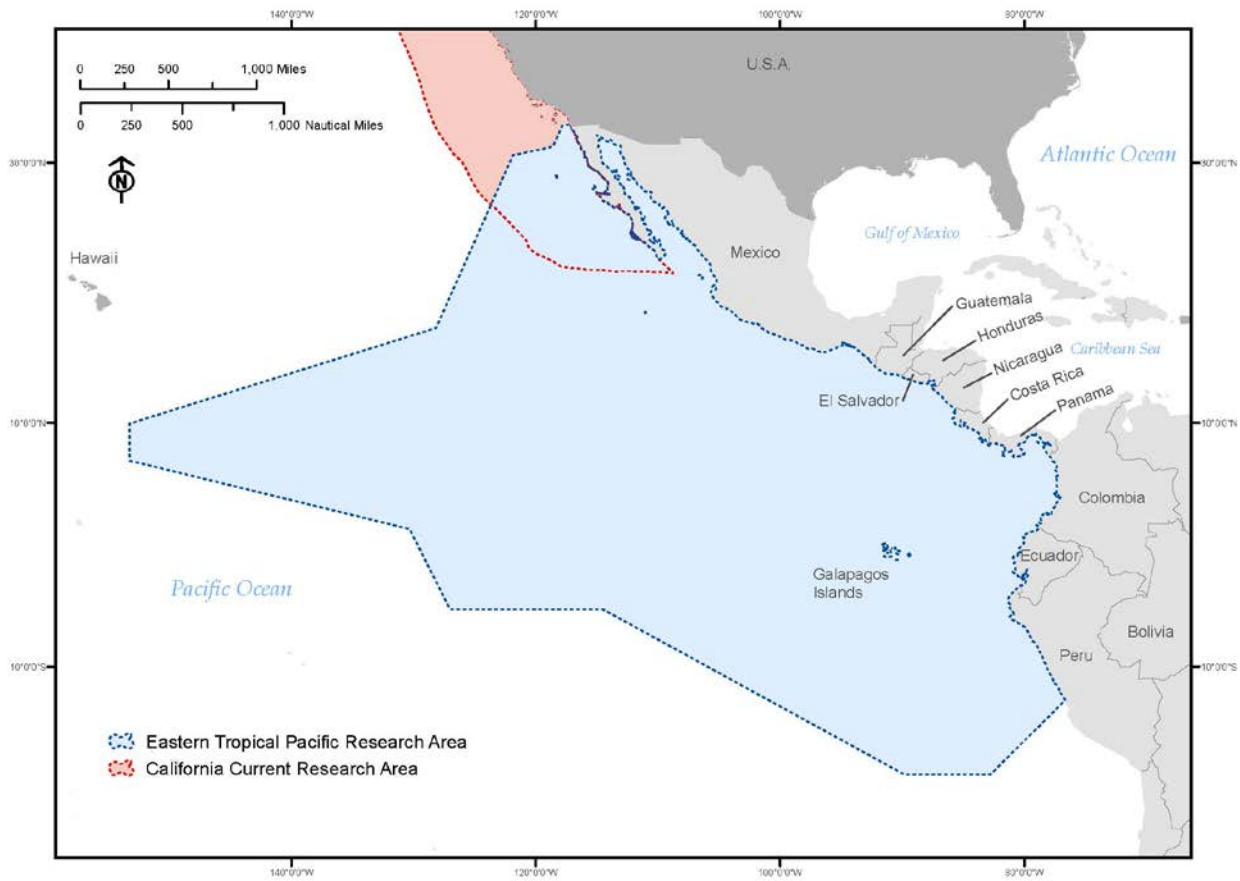

Figure 2.2 Eastern Tropical Pacific (ETP) research area.

2.2.3 AMLR

The AMLR region includes the waters encircling Antarctica south of 60°S latitude. Cold waters flowing north from Antarctica mix with warm sub-Antarctic waters in the Antarctic Ocean. There are only limited areas of shallow waters in the Southern Ocean, where the average depth is between 4,000 and 5,000 meters (13,000 to 16,000 ft) over most of its extent. The Antarctic Circumpolar Current moves eastward and comprises the world's longest ocean current. The keystone species of the Antarctic ecosystem is the Antarctic krill which provides an important food source for many species of marine mammals, seabirds, and fishes (SWFSC 2010).

The SWFSC's survey activities are usually conducted within the Antarctic large marine ecosystem (LME), the northern boundary of which is defined by the Antarctic Convergence. The location of the Antarctic Convergence oscillates between 48 and 60 degrees south and represents the boundary between cold Antarctic Surface water and warmer sub-Antarctic waters (Sherman and Hempel 2008)

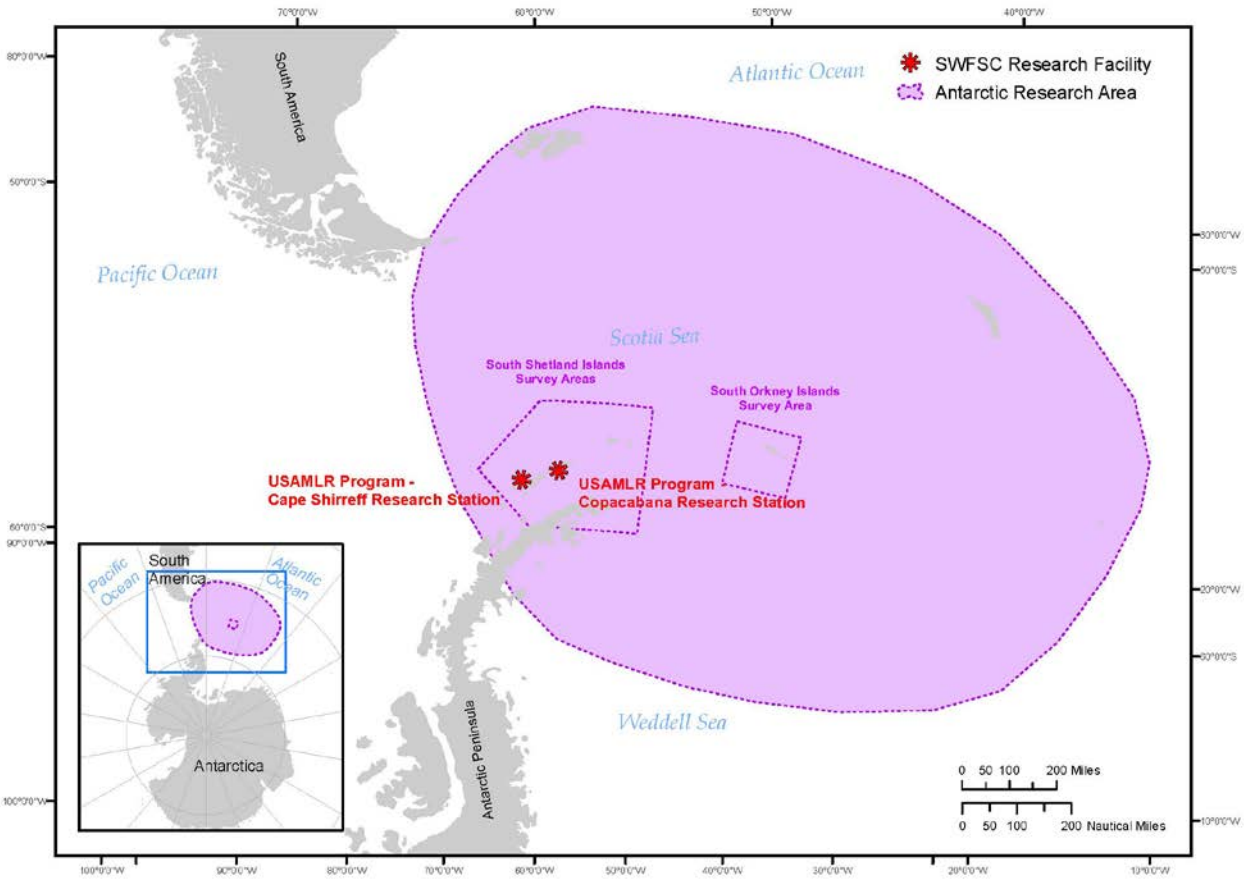

Figure 2.3 Antarctic research area and facilities.

3. SPECIES AND NUMBERS OF MARINE MAMMALS LIKELY TO BE FOUND WITHIN THE ACTIVITY AREA

Marine mammal abundance estimates in this application represent the total number of individuals that make up a given stock or the total number estimated within a particular study area. NMFS stock abundance estimates for most species represent the total estimate of individuals within the geographic area, if known, that comprises that stock. For some species, this geographic area may extend beyond U.S. waters. Survey abundance (as compared to stock or species abundance) is the total number of individuals estimated within the survey area, which may or may not align completely with a stock's geographic range as defined in the NMFS Stock Assessment Reports (SARs) (http://www.nmfs.noaa.gov/pr/sars/region.htm). These surveys may also extend beyond U.S. waters. Both stock abundance and survey abundance are used in this

application when available to determine a density of marine mammal species within the survey area.

The species and approximate numbers of marine mammals likely to be found in the three SWFSC activity areas are shown in Tables 3.1 – 3.4. Extralimital species are not included. These are species that do not normally occur in the survey area for which there are one or more records that are considered beyond the normal range; these species that are not likely to be 'taken' pursuant to the MMPA during survey operations are not included in the take request. For the CCE extralimital species include Bryde's whale (*Balaenoptera edeni*) and the North Pacific right whale (*Eubalaena japonica).* For the Eastern Tropical Pacific (ETP) extralimital species include the pygmy sperm whale (*Kogia breviceps*), Burmeister's porpoise (*Phocoena spinipinnis*), long-finned pilot whales (*Globicephala melas*), southern bottlenose whale (*Hyperoodon planifrons*) and Dall's porpoise (*Phocoenoides dalli*); and for the AMLR extralimital species include the pygmy right whale (*Caperea marginata*), Shepherd's beaked whale (*Tasmacetus shepherdi*), strap-toothed beaked whale (*Mesoplodon layardii)*, Gray's beaked whale (*Mesoplodon grayi*), Cuvier's beaked whale (*Ziphius cavirostris)* and sei whale (*Balaenoptera borealis*), which have distributions that only border the northernmost edge of the AMLR study area. Ross seal (*Ommatophoca rossii*) is also considered extralimital to the AMLR study area due to its preference for dense pack ice, an area that is not part of the AMLR survey.

Table 3.1 lists the twenty-three cetacean species (of which *Mesoplodon* spp. includes six beaked whale species) and six pinniped species that occur in the waters of the CCE. The list includes six cetacean species that are also listed as endangered under the ESA (southern resident killer, sperm, blue, fin, sei, and humpback whales), two pinnipeds listed as threatened under the ESA (eastern subspecies of Steller sea lion and Guadalupe fur seal) and one pinniped designated as depleted under the MMPA (Pribilof Islands stock of northern fur seal). As seen in Table 1.1, SWFSC survey activity occurs during most months of the year; trawl surveys occur during May through June and September and longline surveys are during June/July and September. The CalCOFI surveys occur during January-February, April, July and October. Thus many of the marine mammal species that occur in the CCE may be present when surveys occur. However most survey activity occurs offshore and is unlikely to interact with coastal species such as harbor porpoise or gray whales migrating north. Although sea otters are found in the CCE, they are not included in Table 3.1. Sea otters are under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS) and a separate MMPA permit application for sea otters will be sent to the USFWS. Sea otters will not be discussed further in this application.

Table 3.2 lists the thirty marine mammal species occurring within the ETP Research Program's study area. The list includes twenty-six cetaceans and four pinniped species. The list includes five cetacean species that are also listed as endangered under the ESA (sperm, blue, fin, sei, and humpback whales) and three stocks of dolphin designated as depleted under the MMPA (northeastern offshore pantropical spotted, eastern spinner and coastal pantropical spotted dolphins). The marine mammal surveys currently conducted by the SWFSC in the ETP occur triannually July- December (Table 1.1). Marine mammal species that occur in the ETP may interact with these surveys.

Table 3.3 lists the twelve cetacean species and five pinniped species that occur in the waters of the AMLR Survey area. The list includes four cetacean species that are also listed as endangered under the ESA (blue, fin, humpback, and southern right whales). The AMLR surveys occur annually during January-March or August-October (Table 1.1) and may interact with marine mammals that occur in the survey area.

Marine mammals are seen from vessels while in transit to the AMLR survey areas or to and from AMLR field camps, primarily within the Drake Passage, the Sub-Antarctic, and waters around South America. Sighted species include the sei, fin, southern right, and humpack whales, which are listed as endangered on the ESA, as well as the following that are not listed: Commerson's dolphin, black (Chilean) dolphin, southern right-whale dolphin, Peale's dolphin, dusky dolphin, Risso's dolphin, Gray's beaked whale, strap-toothed beaked whale, Cuvier's beaked whale, dwarf minke whale, sub-Antarctic fur seal, South American fur seal, leopard seal, Weddell seal and South American sea lion. These animals are seen from various vessels used to transport Center scientists to the Antarctic. The vessel operators may use passive and active acoustic gear while transiting to collect baseline environmental data. Center scientists have no control over the operation of this gear; and they are not conducting scientific research during this transit other than visual surveys. Therefore, the Center has concluded that marine mammal species in the transit area should be treated like species present during other vessel transits and will not be considered further in the take request by the Center.

For completeness and to avoid redundancy, the required information about all marine mammal species and numbers of species (insofar as it is known), are included in section 4.

Table 3.1. Marine mammals that occur in the California Current Ecosystem (CCE)[1], their status under the Endangered Species Act and Marine Mammal Protection Act, and estimated numbers and density in the CCE. Density estimates were calculated from line-transect surveys in waters from the California/Mexican border to northern Washington. The transect lines followed a grid that was established before each survey to uniformly cover waters between the coast and approximately 556 km (300 nmi) offshore (Barlow and Forney 2007).

Common Name	**Scientific Name**	**Federal ESA/MMPA Status[2]**	**Estimated Minimum Number in the CCE[3]**	**Best Estimate[3]**	**Density/100 0 km^2 (footnote 3)**
Cetaceans					
Harbor porpoise	*Phocoena phocoena*	--	Morro Bay stock = 1,478 Monterey Bay stock = 1,079 San Fran. /Russian R. = 6,745 N. CA/S. OR = 28,233	Morro Bay stock = 2,044 Monterey Bay stock = 1,492 San Fran. /Russian R. = 9,189 N. CA/S. OR = 39,581	Not determined
Dall's porpoise	*Phocoenoides dalli*	--	32,106	42,000	75.53
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	--	21,406	26,930	20.93
Risso's dolphin	*Grampus griseus*	--	4,913	6,272	10.46
Bottlenose dolphin	*Tursiops truncatus*	--	California coastal = 290; offshore = 684	California coastal = 323; offshore = 1,006	1.78
Striped dolphin	*Stenella coeruleoalba*	--	8,231	10,908	16.67
Short-beaked common dolphin	*Delphinus delphis*	--	343,990	411,211	309.35
Long-beaked common dolphin	*Delphinus capensis*	--	17,127	27,046	19.24
Northern right-whale dolphin	*Lissodelphis borealis*	--	6,019	8,334	9.75
Killer whale[4]	*Orcinus orca*	endangered	S. resident = 86 Transient = 354 Offshore = 162	S. resident = 86 Transient = 354 Offshore = 240	0.71
Short-finned	*Globicephala*	--	465	760	0.31

pilot whale	*macrorhynchus*				
Baird's beaked whale	*Berardius bairdii*	--	615	907	0.88
Mesoplodont beaked whales[5]	*Mesoplodon* spp**.**	--	576	1,024	1.03
Cuvier's beaked whale	*Ziphius cavirostris*	--	1,298	2,143	3.82
Pygmy sperm whale	*Kogia breviceps*	--	271	579	1.09
Dwarf sperm whale	*Kogia sima*	--	No estimate	No estimate	1.09
Sperm whale	*Physeter macrocephalus*	endangered	751	971	1.70
Humpback whale	*Megaptera novaeangliae*	endangered	1,878	2,043	0.83
Blue whale	*Balaenoptera musculus*	endangered	2,046	2,497	1.36
Fin whale	*Balaenoptera physalus*	endangered	2,624	3,044	1.84
Sei whale	*Balaenoptera borealis*	endangered	83	126	0.09
Common Minke whale	*Balaenoptera acutorostrata scammoni*	--	202	478	0.72
Gray whale	*Eschrichtius robustus*	--	18,017	19,126	19.13
Pinnipeds		--			
California sea lion	*Zalophus californianus*	--	153,337	296,750	Not determined
Steller sea lion eastern subspecies[6]	*Eumetopias jubatus monteriensis*	threatened	52,847	58,334-72,223	Not determined
Guadalupe fur seal	*Arctocephalus townsendi*	threatened	3,028	7,408	Not determined
Northern fur seal	*Callorhinus ursinus*	depleted (Pribilof Islands stock only)	San Miguel Is. = 5,395; Pribilof Islands = 642,265	San Miguel = 9.968 P.I. = 653,171	Not determined
Harbor seal	*Phoca vitulina richardsi*	--	CA stock = 26,667 OR/WA = no estimate WA Inland = no estimate	CA stock =30,196 OR/WA unk; WA inland unk	Not determined
Northern elephant seal	*Mirounga angustirostris*	--	74,913	124,000	Not determined

[1] Does not include extralimital species or sea otters.
[2] Denotes ESA listing as either endangered or threatened, or MMPA listing as depleted.
[3] Allen and Angliss (2012), Barlow and Forney (2007), Carretta et al. (2011, 2012), Man-Tec 2007, and see Section 4 below.
[4] Southern Resident Killer Whales that occur in Puget Sound and other locals are listed as endangered under the ESA. All other forms of killer whale that occur in the CCE are not listed under the ESA.
[5] Six *Mesoplodon* spp. beaked whale species occur in the offshore waters of the California Current Ecosystem including Stejneger's, Hubb's, Blainville's, Perrin's, Lesser, and Gingko-toothed beaked whales.
[6] A recent paper has proposed that the two Steller sea lion stocks (eastern and western) be designated as two subspecies (Phillips et al. 2009). Presently the eastern subspecies, which includes those that breed in the California Current Ecosystem, is listed as threatened under the US Endangered Species Act; the western subspecies is listed as endangered.

Table 3.2. Marine mammal species occurring within the Eastern Tropical Pacific (ETP)[1] Research Program's study area, their status under the ESA and MMPA, and estimated numbers in the ETP, if available. The estimated number in the ETP presented in this table is the best estimate available for these marine mammal species.

Common Name	Scientific Name	Federal ESA/MMPA Status[2]	Estimated Number in the ETP[3]	Density/1000 km^2 (see footnote 4)
Cetaceans				
Risso's dolphin	*Grampus griseus*	--	110,457	5.173
Short-beaked common dolphin	*Delphinus delphis*	--	3,127,203	146.453
Long-beaked common dolphin[5]	*Delphinus capensis*	--	372,429	19.45
Rough toothed dolphin	*Steno bredanensis*	--	107,663	5.042
Striped dolphin	*Stenella coeruleoalba*	--	964,362	45.163
Spinner dolphin	*Stenella longirostris*	depleted (eastern stock)	White belly =734,837 East.=1,062,879 Centr. Amer.=no est.	White belly =34.414 Eastern =49.777 Central Amer.= Not determined
Pantropical Spotted dolphin	*Stenella attenuata*	depleted (coastal and northeastern offshore stocks)	NE offshore = 857,884 W/S offshore = 439,208 coastal = 278,155	NE offshore =122.625 W/S offshore =30.592 Coastal =43.435
Dusky dolphin[5]	*Lagenorhynchus obscurus*	--	40,211	2.10
Fraser's dolphin	*Lagenodelphis hosei*	--	289,300	13.548
Melon-headed whale	*Peponocephala electra*	--	45,400	2.126
Bottlenose dolphin	*Tursiops truncatus*	--	335,834	15.728
Killer whale	*Orcinus orca*	--	8,500	0.398
False killer whale	*Pseudorca crassidens*	--	39,800	1.864
Pygmy killer whale	*Feresa attenuata*	--	38,990	1.826
Short-finned pilot whale	*Globicephala macrorhynchus*	--	589,315	27.599
Cuvier's beaked whale	*Ziphius cavirostris*	--	20,000	0.937
Longman's beaked whale[5]	*Indopacetus pacificus*	--	1,007	0.037
Mesoplodont beaked whales	*Mesoplodon spp.*	--	25,300	1.185
Sperm whale	*Physeter macrocephalus*	endangered	4,145	0.194
Dwarf sperm whale	*Kogia sima*	--	11,200	0.525
Humpback whale[5]	*Megaptera novaeangliae*	endangered	2,566	0.134

Blue whale	*Balaenoptera musculus*	endangered	1,415	0.194
Fin whale[5]	*Balaenoptera physalus*	endangered	574	0.03
Sei whale[5]	*Balaenoptera borealis*	endangered	0	0
Common Minke whale[5]	*Balaenoptera acutorostrata scammoni*	--	115	0.006
Bryde's whale	*Balaenoptera edeni*	--	10,411	0.488
Pinnipeds				
California sea lion[6]	*Zalophus californianus*	--	105,000	Not determined
Guadalupe fur seal	*Arctocephalus townsendi*	--	No ETP est.	Not determined
South American sea lion[7]	*Otaria flavescens*	--	150,000	Not determined
Northern elephant seal	*Mirounga angustirostris*	--	No ETP est.	Not determined

[1] Does not include extralimital species.
[2] Denotes ESA listing as either endangered or threatened, or MMPA listing as depleted. All marine mammal stocks are considered protected under the MMPA.
[3] See Section 4.
[4] Densities calculated from Gerrodette et al. 2008. Abundance estimates divided by the whole ETP area, which is the sum of the stratum areas given in the first line of Table 1 of Gerrodette et al. 2008. The exception is the area for NE offshore spotted dolphins, which is the sum of Core, Core2 and N Coastal stratum areas; for the WS spotted dolphins area it is the sum of the Outer and S Coastal areas; and for coastal spotted dolphins the area is the sum of the N Coastal and Core areas.
[5] Densities calculated from abundance reported in Wade and Gerrodette (1993) or, for those not reported in that publication, density was calculated from sighting data collected on board SWFSC cetacean and ecosystem assessment surveys in the ETP during 1998-2000, 2003 and 2006 using number of sightings (n), mean group size (s), total distance on effort (L) and effective strip width (w) as D = n*s/2/w/L
[6] Lowry and Maravilla 2005, Szteren et al. 2006
[7] IUCN Red List of Threatened Species (*www.iucnredlist.org*)

Table 3.3. Marine mammal species occurring within the Antarctic Marine Living Resources (AMLR)[1] Program's study area, their status under the ESA and MMPA, and estimated numbers in the AMLR area, if available. The estimated number in the AMLR survey area presented in this table is the best estimate available for these marine mammal species.

Common Name	Scientific Name	Federal ESA/MMPA Status[2]	Estimated Number in the AMLR	Estimated Density (see footnote 3)
Cetaceans				
Spectacled porpoise[6]	*Phocoena dioptrica*	--	Not determined	0.0015/km^2
Hourglass dolphin	*Lagenorhynchus cruciger*	--	Not determined	0.0015/km
Killer whale	*Orcinus orca*	--	Not determined	0.0015/km
Sperm whale[5]	*Physeter macrocephalus*	endangered	Not determined	0.00065/km^2
Arnoux's beaked whale[6]	*Berardius arnuxii*	--	Not determined	0.0006/km^2
Southern bottlenose whale	*Hyperoodon planifrons*	--	Not determined	0.0006/km
Long-finned pilot whale	*Globicephala melas*	--	Not determined	0.0076/km
Antarctic Minke whale	*Balaenoptera bonaerensis*	--	18,125[4]	0.0018/km
Southern Right whale	*Eubalaena australis*	endangered	1,755[4]	0.00041/km^2
Fin whale	*Balaenoptera physalus*	endangered	4,672[4]	0.0839/km^2
Blue whale[7]	*Balaenoptera musculus*	endangered	Not determined	0.00012/km
Humpback whale	*Megaptera novaeangliae*	endangered	9,484[4]	0.0361/km
Pinnipeds			Not determined	
Antarctic fur seal	*Arctocephalus gazella*	--	Not determined	0.0999/km
Southern elephant seal	*Mirounga leonina*	--	Not determined	0.0003/km
Crabeater seal[6]	*Lobodon carcinophaga*	--	Not determined	0.649/km^2
Weddell seal[6]	*Leptonychotes weddelli*	--	Not determined	0.054/km^2

Leopard seal	*Hydruga leptonyx*	--	Not determined	0.0003/km

[1] Does not include extralimital species.
[2] Denotes ESA listing as either endangered or threatened, or MMPA listing as depleted. All marine mammal stocks are considered protected under the MMPA.
[3] See Section 4 below, and for some species density estimates are available based on marine mammal sightings during 2008/2009 SWFSC AMLR surveys. The following species densities were estimated using strip transect methods during AMLR surveys: hourglass dolphin, killer whale, southern bottlenose whale, long finned pilot whale, humpback whale, Antarctic fur seal, southern elephant seal, leopard seal. These densities are depicted as the number of animals for each km of trackline surveyed.
[4] Reilly et al. (2004)
[5] Whitehead (2002)
[6] IUCN Red List Assessment (iucnredlist.org)
[7] Branch et al. (2007)

4. A DESCRIPTION OF THE STATUS, DISTRIBUTION, AND SEASONAL DISTRIBUTION (WHERE APPLICABLE) OF THE AFFECTED SPECIES OR STOCKS OF MARINE MAMMALS LIKELY TO BE AFFECTED BY SUCH ACTIVITIES

The following information summarizes data on the affected species, status and trends, distribution and habitat preferences, behavior and life history, and auditory capabilities, as available in published literature and reports, including marine mammal stock assessment reports.

Additionally, Southall et al. (2007) provided a comprehensive review of marine mammal acoustics including designating functional hearing groups. Table 4.1 presents the functional hearing groups and representative species or taxonomic groups for each, although most species found in the project area are in the first two groups, low frequency cetaceans (baleen whales) and mid frequency cetaceans (odontocetes). General reviews of cetacean and pinniped sound production and hearing may be found in Richardson et al. (1995), Edds-Walton (1997), Wartzok and Ketten (1999), and Au (2000).

Table 4.1. Summary of the five functional hearing groups of marine mammals (based on Southall et al. 2007 and modified from DON 2008b).

Functional Hearing Group	**Estimated Auditory Bandwidth**	**Species or Taxonomic Groups**
Low frequency cetaceans (Mysticetes–Baleen whales)	7 Hz to 22 kHz (best hearing is generally below 1000 Hz, higher frequencies result from humpback whales)	All baleen whales
Middle frequency Cetaceans (Odontocetes)	150 Hz to 160 kHz (best hearing is from approximately 10-120 kHz)	Most delphinid species including rough-toothed, bottlenose, spinner, common, white-sided, Risso's and right whale dolphins; medium and large odontocete whales including melon-headed pygmy killer, false killer, killer whale, pilot sperm whale, and beaked whales
High frequency cetaceans (Odontocetes)	200 Hz to 180 kHz (best hearing is from approximately 10-150 kHz)	Porpoise species including the harbor, finless, and Dall's porpoise; the dwarf and pygmy sperm whales).
Pinnipeds in water	75 Hz to 75 kHz (best hearing is from approximately 1-30 kHz)	All seals, fur seals, sea lions
Pinnipeds in air	75 Hz to 30 kHz (best hearing is from approximately 1-16 kHz)	All seals, fur seals, sea lions

4.1 California Current Ecosystem (CCE)

As mentioned above, sea otters and extralimital species are not included. For the CCE, extralimital species include Bryde's whale (*Balaenoptera edeni*) and the North Pacific right whale (*Balaena japonica*).

Cetaceans

4.1.1 Harbor Porpoise (*Phocoena phocoena*) Morro Bay, Monterey Bay, San Francisco-Russian River, and Northern California-Southern Oregon Stocks

Description: Harbor porpoise are one of the smaller porpoises and have a short, stocky body. On average females reach 1.6 m in length and 60 kg while males reach 1.4 m and 50 kg (Bjørge and Tolley 2009). The body is dark gray dorsally with the chin and ventral surfaces a contrasting white that sweeps up the mid flanks (ibid). They have a small triangular dorsal fin that facilitates recognition when swimming but are also known to lie on the surface (ibid). Harbor porpoise tend to avoid ships and rarely bow ride.

Status and trends: Harbor porpoise belong to the Order Cetacea, Suborder Odontoceti, and Family Phocoenidae. Within the CCE geographic area four stocks are recognized: Morro Bay, Monterey Bay, San Francisco-Russian River, and Northern California-Southern Oregon. Two additional harbor porpoise stocks are recognized within Washington inland waters and coastal Oregon/Washington but are not discussed in this review.

Morro Bay stock: Based on 2002-2007 aerial surveys conducted under good survey conditions the estimate of abundance for this stock is 2,044 animals (Carretta et al. 2012). The minimum population estimate is 1,478 animals with a Potential Biological Removal (PBR)[1] of 15 animals. There has been an increasing trend in porpoise abundance in the Morro Bay stock since 1988, perhaps partly due to emigration of animals from the Monterey Bay stock.

Monterey Bay: Based on 2002-2007 aerial surveys under good survey conditions the estimate of abundance for this stock is 1,492 animals (Carretta et al. 2012). The minimum population estimate is 1,079 animals with a PBR of 10 animals. Abundance estimates from aerial surveys conducted between 1988 and 2007 show evidence of a declining trend, though this decline is not statistically significant.

San Francisco-Russian River: Based on 2002-2007 aerial surveys under good survey conditions the estimate of abundance for this stock is 9,189 animals (Carretta et al. 2012). The minimum population estimate is 6,745 animals with a PBR of 67 animals. Abundance of the San Francisco-Russian River harbor porpoise stock appeared to be stable or declining between 1988 and 1991 and has steadily increased since 1993.

[1] Potential Biological Removal (PBR) Level is defined by the MMPA as the maximum number of animals, not including natural mortalities, which may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. The PBR level is the product of the minimum population estimate of the stock; one-half the maximum theoretical or estimated net productivity rate of the stock at a small population size; and a recovery factor of between 0.1 and 1.0.

Northern California-Southern Oregon: Based on pooled 2002-2007 aerial survey data including data from both inshore and offshore areas, an updated estimate of abundance for the northern California-southern Oregon harbor porpoise stock is 39,581 harbor porpoise. This estimate represents a combined estimate of aerial surveys completed between 2002-2007 by SWFSC (Carretta et al. 2012) and unpublished data from the National Marine Mammal Laboratory. The minimum population estimate for harbor porpoise in northern California-southern Oregon is 28,833 animals with a PBR of 577 animals. Because the northern boundary of this stock has changed two times in recent years, trends in abundance have been examined only for the northern California portion of this stock. A possible increasing trend in abundance is apparent from surveys conducted between 1989 and 2007, but the trend is not statistically significant (Carretta et al. 2012). ManTech (2007) estimated a density of 1.12 harbor porpoise/km^2 in the coastal and inland waters of Washington but there are no density estimates for coastal waters of the CCE in the SWFSC survey areas.

Harbor porpoise are not listed as "threatened" or "endangered" under the ESA or as "depleted" under the MMPA. The average annual human-caused mortality for all but the Monterey Bay stock is estimated to be less than the PBR, and therefore they are not classified as a "strategic" stock under the MMPA. However, fishery-related mortality of harbor porpoise still occurs in the Monterey Bay stock's range, though the bycatch levels and responsible fisheries are unknown. Because the overall level of fishery mortality is unknown relative to the PBR it cannot be considered to be insignificant and approaching zero mortality and serious injury rate. Although there is uncertainty regarding the observed levels of fishery-related mortality for the Monterey Bay stock, documented human caused mortality is less than the PBR, thus this stock is not considered "strategic" under the MMPA (Carretta et al. 2012).

Distribution and habitat preferences: Harbor porpoises are distributed throughout the coastal waters of the North Pacific, North Atlantic, and Black Sea. In the eastern North Pacific they occur from Point Conception, California to Alaska and across to Russia (Carretta et al. 2012). Harbor porpoise along the west coast of North America are not panmictic or migratory, and movement is sufficiently restricted that genetic differences have evolved. Recent preliminary genetic analyses of samples ranging from Monterey Bay, California to Vancouver Island, British Columbia indicate that there is small-scale subdivision within the U.S. portion of this range. They are typically found in small groups of 1-3 individuals often consisting of a female-calf pair, but larger groups are not uncommon (Bjørge and Tolley 2009). The species frequents inshore areas, shallow bays, estuaries, and harbors. Harbor porpoises are found almost exclusively shoreward of the 200 m contour line, with the vast majority found inside the 50 m curve (Gearin and Scordino 1995; Osmek et al. 1996). A radio-tagged animal remained over deep water of the southern Strait of Georgia (200 m) and movements were confined to a 65 square kilometer area of the capture site off Orcas Island, Washington (Hanson et al. 1999).

Behavior and life history: Harbor porpoises calve and breed throughout the range, and they generally give birth in summer from May through July. Calves remain dependent for at least six months (Leatherwood et al. 1982). Harbor porpoise are usually shy and avoid vessels; thus, they are difficult to approach. Harbor porpoise often feed near bottom in waters less than 200 m deep on bottom-dwelling fishes and small pelagic schooling fishes with high lipid content; herring and anchovy are common prey (Bjørge and Tolley 2009; Leatherwood and Reeves 1986).

Acoustics and hearing: The harbor porpoise has the highest upper-frequency limit of all odontocetes investigated. Kastelein et al. (2002) found that the range of best hearing was from 16 to 140 kHz, with a reduced sensitivity around 64 kHz. Maximum sensitivity (about 33 dB re 1 μPa) occurred between 100 and 140 kHz. This maximum sensitivity range corresponds with the peak frequency of echolocation pulses produced by harbor porpoises (120–130 kHz). Harbor porpoise are in the high-frequency functional hearing group, whose estimated auditory bandwidth is 200 Hz to 180 kHz (Southall et al. 2007). Their vocalizations range from 110 to 150 kHz (DON 2008a) (Table 4.1).

4.1.2 Dall's Porpoise (*Phocoenoides dalli*) California, Oregon, Washington Stock

Description: Dall's porpoises are a stocky, medium sized porpoise with a wide-based dorsal fin that is topped with white pigment. The tail stock is deepened and there is a noticeable beak; the flippers and fluke are small (Jefferson 2009a). Males are somewhat larger than females but both may reach a length of about 2.2 m and weigh about 150 kg or more. The body is black with a large white flank patch that extends to the level of the dorsal fin. They are extremely fast in the water and are often misidentified as 'baby killer whales' (Osborne et al. 1988).

Status and trends: Dall's porpoise belong to the Order Cetacea, Suborder Odontoceti, and Family Phocoenidae. Up to ten populations or stocks are recognized, one of which is the California/Oregon/Washington stock. An estimated 42,000 Dall's porpoises were estimated in the California, Oregon, and Washington population (Carretta et al. 2012). The minimum population estimate is 32,106 Dall's porpoise with a PBR of 257 animals. They were the most common small cetacean observed in ship surveys off the Washington coast from 1995 to 2002 with 115 sightings of 406 animals and mean group size of 3.6 animals (Barlow and Forney 2007). Additional numbers of Dall's porpoise occur in the inland waters of Washington state, but the most recent abundance estimate obtained in 1996 (900 animals, CV = 0.40) is over 8 years old and is not included in the overall estimate of abundance for this stock. Barlow and Forney (2007) estimated the density of Dall's porpoise at 75.53 porpoise/1000 km^2.

As summarized in Carretta et al. (2011, and citations therein) the status of Dall's porpoise in California, Oregon and Washington relative to the Optimal Sustainable Population (OSP) is not known, and there are insufficient data to evaluate potential trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as threatened or endangered under the ESA nor as "depleted" under the MMPA. The average annual human-caused mortality in 2002-2006 (1.6 animals) is estimated to be less than the PBR (318), and therefore they are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for this stock is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

Distribution and habitat preferences: The species is found only in temperate waters of the North Pacific and adjacent seas (Jefferson 2009a). The southern end of this population's range is not well-documented, but they are commonly seen off Southern California in winter, and during cold-water periods they probably range into Mexican waters off northern Baja California. Dall's porpoises occur in small groups, although aggregations of at least 200 individuals have been reported. Dall's porpoise occur only rarely in groups of mixed species, although they are sometimes seen in the company of harbor porpoises and gray whales (Jefferson 2009a). It is

probably the most widely distributed cetacean in temperate and subarctic regions of the North Pacific and Bering Sea. This is an oceanic species found along the continental shelf and in inland and coastal waters. There are seasonal inshore-offshore and north-south movements, but these movements are poorly understood (Jefferson 2009a). Hanson (2007) described movements of radio-tagged Dall's porpoise from the San Juan Islands to the outer coast coincident with the timing of development of the Juan de Fuca eddy in two consecutive years. Their departure is consistent with the breakdown of this feature.

Behavior and life history: Calves are born in summer, and gestation is thought to be about one year (Osborne et al. 1988; Jefferson 2009a). Dall's porpoises apparently feed at night. Prey species in the inland waters of British Columbia and Puget Sound include squid and schooling fishes (Walker et al. 1998). Dall's porpoise equipped with dive recorders dove to about 94 m in water that exceeded 200 m while feeding in Puget Sound inland waters. Dive duration was about 1.3 minutes (Baird and Hanson 1996).

Acoustics and hearing: Only short duration pulsed sounds have been recorded for Dall's porpoise; this species apparently does not whistle often (Richardson et al. 1995). Dall's porpoises produce short-duration (50 to 1,500 μs), high-frequency, narrow band clicks, with peak energies between 120 and 160 kHz. There are no published data on hearing ability of this species (DON 2008b).

4.1.3 Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*) California, Oregon, Washington Northern and Southern Stocks

Description: Pacific white-sided dolphins are a medium sized dolphin with adults ranging from 1.7 m to 2.5 m in length and weighing 75-198 kg; males are slightly larger than females (Black 2009). They are boldly marked with a dark gray or black dorsal surface, light gray sides and light gray 'suspender stripes' anterior. The dorsal fin is falcate to lobate with a rounded tip; it has a darker leading edge with light gray color covering two thirds of the posterior portion; the flukes are all dark (Black 2009). A few predominately white individuals with small patches of black pigmentation on the sides, heads, and fins have been identified in Monterey Bay.

Status and trends: Pacific white-sided dolphins belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. Although there is clear evidence that two forms of Pacific white-sided dolphins occur along the U.S. west coast, there are no known differences in color pattern, and it is not currently possible to distinguish animals without genetic or morphometric analyses. Geographic stock boundaries appear dynamic and are poorly understood, and therefore cannot be used to differentiate the two forms.

Pacific white-sided dolphins may spend time outside the U.S. Exclusive Economic Zone (EEZ), and therefore a multi-year average abundance estimate including California, Oregon and Washington is the most appropriate for management within U.S. waters. The 2005-2008 geometric mean abundance estimates for California, Oregon and Washington waters based on the two most recent ship surveys is 26,930 with a minimal population estimate of 21,406 dolphins. Barlow and Forney (2007) estimated the density of Pacific white-sided dolphins at 20.93 dolphins/1000 km^2. The PBR is 193 animals. No long-term trends in the abundance of Pacific white-sided dolphins in California, Oregon and Washington are suggested based on historical and recent surveys (Carretta et al. 2012).

As summarized in Carretta et al. (2011, and citations therein), the status of Pacific white-sided dolphins in California, Oregon and Washington relative to OSP is not known, and there is no indication of a trend in abundance for this stock. No habitat issues are known to be of concern for this species. They are not listed as threatened or endangered under the ESA nor as "depleted" under the MMPA. The average annual human-caused mortality in 2000-2006 (1.4 animals) is estimated to be less than the PBR (193), and therefore they are not classified as a “strategic" stock under the MMPA. The total fishery mortality and serious injury for this stock is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

Distribution and habitat preferences: This dolphin is one of the most abundant pelagic species of dolphin found in cold-temperate North Pacific waters. In the eastern Pacific it occurs as far west as Amchitka Island in the central Aleutian Islands through the Gulf of Alaska and down to 20° N, just south of Baja California (Black 2009). They do not migrate but exhibit seasonal shifts in distribution related to oceanographic variability. As summarized in Carretta et al. (2011, and citations therein), Pacific white-sided dolphins are endemic to temperate waters of the North Pacific Ocean, and are common both on the high seas and along the continental margins. Off the U.S. west coast, Pacific white-sided dolphins have been seen primarily in shelf and slope waters. Sighting patterns from recent aerial and shipboard surveys conducted in California, Oregon and Washington suggest seasonal north-south movements, with animals found primarily off California during the colder water months and shifting northward into Oregon and Washington as water temperatures increase in late spring and summer. They typically inhabit productive continental shelf and slope waters generally within 185 km of shore (Black 2009). They frequent some areas with complex bathymetry such as Monterey Bay, CA, an area where deep submarine canyons approach shore (ibid).

Behavior and life history: As summarized from Black (2009, and citations therein) calving occurs from May to September. Age and length of maturation varies by area with females becoming sexually mature at 8-11 years with a 4 to 5-year calving interval. These are highly social dolphins and are avid bow riders that commonly occur in groups of less than a hundred but can form herds of over a thousand animals. They often associate with other dolphins typically Risso’s, commons, and northern right-whale dolphins and porpoises and occasionally feed near humpback whales. Killer whales (*Orcinus orca*) appear to be a significant predator. Prey species include cephalopods (30 species known to be consumed) and schooling fishes (at least 60 species) (Black 2009). Pacific white-sided dolphins equipped with radio transmitters had mean dive duration of 24 seconds and a maximum dive time of 6.2 minutes (ibid).

Acoustics and hearing: As summarized in DON (2008b, and citations therein), vocalizations produced by Pacific white-sided dolphins include whistles and clicks. Whistles are in the frequency range of 2 to 20 Hz. Peak frequencies of the pulse trains for echolocation fall between 50 and 80 kHz; the peak amplitude is 170 dB re 1μPa-m. Underwater hearing sensitivity of the Pacific white-sided dolphin is from 75 Hz through 150 kHz. The greatest sensitivities were from 4 to 128 kHz. Below 8 Hz and above 100 kHz, this dolphin’s hearing was similar to that of other toothed whales.

4.1.4 Risso’s Dolphin (*Grampus griseus*) California, Oregon, Washington Stock

Description: Risso's dolphins are large dolphins with adults of both sexes reaching up to 4 m in length; there is no evidence of sexual dimorphism (Baird 2009). The anterior body is robust tapering to a relatively narrow tail stock with a relatively small dorsal fin. The bulbous head has a distinct vertical crease along the anterior surface of the melon (Baird 2009). Color patterns change with age; older animals are covered with linear scars and may appear whitish on the dorsal and lateral surfaces. The dorsal fin is falcate and black in color (Baird 2009). They are often confused with killer whales due to the large size of their dorsal fin.

Status and trends: Risso's dolphins belong to the Order Cetacea, Suborder Odontoceti, and are the fifth largest member of the Family Delphinidae. As oceanographic conditions vary, Risso's dolphins may spend time outside the U.S. EEZ, and therefore a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The 2005-2008 geometric mean abundance estimate for California, Oregon and Washington waters based on the two most recent ship surveys is 6,272 animals with a minimum population estimate of 4,913; the PBR for Risso's dolphins is 39 animals. Barlow and Forney (2007) estimated the density of Risso's dolphins at 10.46 dolphins/1000 km^2. There is no apparent trend in abundance between the most recent survey years 1991 and 2008 (Carretta et al. 2012).

As summarized in Carretta et al. (2011, and citations therein) the status of Risso's dolphins off California, Oregon and Washington relative to OSP is not known, and there are insufficient data to evaluate potential trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as "threatened" or "endangered" under the ESA nor as "depleted" under the MMPA. Over the last 5-year period (2002-2006), the average annual human-caused mortality (4.9 animals) is estimated to be less than the PBR (97), and therefore they are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for this stock is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

Distribution and habitat preferences: Risso's dolphins are distributed world-wide in tropical and warm-temperate waters. Off the U.S. west coast, Risso's dolphins are commonly seen on the shelf in the Southern California Bight and in slope and offshore waters of California, Oregon and Washington (Carretta et al. 2012). Animals found off California during the colder water months are thought to shift northward into Oregon and Washington as water temperatures increase in late spring and summer. The southern end of this population's range is not well-documented, but previous surveys have shown a conspicuous 500 nmi distributional gap between these animals and Risso's dolphins sighted south of Baja California and in the Gulf of California. Thus this population appears distinct from animals found in the eastern tropical Pacific and the Gulf of California (Carretta et al. 2012). They seem to prefer temperate and tropical waters in steep edged habitat between 400- and 1000-m deep. In the Pacific they can be found as far north as the Gulf of Alaska and the Kamchatka Peninsula and south to Tierra del Fuego and New Zealand (Baird 2009).

Behavior and life history: As summarized in Baird (2009, and citations therein), Risso's dolphins are relatively gregarious, typically travelling in groups of 10-50 individuals; the largest group reported had over 4,000 individuals. They have been observed bow riding in front of gray whales and are often seen surfing in swells. Gestation is 13-14 months and calving intervals are about

2.4 years with peak calving during winter in the eastern North Pacific. Sexual maturity for females is thought to be 8-10 years of age and males 10-12 years of age. They feed almost exclusively on squid, likely at night (Baird 2009).

Acoustics and hearing: Risso's dolphins are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007). Vocalizations of Risso's dolphin range from 400 Hz to 65 Hz (DON 2008a) (Table 4.1).

4.1.5 Bottlenose Dolphin (*Tursiops truncatus*) California Coastal Stock and Offshore Stock

Description: Bottlenose dolphins are large and robust, varying in color from light gray to charcoal. The common bottlenose dolphin is characterized by a medium-length stocky beak that is clearly distinct from the melon (Jefferson et al. 2008). The dorsal fin is tall and falcate. There are striking regional variations in body size, with adult lengths from 1.9 to 3.8 m (Wells and Scott 2009).

Status and trends: Bottlenose dolphins belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. Two forms of common bottlenose dolphins are recognized in the western North Pacific Ocean: California coastal stock (coastal) and California/Oregon/Washington offshore (offshore) stock. As summarized in Carretta et al. (2011, and citations therein) the population of the coastal stock has been estimated based on photographic mark-recapture surveys conducted along the San Diego coast in 2004 and 2005. The most recent estimate of population size is 323 dolphins but may be closer to 450-500 animals, with a minimum population estimate of 290 animals and a PBR of 2.4 dolphins per year. The population has remained stable for about 20 years.

Because the distribution of the offshore stock of bottlenose dolphins appears to vary inter-annually and they may spend time outside the U.S. EEZ, a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The most comprehensive multi-year average abundance is the geometric mean abundance estimate for California, Oregon and Washington waters based on the 2005 and 2008 ship surveys, or 1,006 offshore bottlenose dolphins with a minimum population estimate of 684; the PBR is 5.5 animals per year (Carretta et al. 2012). No information on trends in abundance of offshore bottlenose dolphins is available. Barlow and Forney (2007) estimated the density of bottlenose dolphins at 1.78 dolphins/1000 km^2.

The status of coastal and offshore bottlenose dolphins relative to OSP is not known, and there is no evidence of a trend in abundance. They are not listed as "threatened" or "endangered" under the ESA nor as "depleted" under the MMPA. Coastal bottlenose dolphins are not classified as a "strategic" stock under the MMPA because total annual fishery mortality and serious injury for this stock (≥ 0.2 per year) is less than the PBR (2.4 and 5.5, respectively). The total human-caused mortality and serious injury for this stock is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

Distribution and habitat preferences: In general, bottlenose dolphins are distributed world-wide; in the North Pacific they are commonly found as far north as the southern Okhotsk Sea, Kuril Islands, and central California. Bottlenose dolphins are distributed in tropical and warm-

temperate waters that range from about 10 to 32° C. They inhabit temperate and tropical shorelines, adapting to a variety of marine and estuarine habitats, even ranging into rivers (Wells and Scott 2009). They are primarily coastal but do occur in pelagic waters, near oceanic islands and over the continental shelf. In many regions, including California, separate coastal and offshore populations exist. As summarized in Carretta et al. (2011, and citations therein), California coastal bottlenose dolphins are found within about one kilometer of shore primarily from Point Conception (but as far north as San Francisco) south into Mexican waters, at least as far south as San Quintin, Mexico. In southern California, animals are found within 500 m of the shoreline 99% of the time and within 250 m 90% of the time. Oceanographic events appear to influence the distribution of animals along the coasts of California and Baja California as indicated by a change in residency patterns along Southern California and a northward range extension into central California after the 1982-83 El Niño is known.

Offshore bottlenose dolphins have been found at distances greater than a few kilometers from the mainland and throughout the Southern California Bight. They have also been documented in offshore waters as far north as about 41° N, and they may range into Oregon and Washington waters during warm water periods. Sighting records off California and Baja California suggest that offshore bottlenose dolphins have a continuous distribution in these two regions. Based on aerial surveys and shipboard surveys no seasonality in distribution is apparent. Offshore bottlenose dolphins are not restricted to U.S. waters, but cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries that may take this species (e.g., gillnet fisheries).

Behavior and life history: Births have been reported from all seasons with peaks during spring-summer months. Females may give birth as late as their 48th year. A large variety of fish and squid forms most of the diet and varies by region, although they do seem to prefer sciaenids (drums and croakers), scombrids (mackerels and tunas), and mugilids (mullets) (Wells and Scott 2009). Most consumed fish are bottom dwellers. Sharks are probably the most important predators on bottlenose dolphins. As summarized in DON (2008a, and citations therein), dive durations as long as 15 min are recorded for trained individuals but typical dives are more shallow and of a much shorter duration. Mean dive durations of Atlantic bottlenose dolphins typically range from 20 to 40 seconds at shallow depths and can last longer than 5 minutes during deep offshore dives. Offshore bottlenose dolphins regularly dive to 450 m and possibly as deep as 700 m.

Acoustics and hearing: Coastal and offshore stocks of bottlenose dolphins are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007). Bottlenose dolphin vocalization frequencies range from 3.4 to 130 kHz (DON 2008a) (Table 4.1).

4.1.6 Striped Dolphin *(Stenella coeruleoalba)* California, Oregon, Washington Stock

Description: The striped dolphin is uniquely marked with black lateral stripes from eye to flipper and eye to anus. There is also a white V-shaped “spinal blaze” originating above and behind the eye and narrowing to a point below and behind the dorsal fin (Archer 2009). There is a dark cape and white belly; the lateral field is usually darker than the ventral. This is a relatively robust dolphin with a long, slender beak and prominent dorsal fin. The longest specimen was 2.56 m

and the heaviest was 156 kg but mean maximum body length in the western pacific is 2.4 m for males and 2.2 m for females (Archer 2009).

Status and trends: Striped dolphins belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. The abundance of striped dolphins in this region appears to be variable between years and may be affected by oceanographic conditions. Because animals may spend time outside the U.S. EEZ as oceanographic conditions change, a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The 2005-2008 geometric mean abundance estimate for California, Oregon and Washington waters based on the 2005 and 2008 ship surveys is 10,908 striped dolphins; the minimum population estimate is 8,231 striped dolphins with a PBR of 82 striped dolphins per year (Carretta et al. 2012). Barlow and Forney (2007) estimated the density of striped dolphins at 16.67 dolphins/1000 km^2.

The status of striped dolphins in California relative to OSP is not known, and there are insufficient data to evaluate potential trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as threatened or endangered under the ESA nor as "depleted" under the MMPA. Because recent fishery and human-caused mortality is less than 10% of the PBR (82), striped dolphins are not classified as a "strategic" stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero.

Distribution and habitat preferences: Striped dolphins are distributed worldwide in cool-temperate to tropical zones. On recent surveys extending about 300 nmi offshore of California, they were sighted within about 100-300 nmi from the coast. No sightings have been reported for Oregon and Washington waters, but striped dolphins have stranded in both states. Striped dolphins are also commonly found in the central North Pacific, but sampling between this region and California has been insufficient to determine whether the distribution is continuous. Based on sighting records off California and Mexico, striped dolphins appear to have a continuous distribution in offshore waters of these two regions (Carretta et al. 2012). Striped dolphins are usually found beyond the continental shelf, typically over the continental slope out to oceanic waters and are often associated with convergence zones and waters influenced by upwelling. The species feeds on a variety of pelagic and benthopelagic fish and squid.

Behavior and life history: As summarized from Archer (2009, and references therein), mating is seasonal and gestation lasts 12-13 months. Females become sexually mature between 5 and 13 years of age and between 7 and 15 years of age for males. Striped dolphins are acrobatic and perform a variety of aerial behaviors but they do not commonly bow ride. They often feed in pelagic or benthopelagic zones along the continental slope or just beyond it in oceanic waters. A majority of their prey possesses luminescent organs, suggesting that striped dolphins may be feeding at great depths, possibly diving to 200 to 700 m to reach potential prey. Striped dolphins may feed at night in order to take advantage of the deep scattering layer's diurnal vertical movements (Archer 2009).

Acoustics and hearing: Striped dolphins are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007). Their vocalizations range from 6 to > 24 kHz (DON 2008a) (Table 4.1).

4.1.7 Short-Beaked Common Dolphin (*Delphinus delphis*) California, Oregon, Washington Stock

Description: As summarized in DON (2008a, and citations therein) and Perrin (2009), short-beaked common dolphins are slender, moderately robust dolphins, with a moderate length beak, and a tall, slightly falcate dorsal fin. The beak is shorter than in long-beaked common dolphins, and the melon rises from the beak at a steeper angle. Short-beaked common dolphins are distinctively marked with a V-shaped saddle caused by a dip in the cape below the dorsal fin, yielding an hourglass pattern on the side of the body. The back is dark brownish-gray, the belly is white, and the anterior flank patch is tan to cream in color. The lips are dark, and there is a dark stripe from the eye to the apex of the melon and another one from the chin to the flipper (the latter is diagnostic to the genus). There are often variable light patches on the flippers and dorsal fin. Length ranges up to about 2.3 m (females) and 2.6 m (males).

Status and trends: Short-beaked common dolphins belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. As summarized in Carretta et al. (2012, and citations therein), the most recent estimates of abundance estimates are based on two summer/fall shipboard surveys that were conducted within 300 nmi of the coasts of California, Oregon and Washington in 2005 and 2008. The distribution of short-beaked common dolphins throughout this region is highly variable, apparently in response to oceanographic changes on both seasonal and inter-annual time scales. As oceanographic conditions vary, short-beaked common dolphins may spend time outside the U.S. EEZ, and therefore a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The 2005-2008 geometric mean abundance estimates for California, Oregon and Washington waters based on the two ship surveys is 411,211 short-beaked common dolphins; the minimum population estimate is 343,990 short-beaked common dolphins with a PBR of 3,440 short-beaked common dolphins per year (Carretta et al. 2012). Barlow and Forney (2007) estimated the density of short-beaked common dolphins at 309.35 dolphins/1000 km^2.

The status of short-beaked common dolphins in Californian waters relative to OSP is not known (Carretta et al. 2012). The observed increase in abundance of this species off California probably reflects a distributional shift, rather than an overall population increase due to growth. No habitat issues are known to be of concern for this species. They are not listed as threatened or endangered under the ESA nor as "depleted" under the MMPA. The average annual human-caused mortality in 2002-2006 is estimated to be less than the PBR (3,440), and therefore they are not classified as a "strategic" stock under the MMPA. The total estimated fishery mortality and injury for short-beaked common dolphins is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

Distribution and habitat preferences: Short-beaked common dolphins are the most abundant dolphin in offshore warm-temperate waters in the Atlantic and Pacific (Perrin 2009). They occur worldwide from about 40-60° N to about 50° S (Perrin 2009). They are the most abundant cetacean off California, and are widely distributed between the coast and at least 300 nmi distance from shore (Carretta et al. 2012). The abundance of this species off California has been shown to change on both seasonal and inter-annual time scales. Historically, they were reported primarily south of Pt. Conception, but have been commonly recorded as far north as 42° N

(Carretta et al. 2012). The short-beaked common dolphin is found in coastal and offshore waters along the eastern Pacific coast from Peru to Vancouver Island. They are widely distributed to 556 km offshore (Carretta et al. 2012). They tend to prefer cooler water farther offshore than the sympatric long-beaked common dolphin; they occupy upwelling-modified habitats with less tropical characteristics than surrounding water masses (Perrin 2009). During summer and fall, short-beaked common dolphins primarily occur along the outer coast in waters deeper than 200 m, south of 42° N and to a lesser extent in water depths between 100 m and 200 m south of 42° N, and seaward of the 100 m water depth north of 42° N. In winter and spring, animals typically stay south of the 13° C isotherm. There is a rare occurrence for this species in waters cooler than 12° C and within the Puget Sound (DON 2008b). Separate northern, central, and southern stocks associated with different upwelling areas are recognized in the management of incidental mortality in tuna fisheries (Perrin 2009).

Behavior and life history: Short-beaked common dolphins are usually found in large groups of hundreds to thousands of individuals and are often associated with other marine mammal species. Gestation is 10-11.7 months with a calving interval of 1-3 years, depending on location (Perrin 2009). Age at sexual maturity varies by region from 3 years to 7-12 years for males and 2-4 and 6-8 years for females. Cooler water populations exhibit more seasonality in reproduction (Perrin 2009). There are limited direct measurements of dive behavior but dives to > 656 ft (200 m) are possible, but most occur in the range of 9-50 m based on a study on one tagged individual tracked off San Diego (DON 2008b). Diel fluctuations in vocal activity of this species (more vocal activity during late evening and early morning) appear to be linked to feeding on the deep scattering layer as it rises. Foraging dives up to 200 m in depth have been recorded off southern California (DON 2008b).

Acoustics and hearing: As summarized in DON (2008a, and citations therein), recorded vocalizations include whistles, chirps, barks, and clicks. Clicks range from 0.2 to 150 kHz with dominant frequencies between 23 and 67 kHz and estimated source levels of 170 dB re 1 μPa. Chirps and barks typically have a frequency range from less than 0.5 to 14 kHz, and whistles range in frequency from 2 to 18 kHz. Maximum source levels are approximately 180 dB 1 μPa-m.

4.1.8 Long-Beaked Common Dolphin (*Delphinus capensis*) California Stock

Description: As summarized in Perrin (2009), all common dolphins are slender and have a moderate length beak, and a tall, slightly falcate dorsal fin that may tend toward triangular. The beak is longer than in short-beaked common dolphins, and the melon rises from the beak at a steeper angle. Long-beaked common dolphins in California tend to be longer and heavier than the short-beaked common dolphin. Both species are distinctively marked with a V-shaped saddle caused by a dip in the cape below the dorsal fin, yielding an hourglass pattern on the side of the body. The back is dark brownish-gray, the belly is white, and the anterior flank patch is tan to cream in color. The lips are dark, and there is a dark stripe from the eye to the apex of the melon and another one from the chin to the flipper (the latter is diagnostic to the genus). There are often variable light patches on the flippers and dorsal fin. Length ranges up to about 2.3 m (females) and 2.6 m (males).

Status and trends: Long-beaked common dolphins belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. Long-beaked common dolphins have only recently been

recognized as a distinct species. Along the U.S. west coast, their distribution overlaps with that of the short-beaked common dolphin, and much historical information has not distinguished between these two species. The most recent abundance estimate is 27,046 long-beaked common dolphin based on 2005 and 2008 ship line transect surveys of California, Oregon, and Washington waters with a minimum population estimate of 17,127; the PBR is 164 long-beaked common dolphins for the California stock (Carretta et al. 2012). Barlow and Forney (2007) estimated the density of long-beaked common dolphins at 19.24 dolphins/1000 km^2.

The status of long-beaked common dolphins in California waters relative to OSP is not known, and there are insufficient data to evaluate potential trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as threatened or endangered under the ESA or as “depleted” under the MMPA. The average annual human-caused mortality from 2002-2006 does not exceed the PBR (164), and therefore they are not classified as a "strategic" stock under the MMPA. The average total fishery mortality and injury for long-beaked common dolphins (13) is less than 10% of the PBR and, therefore, is considered to be insignificant and approaching zero mortality and serious injury rate (Carretta et al. 2012).

Distribution and habitat preferences: Long-beaked common dolphins are commonly found within about 50 nmi of the coast, from Baja California (including the Gulf of California) northward to about central California. California waters represent the northern limit for this stock and they likely move between U.S. and Mexican waters. No information on trends in abundance is available for this stock because of high interannual variability in line-transect abundance estimates. Heyning and Perrin (1994) detected changes in the proportion of short-beaked to long-beaked common dolphins stranding along the California coast, with the short-beaked common dolphin stranding more frequently prior to the 1982-83 El Niño (which increased water temperatures off California), and the long-beaked common dolphin more commonly observed for several years afterwards. Thus, it appears that both relative and absolute abundance of these species off California may change with varying oceanographic conditions (Carretta et al. 2012). The long-beaked species seems to prefer shallower and warmer water and generally occurs closer to shore than the short-beaked form (Perrin 2009).

Behavior and life history: Long-beaked common dolphins, as with the short-beaked, are usually found in large groups of hundreds to thousands of individuals and are often associated with other marine mammal species. Other traits are as described above for the short-beaked common dolphin.

Acoustics and hearing: Long-beaked common dolphins likely have similar acoustics and hearing to the short-beaked common dolphin. As above for the short-beaked common dolphin, DON (2008a) state that recorded vocalizations include whistles, chirps, barks, and clicks. Clicks range from 0.2 to 150 kHz with dominant frequencies between 23 and 67 kHz and estimated source levels of 170 dB re 1 μPa. Chirps and barks typically have a frequency range from less than 0.5 to 14 kHz, and whistles range in frequency from 2 to 18 kHz. Maximum source levels are approximately 180 dB 1 μPa-m.

4.1.9 Northern Right-Whale Dolphin (*Lissodelphis borealis*) California, Oregon, Washington Stock

Description: Right-whale dolphins, of which there are two recognized species, are slender, sleek dolphins known for their distinctive black and white color patterns and lack of a dorsal fin. The northern right-whale dolphin is mainly black with a white ventral patch that runs from the fluke notch to the throat region; there is another white patch on the ventral tip of the rostrum and the underside of the flipper (Lipsky 2009). They can grow to 3 m in length and 116 kg; and males tend to be larger than females.

Status and trends: Northern right-whale dolphins belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. A multi-year average abundance estimate is the most appropriate for management within U.S. waters; the 2005-2008 geometric mean abundance estimate for California, Oregon and Washington waters based on the two ship surveys is 8,334 (CV= 0.40) northern right-whale dolphins with a minimum population estimate for 2005-2008 of 6,019 dolphins; the PBR is 48 dolphins per year (Carretta et al. 2012). Barlow and Forney (2007) estimated the density of northern right-whale dolphins at 9.75 dolphins/1000 km^2.

The status of northern right-whale dolphins in California, Oregon and Washington relative to OSP is not known, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as threatened or endangered under the ESA nor as "depleted" under the MMPA. The average annual human-caused mortality in 2002-2006 (4.8 animals) is estimated to be less than the PBR (48), and therefore they are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for northern right-whale dolphins is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate (Carretta et al. 2012).

Distribution and habitat preferences: This species is endemic to the North Pacific Ocean, and is found primarily in cool-temperate (8–19° C) continental shelf and slope waters. They range from the Kuril Islands south to Sanriko, Japan extending eastward to the Gulf of Alaska and south to Southern California (Lipsky 2009). Northern right-whale dolphins occur in the survey area year-round, but their abundance and distribution vary seasonally. This species is most abundant off central and northern California in nearshore waters in winter. They occur off Oregon and Washington except in winter; peak abundance occurs along the continental slope in fall (Carretta et al. 2012; DON 2008b). Right-whale dolphins prefer cool-temperate and subarctic waters in the North Pacific. They tend to be offshore oceanic cetaceans with rare inshore sightings (Lipsky 2009).

Behavior and life history: Sexual maturity occurs at about 10 years of age. Although calving seasonality is unknown, small calves are seen in winter and early spring. They tend to be gregarious and travel in groups of up to 2,000-3,000 in the North Pacific. Males may attain sexual maturity between 212 and 220 cm in length and females at about 200 cm but few data are available on age, growth, and reproduction. The diet primarily includes squid and mesopelagic fish. No dive data are available.

Acoustics and hearing: As summarized in DON (2008b), clicks with high repetition rates and whistles have been recorded from animals at sea. Maximum source levels were approximately

170 dB 1 μPa-m. Mean frequency of individual echolocation clicks was 31.3 kHz (range of 23 – 41 kHz; SD = 3.7 kHz). There is no published data on the hearing abilities of this species.

4.1.10a Killer Whale (*Orcinus orca*) – Resident Ecotype

Description: Killer whales are the largest member of the dolphin family attaining maximum body lengths of 9 m for males and 7.7 m for females (Ford 2009). Maximum measured weights for males is 5,568 kg and for females 3,810 kg (Ford 2009). Males develop larger appendages than females including the pectoral fins, tail flukes, and dorsal fin, which is erect in shape and may be as high as 1.8 m in males. Directly behind the dorsal fin is a gray area of variable shape called the saddle patch. Killer whales are generally black dorsally and white ventrally with a conspicuous elliptically shaped white patch behind the eye (post-ocular patch). Considerable variation exists in the shape and color of the post-ocular patch, saddle patch, and the size and shape of the dorsal fin such that they are used to identify individuals.

Status and trends: Killer whales belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. There are three recognized ecotypes in the North Pacific Ocean: residents, transients, and offshores (Krahn et al. 2004). Resident killer whales forage primarily for fish in relatively large groups in coastal areas. Transient killer whales, whose range extends over a broader area, primarily hunt marine mammals (Krahn et al. 2004; Baird et al. 1992). Transient pods are usually fewer in number than resident pods, and they typically have different dorsal fin shapes and saddle patch pigmentation than resident pods. Little is known about offshore killer whales, but their groupings are large, they range from Mexico to Alaska, and their prey includes fish (Ford et al. 2000; Krahn et al. 2004).

In 2005, NMFS listed the Puget Sound southern resident killer whale (SRKW) distinct population segment (DPS) as an endangered species under the ESA. Listing factors included reduced quantity and quality of prey, persistent pollutants that could cause immune or reproductive system dysfunction (see Krahn et al. 2009), oil spills, and noise and disturbance from vessel traffic. Additionally, the small size of this stock made it potentially vulnerable to inbreeding that could cause a major population decline. In June 2006, NMFS designated critical habitat for the southern resident killer whales. The designation included approximately 2,500 square miles of Puget Sound, including the entire Strait of Juan de Fuca. Areas with water less than 20 feet deep were not proposed. Also excluded was the Admiralty Inlet naval restricted area.

Resident killer whales of British Columbia and Washington occur as two communities, a northern resident community and a southern resident community. The northern resident community is composed of three clans, A, G, and R with a total of 16 pods. The southern resident community is comprised of a single clan, J-clan made of three pods J1, K1, and L1 (Ford et al. 2000). Population estimates are direct counts of known individuals. The southern resident killer whale population increased to 99 whales in 1995, then declined to 79 whales in 2001 before increasing slightly to 84 whales in 2004 (Ford et al. 2000; Center for Whale Research, unpublished data). About 84 total animals were documented in the J, K, and L pods in 2008; however the minimum population estimate as reported in Carretta et al. (2012) is 86 whales. One birth was recorded in 2008 and seven animals were lost as of October 2008 (Center for Whale Research 2008, NMFS 2008b). Two of these deaths were calves which would not have been counted as part of the population until they were older; females K7 and L21 were 98

and 56 years of age respectively and their deaths were not surprising; the deaths of reproductively active females J11 (35 years old) and L67 (32 years old) were unexpected; and subadult male L101 (5 years old) was attributed to L67 being ill (NMFS 2008b). Two births were reported in February 2009, one in January 2010, and another in February 2010. The unofficial count of the SRKW clan in February 2010 was 89 whales. The PBR level for this stock is calculated as the minimum population size (85) times one-half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.1 (for an endangered stock), resulting in a PBR of 0.17 whales per year

Distribution and habitat preferences: Killer whales are found in all oceans and are second only to humans as the most widely spread of all mammals (Ford 2009). They are most commonly found in coastal and temperate waters of high productivity. The range of southern resident killer whales during the spring, summer, and fall includes the inland waters of Puget Sound, Strait of Juan de Fuca, and Southern Georgia Strait. The southern residents also occur in the coastal waters off the coast of Oregon, Washington, and Vancouver Island and in recent years off the central California coast and the Queen Charlotte Islands. Winter movements and range are poorly known for this stock; however, the J pod is more commonly sighted in inland waters in winter, while pods K and L spend more time offshore during winter (Ford et al. 2000). As summarized by Carretta et al. (2011), most sightings of the SRKW stock have occurred in the summer in inland waters of Washington and southern British Columbia. The complete winter range of this stock is uncertain.

Heimlich-Boran (1988) found that resident killer whales in the inland waters of the Pacific Northwest fed more in areas of high substrate topography along salmon migratory routes while transient whales fed in shallow protected areas around concentrations of their prey. The location of food resources and habitats suitable for prey capture appeared to be the prime determining factor in the behavioral ecology of killer whales.

Behavior and life history: Killer whales are very social and the basic social unit is based on matriline relationship and linked by maternal decent. A typical matriline is composed of a female, her sons and daughters, and the offspring of her daughters (Ford 2009). Females may live to 80-90 years so a female's line may contain four generations. The pod is the next level of organization that is a group of related matrilines that shared a common maternal ancestor. The next level of social structure is the clan, followed by a resident society.

Births may occur in any month but most are in October-March. Females give birth when between 11 and 16 years of age with a 5-year interval between births. Gestation is 15-18 months and weaning is about 1-2 years after birth. Males attain sexual maturity at about 15 years of age. Life expectancy for females is about 50 years with a maximum of 80-90; males typically live to about 29 years of age (Ford 2009).

The southern residents primarily feed on salmon, especially Chinook salmon, returning to rivers in Washington and southern British Columbia. Resident killer whale pods in Puget Sound exhibit cooperative food searching but perhaps not food capture (Hoelzel 1993). Transient killer whales feed on seals, sea lions, and young or smaller cetaceans (Ford 2009) with an optimal group size of at least three whales needed to efficiently chase and capture marine mammal prey (Baird and

Dill 1996). Although killer whales regularly dive to greater than 150 m, there appears to be a trend toward a greater frequency of shallower dives and that males dive deeper than females (Krahn et al. 2004). Seven resident killer whales followed in 2002 were found to have dives that exceeded 228 m with an average maximum depth of 141 m (Baird et al. 2003). Dive rates (number of dives/hour) are similar for males and females and by age and among pods, but dive rates and swim speeds were greater during the day than at night (Baird et al. 2005). Killer whales have no natural predators other than humans but neonatal mortality is high with nearly 46% dying in the first 6 months (Ford 2009).

Acoustics and hearing: Killer whales, like most cetaceans, are highly vocal and use sound for social communication and to find and capture prey. The sounds include a variety of clicks, whistles, and pulsed calls (Ford 2009). As summarized in DON (2008b, and citations therein), the peak to peak source levels of echolocation signals range between 195 and 224 dB re 1 μPa-m. The source level of social vocalizations ranges between 137 to 157 dB re 1 μPa-m. Acoustic studies of resident killer whales in British Columbia have found that there are dialects, in their highly stereotyped, repetitive discrete calls, which are group-specific and shared by all group members (Ford 2009). These dialects likely are used to maintain group identity and cohesion, and may serve as indicators of relatedness that help in the avoidance of inbreeding between closely related whales (Ford 2009). The killer whale has the lowest frequency of maximum sensitivity and one of the lowest high frequency hearing limits known among toothed whales. The upper limit of hearing is 100 kHz for this species.

4.1.10b Killer Whale (*Orcinus orca*) – Transient Ecotype

Please refer to the descriptions above for transient ecotype killer whales regarding description and taxonomy. Transient killer whales, whose range extends over a broader area, primarily hunt marine mammals. Transient pods are usually fewer in number than resident pods, and they typically have different dorsal fin shapes and saddle patch pigmentation than resident pods. As summarized in Allen and Angliss (2011, and references therein) the transient ecotype contains three communities of transient whales within three discrete populations: 1) Gulf of Alaska, Aleutian Islands, and Bering Sea transients, 2) AT1 transients, and 3) West Coast transients. The West Coast Transient Stock includes animals that occur in California, Oregon, Washington, British Columbia and southeastern Alaska. On many occasions, transient whales from the inland waters of southeastern Alaska have been seen in association with British Columbia/Washington State transients. On other occasions, some of those same British Columbia whales have been sighted with whales more frequently seen off California thus linking these whales by association. Combining the counts of cataloged ‘transient’ whales gives a minimum number of 354 killer whales belonging to the West Coast Transient stock with a PBR of 3.5 animals per year.

Barlow and Forney (2007) estimated the density of killer whales, regardless of ecotype, at 0.71 killer whales/1000 km^2.

In contrast to resident whales, transient killer whales appear to use passive listening as a primary means of locating prey, call less often, and use high-amplitude vocalizations only when socializing, communicating over long distances, or after a successful attack (Deecke et al. 2002). This probably results from the increased cost to killer whales of warning wary marine mammal prey and reducing the chance of a successful attack (Deecke et al. 2002; DON 2008b).

4.1.10c Killer Whale (*Orcinus orca*) – Offshore Ecotype

As summarized in Carretta et al. (2011), the total number of known offshore killer whales along the U.S. West coast, Canada and Alaska is 211 animals, but it is not known what proportion of time this transboundary stock spends in U.S. waters, and therefore this number is difficult to work with for PBR calculations. A minimum abundance estimate for all killer whales along the coasts of California, Oregon and Washington can be estimated from the 2005-2008 line-transect surveys as the 20th percentile of the geometric mean 2005-2008 abundance estimate, or 466 killer whales. Using a prorating of known ecotypes, a minimum of 162 offshore killer whales are estimated to be in U.S. waters off California, Oregon and Washington. No information is available regarding trends in abundance of Eastern North Pacific offshore killer whales.
The PBR level is 1.6 offshore killer whales per year.

4.1.11 Short-Finned Pilot Whale (*Globicephala macrorhynchus*) California, Oregon, Washington Stock

Description: Pilot whales appear black or dark gray; the body is robust with a thick tailstock. The melon is exaggerated and bulbous and there is either no beak or a barely discernable one (Olson 2009). They exhibit striking sexual dimorphism with adult males reaching an average length of 6 m and they are larger than females; the broad-based dorsal fin of a male is larger than that of a female (Olson 2009).

Status and trends: Short-finned pilot whales belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. The abundance of short-finned pilot whales in this region appears to be variable and influenced by prevailing oceanographic conditions. Because animals may spend time outside the U.S. EEZ as oceanographic conditions change, a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The 2005-2008 unweighted average abundance estimate for California, Oregon and Washington waters based on two ship surveys is 760 (CV=0.64) short-finned pilot whales with a minimum population estimate of 465; the PBR is 4.6 short-finned pilot whales per year. Barlow and Forney (2007) estimated the density of short-finned pilot whales at 0.31 whales/1000 km^2.

The status of short-finned pilot whales off California, Oregon and Washington in relation to OSP is unknown. They have declined in abundance in the Southern California Bight, likely a result of a change in their distribution since the 1982-83 El Niño, but the nature of these changes and potential habitat issues are not adequately understood. Short-finned pilot whales are not listed as threatened or endangered under the ESA or as depleted under the MMPA. The average annual human-caused mortality from 2004-2008 is zero animals, less than the PBR of 4.6, and therefore they are not classified as a "strategic" stock under the MMPA. Total annual human-caused mortality and serious injury for this stock is estimated at zero animals, therefore, mortality is considered to be approaching a zero mortality and serious injury rate (Carretta et al. 2012).

Distribution and habitat preferences: The short-finned pilot whale is found in tropical to warm-temperate seas. It usually does not range north of 50° N or south of 40° S. Along the west coast of North America, sightings of short-finned pilot whales north of Point Conception are uncommon but there are infrequent sightings off Oregon and Washington. Worldwide, pilot whales usually are found over the continental shelf break, in slope waters, and in areas of high topographic relief, but movements over the continental shelf and close to shore at oceanic islands can occur.

Behavior and life history: Pilot whales are very social and may travel in groups of several to hundreds of animals, often with other cetaceans. They appear to live in relatively stable, female-based groups (DON 2008b). Sexual maturity occurs at 9 years for females and 17 years for males. The mean calving interval is 4 to 6 years. Pilot whales are deep divers; the maximum dive depth measured is about 971 m (Baird et al. 2002). Short-finned pilot whales feed on squid and fish. Stomach content analysis of pilot whales in the Southern California Bight consisted entirely of cephalopod remains. The most common prey item identified was *Loligo opalescens*, which has been documented in spawning concentrations at depths of 20-55 m.

Acoustics and hearing: Short-finned pilot whale whistles and clicks have a dominant frequency range of 2 to14 kHz and a source level of 180 dB re 1 μPa-m for whistles (DON 2008b). *Globicephala* spp. are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007) (Table 4.1).

4.1.12 Baird's Beaked Whale (*Berardius bairdii*) California, Oregon, Washington Stock

Description: Baird's beaked whales are one of the largest members of the family Ziphiidae. The entire body is dark brown with the ventral side paler with irregular white patches; tooth marks of conspecifics are numerous on the back, particularly on adult males (Kasuya 2009). The body is slender with a small head, low falcate dorsal fin and small flippers that fit into depressions on the body. The melon is small and its front surface is almost vertical with a slender projecting rostrum (ibid). Mean body length of whales 15 years or older are 10.5 m in females and 10.1 m in males.

Status and trends: Baird's beaked whales belong to the Order Cetacea, Suborder Odontoceti, and Family Ziphiidae. Because the distribution of Baird's beaked whale varies and animals probably spend time outside the U.S. EEZ, a multi-year average abundance estimate is the most appropriate for management within U.S. waters (Carretta et al. 2012). The 2005-2008 geometric mean abundance estimate for California, Oregon and Washington waters based on the above two ship surveys is 907 (CV=0.49) Baird's beaked whales (Barlow and Forney 2007; Forney 2007), with a minimum population estimate of 615 Baird's beaked whales; the PBR is 6.2 Baird's beaked whales per year (Carretta et al. 2012). Barlow and Forney (2007) estimated the density of Baird's beaked whale at 0.88 whales/1000 km^2.

The status of Baird's beaked whales in California, Oregon and Washington waters relative to OSP is not known, and there are insufficient data to evaluate trends in abundance (Carretta et al. 2012). No habitat issues are known to be of concern for this species, but in recent years questions have been raised regarding potential effects of human-made sounds on deep-diving cetacean species, such as Baird's beaked whales. In particular, active sonar has been implicated in the mass stranding of beaked whales in the Mediterranean Sea and in the Caribbean. They are not listed as threatened or endangered under the ESA nor as "depleted" under the MMPA. Including the one animal that died as the result of a ship strike in 2003, the average annual human-caused mortality in 2004-2008 is zero animals/year. Because recent fishery and human-caused mortality is less than the PBR (6.2), Baird's beaked whales are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for this stock is zero and can be considered to be insignificant and approaching zero.

Distribution and habitat preferences: Baird's beaked whale is distributed throughout deep waters and along the continental slopes of the North Pacific Ocean (Kasuya 2009). In the eastern North Pacific the northern limits are Cape Navarin (62° N) in the Bering Sea south to just north of northern Baja California. They have been harvested and studied in Japanese waters, but little is known about this species elsewhere. Along the U.S. west coast, Baird's beaked whales have been seen primarily along the continental slope from late spring to early fall. They have been seen less frequently and are presumed to be farther offshore during the colder water months of November through April (Carretta et al. 2012). Baird's beaked whale probably is a slope-associated species. As a result, the area of highest utilization for this whale in the eastern North Pacific is in waters deeper than 500 m. The area of lower utilization is between 200 m to 500 m water depth. There is a rare occurrence in waters shallower than 200 m.

Behavior and life history: Baird's beaked whales occur in relatively large groups of 6 to 30, and groups of 50 or more sometimes are seen (Kasuya 2009). Sexual maturity occurs at about 8 to 10 years, and the calving peak is in March and April (Kasuya 2009). Mating generally occurs in October and November but little else is known of their reproductive behavior (Kasuya 2009). They feed mainly on benthic fish and cephalopods, but prey also includes pelagic fish such as mackerel, sardine, and saury (Walker et al. 2002). Baird's beaked whales in Japan prey primarily on deepwater gadiform fishes and cephalopods, indicating that they feed primarily at depths ranging from 800 to 1,200 m (Walker et al. 2002). Baird et al. (2006) reported on the diving behavior of four Blainville's beaked whales (a similar species) off the west coast of Hawaii. The four beaked whales foraged in deep ocean areas with a maximum dive to 1,407 m. Dives ranged from at least 13 min to a maximum of 68 min (Baird et al. 2006).

Acoustics and hearing: DON (2008b) reviewed the literature on beaked whale acoustics and reported that beaked whales use frequencies of between 300 Hz and 129 kHz for echolocation, and between 2 and 10 kHz, and possibly up to 16 kHz, for social communication. Both whistles and clicks have been recorded from Baird's beaked whales in the eastern North Pacific Ocean. Whistles had fundamental frequencies between 4 and 8 kHz, with 2 to 3 strong harmonics within the recording bandwidth. Pulsed sounds (clicks) had a dominant frequency around 23 kHz, with a second frequency peak around 42 kHz. Baird's beaked whales are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007). There is no information on the hearing abilities of Baird's beaked whale.

4.1.13 Mesoplodont Beaked Whales (*Mesoplodon* spp.) California, Oregon, Washington Stocks

Description: At least six species in this genus have been recorded off the U.S. west coast, but due to the rarity of records and the difficulty in identifying these animals in the field, virtually no species-specific information is available (Carretta et al. 2012). The six species known to occur in this region are: Blainville's beaked whale (*M. densirostris*), Perrin's beaked whale (*M. perrini*), Lesser beaked whale (*M. peruvianus*), Stejneger's beaked whale (*M. stejnegeri*), Gingko-toothed beaked whale (*M. gingkodens*), and Hubbs' beaked whale (*M. carlhubbsi*). Insufficient sighting records exist off the U.S. west coast to determine any possible spatial or seasonal patterns in the distribution of mesoplodont beaked whales. Although they are fairly common in some parts of the ocean, because of their shyness around vessels and unobtrusive behavior, they are rarely observed (Pitman 2009). All have a single tooth in the front to the middle of the jaw. They are relatively small whales ranging in length from about 4 m to 6.2 m, depending on species (Pitman 2009). The body is spindle shaped with a small, usually triangular dorsal fin located

approximately two-thirds of the way back on the body. The flippers are small and narrow and fit into pigmented depressions in the body.

Status and trends: Mesoplodont beaked whales belong to the Order Cetacea, Suborder Odontoceti, and Family Ziphiidae. Although mesoplodont beaked whales have been sighted along the U.S. west coast on several line transect surveys utilizing both aerial and shipboard platforms, sightings have generally been too rare to produce reliable population estimates, and species identification has been problematic (Barlow 2010; Barlow and Forney 2007; Forney 2007). Previous abundance estimates have been imprecise and biased downward by an unknown amount because of the large proportion of time mesoplodont beaked whales spend submerged, and because the surveys on which they were based covered only California waters, and thus could not include animals off Oregon/Washington. The abundance of Blainville's beaked whales for California, Oregon, and Washington, based on the geometric mean of 2005-2008 surveys is 603 animals. The abundance estimate for mesoplodont beaked whales of unknown species, based on the same 2005-2008 surveys is 421 (CV=0.88). The combined estimate of abundance for all species of *Mesoplodon* beaked whales in California, Oregon, and Washington waters out to 300 nmi is 1,024 (CV=0.77) animals with a minimum population estimate of 576 animals. This estimate does not include sightings of 'unidentified beaked whales' made during 2005, some of which may have been *Mesoplodon* beaked whales. The PBR for this group is 5.8 beaked whales per year (Carretta et al. 2012). Barlow and Forney (2007) estimated the density of Mesoplodont beaked whales at 1.03 whales/1000 km^2.

The status of mesoplodont beaked whales in California, Oregon and Washington waters relative to OSP is not known, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for these species, but in recent years questions have been raised regarding potential effects of human-made sounds on deep-diving cetacean species, such as mesoplodont beaked whales. None of the six species are listed as threatened or endangered under the ESA nor considered "depleted" under the MMPA. Including driftnet mortality only for years after implementation of the Take Reduction Plan (1997-98), the average annual human-caused mortality in 2002-2006 is zero. Because recent mortality is zero, mesoplodont beaked whales are not classified as a "strategic" stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero. It is likely that the difficulty in identifying these animals in the field will remain a critical obstacle to obtaining species-specific abundance estimates and stock assessments in the future.

Distribution and habitat preferences: Mesoplodon beaked whales are distributed throughout deep waters and along the continental slopes of the North Pacific Ocean. World-wide, beaked whales normally inhabit continental slope and oceanic waters that are deeper than 200 m (Pitman 2009). Occurrence often has been linked to the continental slope, canyons, escarpments, and oceanic islands (MacLeod and D'Amico 2006). They may associate with strong turbulence caused by rough topography along the slope near Heceta Bank off the Oregon coast but beaked whales are only occasionally reported in waters over the continental shelf (Pitman 2009).

Behavior and life history: They occur alone or in groups of up to 15, and probably calve in the summer. They may be both a mid-water and bottom feeder on squid and fish (Pitman 2009). Analysis of stomach contents from captured and stranded individuals suggests that beaked

whales are deep-diving animals, feeding by suction (Heyning and Mead 1996). Baird et al. (2006) reported on the diving behavior of four Blainville's beaked whales (*M. densirostris*) off the west coast of Hawaii. The four beaked whales foraged in deep ocean areas (690-3,000 m) with a maximum dive to 1,408 m. Dives ranged from at least 13 min to a maximum of 68 min (Baird et al. 2006).

Acoustics and hearing: Mesoplodon spp. beaked whales are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007). Vocalization ranges are similar at 300 Hz to 135 kHz (DON 2008a) (Table 4.1).

4.1.14 Cuvier's Beaked Whale (*Ziphius cavirostris)* California, Oregon, Washington Stock

Description: Cuvier's beak whale resembles other beaked whales in that it has a robust, cigar-shaped body with a smallish falcate dorsal fin set about two thirds back; the small flippers fit into a slight depression as with other beaked whales (Heyning and Mead 2009). The head is blunt with a small poorly defined rostrum that grades into a generally sloping melon region (Heyning and Mead 2009). Minimum length at sexual maturity is 5.3 m for females and 5.3 m for males.

Status and trends: Cuvier's beaked whales belong to the Order Cetacea, Suborder Odontoceti, and Family Ziphiidae. Previous abundance estimates for this species of beaked whale have been imprecise and biased downward by an unknown amount because of the large proportion of time this species spends submerged, and because the ship surveys on which they were based covered only California waters, and thus could not observe animals off Oregon/Washington. Furthermore, there were a large number of unidentified beaked whale sightings, which were probably either *Mesoplodon* spp. or Cuvier's beaked whales (*Ziphius cavirostris*). Updated analyses are based on 1) combining data from two surveys conducted within 300 nmi of the coasts of California, Oregon and Washington in 2005 (Forney 2007) and 2008 (Barlow 2010), 2) whenever possible, assigning unidentified beaked whale sightings to *Mesoplodon* spp. or *Ziphius cavirostris* based on written descriptions, size estimates, and 'most probable identifications' made by the observers at the time of the sightings, and 3) estimating a correction factor for animals missed, based on a model of their diving behavior, detection distances, and the searching behavior of observers. An estimated 23% of track line groups are estimated to be seen. Because animals probably spend time outside the U.S. EEZ, a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The 2005-2008 geometric mean abundance estimate for California, Oregon and Washington waters based on the above analyses is 2,143 (CV=0.65) Cuvier's beaked whales. The minimum population estimate for Cuvier's beaked whale is 1,298 animals with a PBR of 13 whales per year (Carretta et al. 2012). Barlow and Forney (2007) estimated the density of Cuvier's beaked whale at 3.82 whales/1000 km^2.

The status of Cuvier's beaked whales in California, Oregon and Washington waters relative to OSP is not known, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species, but in recent years questions have been raised regarding potential effects of human-made sounds on deep-diving cetacean species, such as Cuvier's beaked whales. They are not listed as threatened or endangered under the ESA nor as "depleted" under the MMPA. The average annual human-caused mortality in 2002-2006 is zero. Because recent human-caused mortality is less than the PBR, Cuvier's beaked whales are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury

for this stock is less than 10% of the PBR and thus can be considered to be insignificant and approaching zero.

Distribution and habitat preferences: Cuvier's beaked whale is distributed in all oceans and seas except the high polar regions. Cuvier's beaked whale generally is sighted in waters >200 m deep, and is frequently recorded at depths >1,000 m. They are commonly sighted around seamounts, escarpments, and canyons (Heyning and Mead 2009). In Hawaii, Cuvier's beaked whales showed a high degree of site fidelity in a study spanning 21 years and showed that there was an offshore population and an island associated population (McSweeney et al. 2007). The site fidelity in the island associated population was hypothesized to take advantage of the influence of islands on oceanographic conditions that may increase productivity (McSweeney et al. 2007). Waters deeper than 1,000 m are the area of highest utilization for the Cuvier's beaked whale in the Northeast Pacific while water depths between 500 m and 1,000 m are less utilized. Occurrence in waters shallower than 500 m is rare (DON 2008b).

Behavior and life history: Little is known of the feeding preferences of Cuvier's beaked whale. They may be mid-water and bottom feeders on cephalopods and, rarely, fish. There is little information on beaked whale reproductive behavior. Recent studies by Baird et al. (2006) show that Cuvier's beaked whales dive deeply (maximum of 1,450 m) and for long periods (maximum dive duration of 68.7 min) but also spent time at shallow depths. Tyack et al. (2006) has also reported deep diving for Cuvier's beaked whales with mean depth of 1,070 m and mean duration of 58 min.

Acoustics and hearing: DON (2008b) reviewed the literature on beaked whale acoustics and reported that beaked whales use frequencies of between 300 Hz and 129 kHz for echolocation, and between 2 and 10 kHz, and possibly up to 16 kHz, for social communication. Cuvier's beaked whales echolocation clicks were recorded at frequencies from 20 to 70 kHz. There is no information on the hearing abilities of Cuvier's beaked whale. Cuvier's beaked whales are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007). Vocalizations ranges are similar at 300 Hz to 135 kHz (DON 2008a) (Table 4.1).

4.1.15 Pygmy Sperm Whale (*Kogia breviceps*) and Dwarf Sperm Whale (*K. sima*) California, Oregon, Washington Stock

Description: Kogia spp. are porpoise-like and robust with a distinctive under-slung lower jaw. Pygmy sperm whales reach a maximum size of about 3.8 m and weight of 450 kg; dwarf sperm whales are smaller at 2.7 m and 272 kg (McAlpine 2009). Adults of both species are bluish-gray to blackish-brown dorsally and light below (ibid). On the side of the head between the eye and the flipper there is a crescent shaped light colored mark referred to as a "false gill." Both species have the shortest rostrum of any cetacean, and the skull is markedly asymmetrical (ibid).

Status and trends: Pygmy and dwarf sperm whales belong to the Order Cetacea, Suborder Odontoceti, and Family Kogiidae. As summarized in Carretta et al. (2011, and citations therein), the most recent abundance estimate for pygmy sperm whales is 579 (CV=1.02) animals and is based on one sighting of an unidentified *Kogia* during a 2008 ship survey of California, Oregon, and Washington waters (Barlow 2010). Based on previous sighting surveys and historical stranding data, it is likely that these sightings were of pygmy sperm whales. The estimate

incorporates a correction factor for animals missed, based on a model of their diving behavior, detection distances, and the searching behavior of observers. Based on this sighting and population estimate the current estimate of minimum population is 271 pygmy sperm whales with a calculated PBR of 2.7 whales. The lack of recent sightings likely reflects the cryptic nature of this species (they are detected almost exclusively in extremely calm sea conditions), rather than an absence of animals in the region.

There is no information on population size for the dwarf sperm whale in the California Current Ecosystem and thus no minimum population estimate or PBR can be calculated.

Barlow and Forney (2007) estimated the density of *Kogia* spp. at 1.09 animals/1000 km^2.

The status of pygmy and dwarf sperm whales in California, Oregon and Washington waters relative to OSP is not known, and there are insufficient data to evaluate potential trends in abundance. No habitat issues are known to be of concern for these species. They are not listed as threatened or endangered under the ESA nor as "depleted" under the MMPA. Given the rarity of sightings and fishery interactions in U.S. west coast waters, pygmy and dwarf sperm whales are not classified as a “strategic” stock under the MMPA.

Distribution and habitat preferences: Pygmy and dwarf sperm whales have a worldwide distribution in tropical and temperate waters of the Atlantic, Pacific, and Indian Oceans (McAlpine 2009). Pygmy sperm whales are sighted primarily along the continental shelf edge and over deeper waters off the shelf. However, along the U.S. west coast, sightings of the whales have been rare, although that is likely a reflection of their pelagic distribution and small size rather than their true abundance (Carretta et al. 2012). Several studies have suggested that pygmy sperm whales live mostly beyond the continental shelf edge. There are eight confirmed stranding records of *Kogia* from Oregon and Washington (Carretta et al. 2012).

Behavior and life history: As summarized in DON (2008b, and citations therein) pygmy and dwarf sperm whales probably feed on fish and invertebrates that feed on the zooplankton in tropical and temperate waters. There is no information on the breeding behavior of either species. *Kogia* feed on cephalopods and, less often, on deep-sea fishes and shrimps. *Kogia* make dives of up to 25 min. Median dive times of around 11 minutes have been documented. A satellite-tagged pygmy sperm whale released off Florida was found to make long nighttime dives, presumably indicating foraging on squid in the deep scattering layer (Scott et al. 2001). Most sightings are brief; these whales are often difficult to approach and they actively avoid aircraft and vessels.

Acoustics and hearing: Kogia species are in the high-frequency functional hearing group, with an estimated auditory bandwidth of 200 Hz to 180 kHz (Southall et al. 2007). Vocalizations frequencies range from 13 to 200 kHz (Table 4.1). Recordings of clicks emitted by free-ranging *K. sima* (dwarf sperm whales) in the Lesser Antilles were in the lower end of the range (13-30 kHz). Recordings of stranded pygmy sperm whales were in the 60 to 200 kHz range (DON 2008a).

4.1.16 Sperm Whale (*Physeter macrocephalus)* California, Oregon, Washington Stock

Description: The sperm whale is the largest toothed whale species and the most sexually dimorphic cetacean in body length and weight (Whitehead 2009). Adult females can reach 12 m

in length, while adult males measure as much as 18 m in length (Jefferson et al. 1993). The head is large (comprising about one-third of the body length) and squarish. The lower jaw is narrow and under slung. The blowhole is located at the front of the head and is offset to the left. Sperm whales are brownish gray to black in color with white areas around the mouth and often on the belly. The flippers are relatively short, wide, and paddle-shaped. There is a low rounded dorsal hump and a series of bumps on the dorsal ridge of the tailstock and the surface of the body behind the head tends to be wrinkled (Whitehead 2009).

Status and trends: Sperm whales belong to the Order Cetacea, Suborder Odontoceti, and Family Physeteridae. As summarized in Carretta et al. (2011, and citations therein), large populations of sperm whales exist in waters of the California Current Ecosystem that are within several thousand miles west and south of the California, Oregon, and Washington region; however, there is no evidence of sperm whale movements into this region from either the west or south and genetic data suggest that mixing to the west is extremely unlikely. There is limited evidence of sperm whale movement from California to northern areas off British Columbia, but there are no abundance estimates for this area. The most precise and recent estimate of sperm whale abundance for this stock is 971 (CV=0.33) animals from the ship surveys conducted in 2005 (Forney2007) and 2008 (Barlow 2010). The minimum population estimate for sperm whales in this region is 751 whales with a calculated PBR of 1.5 sperm whales per year. Barlow and Forney (2007) estimated the density of sperm whales at 1.70 whales/1000 km^2.

Whaling removed at least 436,000 sperm whales from the North Pacific between 1800 and the end of commercial whaling (summarized in Carretta et al. 2012 and references therein). Of this total, an estimated 33,842 were taken by Soviet and Japanese pelagic whaling operations in the eastern North Pacific from the longitude of Hawaii to the U.S. West coast, between 1961 and 1976, and approximately 1,000 were reported taken in land-based U.S. West coast whaling operations. There has been a prohibition on taking sperm whales in the North Pacific since 1988, but large-scale pelagic whaling stopped earlier, in 1980. As a result of this whaling, sperm whales are formally listed as "endangered" under the ESA, and consequently the California to Washington stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. The annual rate of kill and serious injury (0.4 per year) is less than the calculated PBR for this stock (1.5). Total human-caused mortality is greater than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate.

Distribution and habitat preferences: With the exception of humans and killer whales, few animals on earth are as widely distributed as the sperm whale (Whitehead 2009). As summarized in Carretta et al. (2011, and citations therein), sperm whales are widely distributed across the entire North Pacific and into the southern Bering Sea in summer but the majority are thought to be south of 40° N in winter. Sperm whales are found year round in California waters, but they reach peak abundance from April through mid-June and from the end of August through mid-November. They were seen in every season except winter (Dec.-Feb.) in Washington and Oregon. Of 176 sperm whales that were marked with Discovery tags off southern California in winter 1962-70, only three were recovered by whalers: one off northern California in June, one off Washington in June, and another far off British Columbia in April. Recent summer/fall surveys in the eastern tropical Pacific show that although sperm whales are widely distributed in

the tropics, their relative abundance tapers off markedly westward towards the middle of the tropical Pacific (near the IWC stock boundary at 150° W) and tapers off northward towards the tip of Baja California.

Behavior and life history: Females reach sexual maturity at about age 9 when roughly 9 m long and they give birth about every 5 years; gestation is 14-16 months (Whitehead 2009). Males are larger during the first 10 years and continue to grow well into their 30s, finally reaching physical maturity at about 16 m (ibid). The sperm whale consumes numerous varieties of deep water fish and cephalopods. Sperm whales forage during deep dives that routinely exceed a depth of 400 m and duration of 30 min (Watkins et al. 2002). They are capable of diving to depths of over 2,000 m with durations of over 60 min. Sperm whales spend up to 83 percent of daylight hours underwater. Males do not spend extensive periods of time at the surface. In contrast, females spend prolonged periods of time at the surface (1 to 5 hrs daily) without foraging (Whitehead 2009). An average dive cycle consists of about a 45 min dive with a 9 min surface interval. The average swimming speed is estimated to be 2.5 km/hr.

Acoustics and hearing: As summarized in DON (2008a, and citations therein), sperm whales typically produce short-duration (less than 30 ms), repetitive broadband clicks used for communication and echolocation. These clicks range in frequency from 0.1 to 30 kHz, with dominant frequencies between the 2 to 4 kHz and 10 to 16 kHz ranges. When sperm whales are socializing, they tend to repeat series of group-distinctive clicks (codas), which follow a precise rhythm and may last for hours (Whitehead 2009). Codas are shared between individuals of a social unit and are considered to be primarily for intra-group communication. Neonatal clicks are of low directionality, long duration (2 to 12 ms), low frequency (dominant frequencies around 0.5 kHz) with estimated source levels between 140 and 162 dB re 1 μPa-m rms. Source levels from adult sperm whales' highly directional (possible echolocation), short (100 μs) clicks have been estimated up to 236 dB re 1 μPa-m rms. Creaks (rapid sets of clicks) are heard most frequently when sperm whales are engaged in foraging behavior in the deepest portion of their dives with intervals between clicks and source levels being altered during these behaviors. In summary, sperm whales are in the mid-frequency functional hearing group, with an estimated auditory range of 150 Hz to 160 kHz (Southall et al. 2007). Vocalizations, including echolocation clicks, range from 100 Hz to 30 kHz (DON 2008a) (Table 4.1).

4.1.17 Humpback Whale (*Megaptera novaeangliae*) California, Oregon, Washington Stock

Description: As summarized by Clapham (2009, and citations therein), humpback whales are large baleen whales with females slightly larger than males. Adult lengths are 16-17 m and calves are about 4 m. Humpback whales are easily recognized at close range by their extremely long flippers, which may be one-third the length of the body. The flippers are white on the bottom and may be white or black on top, depending on the population. The body is black on top with variable coloration ventrally and on the sides. The head and jaws have numerous knobs that are diagnostic for the species. The dorsal fin is small and variable in shape. The underside of the tail exhibits a pattern of white to black that is individually identifiable. The baleen is primarily black and occurs in 270-400 plates on each side of the mouth.

Status and trends: The humpback whale belongs to the Order Cetacea, Suborder Mysticeti, and Family Balaenopteridae. No subspecies are recognized. The species is listed as endangered

throughout its range. Three relatively distinct stocks migrate between their summer/fall feeding areas and winter/spring calving and mating areas: eastern, central, and western North Pacific stocks. The eastern North Pacific stock spends the winter/spring in Central America and Mexico and migrates along the west coast from California to British Columbia during summer and fall. Some individuals from the central North Pacific stock, which winters in Hawaii and summers in Alaska, overlap with the summer/fall distribution of the eastern North Pacific stock off the coast of Washington and British Columbia (Clapham 2009). The eastern North Pacific stock contains several distinct populations including the California/Oregon/Washington population. Waters off northern Washington may be an area of mixing between the California/Oregon/Washington population and a southern British Columbia population (Carretta et al. 2012).

Forney (2007) estimated 1,769 (CV=0.16) humpbacks in the California/Oregon/Washington region based on a 2005 summer/fall ship line-transect survey, which included additional fine-scale coastal strata not included in a 2001 survey. Barlow (2010) estimated 1,090 (CV=0.41) humpback whales from a 2008 summer/fall ship line-transect survey of the same region. The combined 2005 and 2008 line-transect estimate of abundance is the geometric mean of the two annual estimates, or 1,389 (CV=0.21). The minimum population estimate for humpback whales in the California/Oregon/Washington population is based on abundance estimated from line-transect and mark-recapture methods and is approximately 1,878 whales and the best estimate is 2,043 humpback whales (Carretta et al. 2012). The population is growing at about 6-7% per year. The PBR level for this stock is calculated as the minimum population size (1,878) times one half the estimated population growth rate for this stock times a recovery factor of 0.1, resulting in a PBR of 22.5. Because this stock spends approximately half its time outside the U.S. EEZ, the PBR allocation for U.S. waters is 11.3 whales per year. Barlow and Forney (2007) estimated the density of humpback whales at 0.83 whales/1000 km^2.

The species is listed as endangered under the ESA, and consequently the California/Mexico stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. The estimated annual mortality and serious injury due to entanglement (3.2/yr), other anthropogenic sources (zero), plus ship strikes (0.4/yr) in California is less than the PBR allocation of 11.3 for U.S. waters. Based on strandings and at sea observations, annual humpback whale mortality and serious injury in commercial fisheries is greater than 10% of the PBR; therefore, total fishery mortality and serious injury is not approaching zero mortality and serious injury rate. The eastern North Pacific stock appears to be increasing in abundance (Carretta et al. 2012).

Distribution and habitat preferences: Surveys conducted by Brueggeman et al. (1992) recorded 36 groups of 68 humpbacks off the Oregon and Washington coasts between May and November. Humpbacks were most abundant between May and September, and no whales were observed during winter. No calves were observed during the surveys. Green et al. (1993) reported 50 groups of 77 humpback whales off the Oregon and Washington coasts between March and April, but did not give their locations relative to the continental shelf. Humpback whales are found in all oceans of the world and are highly migratory from high latitude feeding grounds to low latitude calving areas. They are typically found in coastal or shelf waters in summer and close to islands and reef systems in winter (Clapham 2009). Humpbacks primarily occur near the edge of the continental slope and deep submarine canyons, where upwelling concentrates zooplankton near the surface for feeding. They often feed in shipping lanes, which makes them susceptible to

mortality or injury from large ship strikes (Douglas et al. 2008). About 10% of the whales that were identified off Oregon were also photographed off northern Washington. The results from these surveys showed that humpback whales fed off the Washington coast near the edges of the continental slope or deep canyons from May through September, with the highest numbers in June and July (Calambokidis et al. 2004).

Behavior and life history: Humpback whales are known for their spectacular aerial behaviors and complex songs of males. They breed in warm tropical waters after an 11 month gestation period; calves likely feed independently after 6 months. Humpback whales feed on euphausiids and various schooling fishes, including herring, capelin, sand lance, and mackerel (Clapham 2009). As summarized in Clapham (2009, and citations therein) and DON (2008b, and citations therein), humpback whale dives in summer last less than 5 min; those exceeding 10 min are atypical. In winter (December through March), dives average 10 to 15 min. Although humpback whales have been recorded to dive as deep as about 500 m, on the feeding grounds they spend the majority of their time in the upper 122 m of the water column. On the wintering grounds they dive deeper to 176 m or greater. 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 mouths open through the middle.

Acoustics and hearing: Humpback whales are known to produce three classes of vocalizations: (1) "songs" in the late fall, winter, and spring by solitary males; (2) sounds made within groups on the wintering (calving) grounds; and (3) social sounds made on the feeding grounds (Richardson et al. 1995). The main energy of humpback whale songs lies between 0.2 and 3.0 kHz, with frequency peaks at 4.7 kHz. Feeding calls, unlike song and social sounds, are highly stereotyped series of narrow-band trumpeting calls. They are 20 Hz to 2 kHz, less than 1 second in duration, and have source levels of 175 to 192 dB re 1 μPa-m. The fundamental frequency of feeding calls is approximately 500 Hz (summarized in DON 2008b, and citations therein). Thus, humpback whales are in the low-frequency functional hearing group, with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007). Their vocal repertoire ranges from 20 Hz to greater than 10 kHz (DON 2008a) (Table 4.1).

4.1.18 Blue Whale (*Balaenoptera musculus*) Eastern North Pacific Stock

Description: The blue whale is the largest animal to have ever existed on earth and is found world-wide ranging into all oceans. The largest recorded blue whale from the northern hemisphere was a 28.1 m female; females tend to be larger than males, and southern hemisphere blue whales are larger than those in the north (Sears and Perrin 2009). They have a tapered, elongated shape with a huge broad, relatively flat, U-shaped head. The baleen is black (ibid). The dorsal fin is proportionately smaller than in other baleen whales and varied in shape, ranging from a small nubbin to triangular and falcate positioned far back on the body (Ibid). Underwater they are slate blue; above water they appear mottled light and dark shades of gray.

Status and trends: The blue whale belongs to the Order Cetacea, Suborder Mysticeti, and Family Balaenopteridae. The U.S. west Coast feeding stock of blue whales was estimated recently by both line transect and mark-recapture methods (Carretta et al. 2012). Because some fraction of the population is always outside the survey area, the line-transect and mark recapture estimation methods provide different measures of abundance for this stock. Line transect estimates reflect

the average density and abundance of blue whales in the study area during summer and autumn surveys, while mark recapture estimates provide an estimate of total population size. Therefore, the best estimate of blue whale abundance is the average of mark-recapture estimates, or 2,497 (CV= 0.24). The minimum population is approximately 2,046 blue whales with a calculated PBR of 12.2. Because whales in this stock spend approximately three quarters of their time outside the U.S. EEZ, the PBR allocation for U.S. waters is one-quarter of this total, or 3.1 whales per year. Barlow and Forney (2007) estimated the density of blue whales at 1.36 whales/1000 km^2.

As summarized in Carretta et al. (2011, and references therein), the reported take of North Pacific blue whales by commercial whalers totaled 9,500 between 1910 and 1965. Approximately 3,000 of these were taken from the west coast of North America from Baja California, Mexico to British Columbia, Canada. Blue whales in the North Pacific were given protected status by the IWC in 1966. As a result of commercial whaling, blue whales were listed as "endangered" under the Endangered Species Conservation Act of 1969. This protection was transferred to the ESA in 1973. They are still listed as “endangered”, and consequently the Eastern North Pacific stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. The annual incidental mortality and injury rate (1.0/year) from ship strikes is less than the calculated PBR for this stock, but this rate does not include unidentified large whales struck by vessels, some of which may have been blue whales. To date, no blue whale mortality has been associated with California gillnet fisheries; therefore total fishery mortality is approaching zero mortality and serious injury rate.

Distribution and habitat preferences: The blue whale has a worldwide distribution in circumpolar and temperate waters. They undertake seasonal migrations and were historically hunted on their summer, feeding areas. It is assumed that blue whale distribution is governed largely by food requirements and that populations are seasonally migratory. Pole-ward movements in spring allow the whales to take advantage of high zooplankton production in summer. Movement toward the subtropics in the fall allows blue whales to reduce their energy expenditure while fasting and to avoid ice entrapment. For the California Current Ecosystem as defined in Carretta et al. (2011), the Eastern North Pacific Stock of blue whales includes animals found in the eastern North Pacific from the northern Gulf of Alaska to the eastern tropical Pacific. This definition is consistent with both the distribution of the northeastern call type and with the known range of photographically identified individuals. Based on locations where the northeastern call type has been recorded, some individuals in this stock may range as far west as Wake Island and as far south as the Equator. The U.S. west coast is certainly one of the most important feeding areas in summer and fall, but, increasingly, blue whales from this stock have been found feeding to the north and south of this area during summer and fall. Six blue whales were sighted 25 miles off the Washington coast during October and November 2011. Most of this stock is believed to migrate south to spend the winter and spring in high productivity areas off Baja California, in the Gulf of California, and on the Costa Rica Dome (a large, 300-500 km^2, relatively stationary eddy centered near 9° N and 89° W).

Behavior and life history: Blue whales reach sexual maturity at 5-15 years of age; length at sexual maturity in the Northern Hemisphere for females is 21-23 m and for males it is 20-21 m (Sears and Perrin 2009). Females give birth about every 2-3 years in winter after a 10-12 month gestation; longevity is thought to be at least 80-90 years (ibid). Blue whales occur primarily in

offshore deep waters (but sometimes near shore, e.g., the deep waters in Monterey Canyon, CA) and feed almost exclusively on euphausiids. Croll et al. (2001) determined that blue whales dived to an average of 141 m and for 7.8 min when foraging and to 68 m and for 4.9 min when not foraging. Data from southern California and Mexico showed that whales dove to > 100 m for foraging. Calambokidis et al. (2003) deployed tags on blue whales and collected data on dives as deep as about 300 m.

Acoustics and hearing: Blue whales, along with other mysticetes, are in the low-frequency functional hearing group, with an estimated auditory range of 7 Hz to 22 kHz (Southall et al. 2007). Their vocalizations range from 12 Hz to 400 Hz, with a dominant range of 12-25 Hz (DON 2008a) (Table 4.1).

4.1.19 Fin Whale (*Balaenoptera physalus)* California, Oregon, Washington Stock

Description: Fin whales are sexually dimorphic with females about 10-15% longer than males; in the Northern Hemisphere female length is about 22.5 m and for males 21 m (Aguillar 2009). Fin whales are slender with a narrow rostrum, a falcate fin located at 75% of total length; it is higher than the blue whale but lower than the sei whale (ibid). The ventral grooves are numerous and extend from the chin to the umbilicus. The pigmentation of the head region is strikingly asymmetrical whereas the left side, dorsal and ventral, is dark slate and the right side dorsal is light gray and the right ventral is white (ibid). The pigmentation also is shown in the baleen plates, which are gray and yellowish.

Status and trends: The fin whale belongs to the Order Cetacea, Suborder Mysticeti, and Family Balaenopteridae. As summarized in Carretta et al. (2011, and references therein), a 2005 ship survey of the California/Oregon/Washington stock resulted in an abundance estimate of 3,281 (CV=0.25) fin whales (Forney 2007). The best estimate of fin whale abundance in California, Oregon, and Washington waters out to 300 nmi is the geometric mean of line transect estimates from summer/autumn ship surveys conducted in 2005 (Forney 2007) and 2008 (Barlow 2010), or 3,044 (CV = 0.18) whales. This is probably an underestimate because it almost certainly excludes some fin whales which could not be identified in the field and which were recorded as “unidentified rorqual” or “unidentified large whale”. The minimum population estimate is 2,624 fin whales with a calculated PBR of 16 whales per year. Barlow and Forney (2007) estimated the density of fin whales at 1.84 whales/1000 km^2.

Fin whales in the entire North Pacific were estimated to be at less than 38% (16,625 out of 43,500) of historic carrying capacity (Mizroch et al. 1984). The initial abundance has never been estimated separately for the "west coast" stock, but this stock was also probably depleted by whaling. Approximately 46,000 fin whales were taken from the North Pacific by commercial whalers between 1947 and 1987. Approximately 5,000 fin whales were taken from the west coast of North America from 1919 to 1965. Fin whales in the North Pacific were given protected status by the IWC in 1976. Fin whales are formally listed as "endangered" under the ESA, and consequently the California to Washington stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. The total incidental mortality due to fisheries (zero) and ship strikes (1.0/yr) is less than the calculated PBR (16). Total fishery mortality is less than 10% of PBR and, therefore, may be approaching zero mortality and serious injury rate. There is some indication that the population may be growing.

Distribution and habitat preferences: As summarized in DON (2008b, and references therein), fin whales occur in oceans of both Northern and Southern Hemispheres between 20–75° N and S latitudes. Fin whales are distributed widely in the world's oceans. In the northern hemisphere, most migrate seasonally from high Arctic feeding areas in summer to low latitude breeding and calving areas in winter. During the summer in the North Pacific Ocean, fin whales are distributed in the Chukchi Sea, around the Aleutian Islands, the Gulf of Alaska, and along the coast of North America to California. The fin whale is found in continental shelf and oceanic waters. Globally, it tends to be aggregated in locations where populations of prey are most plentiful, irrespective of water depth, although those locations may shift seasonally or annually. Fin whales in the North Pacific spend the summer feeding along the cold eastern boundary currents. The North Pacific population summers from the Chukchi Sea to California, and winters from California southward.

Behavior and life history: Fin whales become sexually mature between six to ten years of age, depending on density-dependent factors. Reproduction occurs primarily in the winter. Gestation lasts about 11 months and nursing occurs for 6 to 11 months (Aguillar 2009). Fin whales typically dive for 5 to 15 min, separated by sequences of 4 to 5 blows at 10 to 20 second intervals. Goldbogen et al. (2006) reported that fin whales in California made foraging dives to a maximum of 228-271 m and dive durations of 6.2-7.0 min. Fin whale dives likely coincide with the diel migration of krill. Fin whales feed on planktonic crustaceans, including *Thysanoessa* sp. and *Calanus* sp., as well as schooling fish including herring, capelin and mackerel (Aguilar 2009).

Acoustics and hearing: Fin whales are in the low-frequency functional hearing group, with an estimated auditory range of 7 Hz to 22 kHz (Southall et al. 2007). They also vocalize at low frequencies of 15-30 Hz (DON 2008a) (Table 4.1).

4.1.20 Sei Whale (*Balaenoptera borealis)* Eastern North Pacific Stock

Description: The sei whale is a typical sleek rorqual and is the third largest whale (behind blue and fin) reaching a maximum length of about 20 m and weighing 20 tons; the dorsal fin is larger than that of the blue and fin but all three species may be confused at sea (Horwood 2009). There is a single prominent ridge on the rostrum and a slightly arched rostrum with a downturned tip. They are dark gray dorsally and on the ventral surfaces of the flukes and flippers (ibid). There is no whitening of the lower lip as in fin whales and the baleen is dark gray, often with a yellowish-blue hue; but some white baleen may occur in some individuals (ibid).

Status and trends: The sei whale belongs to the Order Cetacea, Suborder Mysticeti, and Family Balaenopteridae. As summarized in Carretta et al. (2011, and references therein) only five confirmed sightings of sei whales were made in California, Oregon, and Washington waters during extensive ship and aerial surveys between 1991-2005. Green et al. (1992) did not report any sightings of sei whales in aerial surveys of Oregon and Washington. Abundance estimates for the two most recent line transect surveys of California, Oregon, and Washington waters out to 300 nmi are 74 (CV=0.88) and 215 (CV=0.71) sei whales, respectively (Forney 2007, Barlow 2010). The best estimate of abundance for California, Oregon, and Washington waters out to 300 nmi is the unweighted geometric mean of the 2005 and 2008 estimates, or 126 (CV=0.53) sei whales (Barlow and Forney 2007 ; Forney 2007; Barlow 2010).with a minimum population estimate of 83; the calculated PBR is 0.17 sei whales per year. Barlow and Forney (2007) estimated the density of sei whales at 0.09 whales/1000 km^2.

Previously, sei whales were estimated to have been reduced to 20% (8,600 out of 42,000) of their pre-whaling abundance in the North Pacific. The initial abundance has never been reported separately for the eastern North Pacific stock, but this stock was also probably depleted by whaling. The reported take of North Pacific sei whales by commercial whalers totaled 61,500 between 1947 and 1987. Of these, at least 410 were taken by-shore-based whaling stations in central California between 1919 and 1965. There has been an IWC prohibition on taking sei whales since 1976, and commercial whaling in the U.S. has been prohibited since 1972. Sei whales are formally listed as "endangered" under the ESA, and consequently the eastern North Pacific stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. Total estimated fishery mortality is zero and therefore is approaching zero mortality and serious injury rate. The total incidental mortality due to ship strikes is greater than the calculated PBR (0.17).

Distribution and habitat preferences: As summarized in Horwood (2009) and DON (2008a,b), sei whales have a worldwide distribution but are found primarily in cold temperate to subpolar latitudes rather than in the tropics or near the poles (Horwood 2009). Sei whales spend the summer months feeding in subpolar higher latitudes and return to lower latitudes to calve in the winter. There is some evidence from whaling catch data of differential migration patterns by reproductive class, with females arriving at and departing from feeding areas earlier than males. For the most part, the location of winter breeding areas is unknown.

Behavior and life history: Sei whales mature at about 10 years for both sexes. They 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. On feeding grounds, the distribution is largely associated with oceanic frontal systems (Horwood 2009). In the North Pacific, sei whales feed along the cold eastern currents (Perry et al. 1999). Prey includes calanoid copepods, krill, fish, and squid. The dominant food for sei whales off California during June through August is the northern anchovy, while in September and October they eat mainly krill. There are no reported diving depths or durations for Sei whales.

Acoustics and hearing: Sei whales are in the low-frequency hearing group, along with other baleen whales, with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007). There are few recordings of sei whale vocalizations in the North Pacific, where the sweep frequency ranged from 1.5 to 3.5 kHz (DON 2008a) (Table 4.1).

4.1.21 Common Minke Whale (*Balaenoptera acutorostrata scammoni*) California, Oregon, Washington Stock

Description: As summarized by Perrin and Brownell (2009, and citations therein), the North Pacific minke whale is the second smallest baleen whale with females somewhat larger than males. Females have been measured at 8.5 m and males at 7.9 m and weigh about 10 tons. The body is dark gray to brownish dorsally and white to cream ventrally; the flipper has a white chevron that is diagnostic. The baleen is white and short and numbers between 230-360 plates; the dorsal fin is relatively tall and falcate and located forward on the posterior one-third of the body. The rostrum is very narrow and pointed (thus the species name acutorostrata).

Status and trends: The common minke whale belongs to the Order Cetacea, Suborder Mysticeti, and Family Balaenopteridae. They are widely distributed in all oceans with three recognized subspecies, one in the North Atlantic (*B. a. acutorostrata*), one in the North Pacific (*B. a. scammoni*), and one around the Antarctic Peninsula (*B. acutorostrata)* where it is known as the dwarf minke whale (Acevedo et al. 2011; section 4.4.10). A second minke whale species is recognized in the southern hemisphere as the Antarctic minke whale (*B. bonaerensis*, section 4.3.8). Because 'resident' minke whales from California to Washington appear behaviorally distinct from migratory whales further north, minke whales in coastal waters of California, Oregon, and Washington are considered a separate stock (Carretta et al. 2012).

The number of minke whales in this stock has been estimated to be 478 whales with a minimum population estimate of 202 whales; the calculated PBR for this stock is 2 whales (Carretta et al. 2012). They typically occur as single animals, rather than in groups. Barlow and Forney (2007) estimated the density of minke whales at 0.72 whales/1000 km^2.

The annual mortality due to fisheries (0.0/yr) and ship strikes (0.0/yr) is less than the calculated PBR for this stock (2.0), so they are not considered a "strategic" stock under the MMPA. Fishery mortality is less than 10% of the PBR; therefore, total fishery mortality is approaching zero mortality and serious injury rate (Carretta et al. 2012).

Distribution and habitat preferences: Minke whales are common and the most numerous baleen whales found throughout the world. In the Northeast Pacific Ocean, minke whales range from the Chukchi Sea south to Baja California (Perrin and Brownell 2009). They occur year-round off California. The minke whales found in waters off California, Oregon, and Washington appear to be resident in that area, and to have home ranges, whereas those farther north are migratory. The minke whale generally occupies waters over the continental shelf, including inshore bays and estuaries (ibid). However, based on whaling catches and surveys worldwide, there is also a deep-ocean component to the minke whale's distribution. Minke whales appear to establish home ranges in the inland waters of Washington and along central California, and exhibit site fidelity to these areas. In Puget Sound they may be seen during all months but are most often seen during March through November (Calambokidis and Baird 1994). Little is known of specific habitat preferences for minke whales but they are seen in coastal, continental shelf, and deep pelagic waters. They are common but not numerous visitors to Puget Sound with 'resident' identifiable minke whales commonly observed in the San Juan Islands.

Behavior and life history: Little is known of the natural history of minke whales. They are assumed to breed in winter in warm waters of low latitudes, give birth to a single calf every other year, and reach sexual maturity when 7-9 m long (Osborne et al. 1988, Perrin and Brownell 2009). Minke whales in the North Pacific typically prey on euphausiids, Japanese anchovy, Pacific saury, walleye pollock, small fish, and squid (Perrin and Brownell 2009). There are no data on dive depth for minke whales. Minke whales are predated upon by killer whales.

Acoustics and hearing: Minke whales are in the low-frequency functional hearing group with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007). Vocalizations range from 60 Hz to 20 kHz (DON 2008a) (Table 4.1).

4.1.22 Gray Whale (*Eschrichtius robustus*) Eastern North Pacific Stock

Description: The gray whale is a robust, slow-moving whale recognized by a mottled gray color with numerous light patches scattered along the body and lack of a dorsal fin (Jones and Swartz 2009). They have more external parasites and epizoites than any other cetacean (Jones and Swartz 2009). Instead of a dorsal fin, they have a low hump, followed by a series of 10 or 12 knobs along the dorsal ridge of the tail, which are easily seen when the animal arches to dive. The baleen is short (5-40 cm), thick, and coarse and is cream-white to yellow. The upper jaw has 130-180 baleen plates (Jones and Swartz 2009). Adults are 10-15 m long and weigh between 16 and 45 tons. At birth, the calves are 5 m long and weigh close to 450 kg. Both male and female gray whales reach sexual maturity when they are between five and 11 years old, with the average being eight years (Rice 1986).

Status and trends: Gray whales belong to the Order Cetacea, Suborder Mysticeti, and Family Eschrichtiidae. There are two populations, the western North Pacific population that migrates along Asia and into the Okhotsk Sea, and the eastern North Pacific population that migrates along the coasts of eastern Siberia, North America, and Mexico. Over 20,000 gray whales swim through the California Current Ecosystem each year during their annual migration from feeding grounds in the Bering Sea to calving bays in Baja California. Of these a small number remain along the Canadian/Washington/Oregon coast to feed and explore, of which an even smaller number swim into Puget Sound and into and through Admiralty Inlet. On June 16, 1994, the eastern North Pacific gray whale population was formally removed from the list of endangered and threatened wildlife under the ESA. The stock is stable or increasing. The most recent abundance estimates are based on counts made during the 1997/98, 2000/01, 2001/02, and 2006/07 southbound migrations. Analyses of these data resulted in abundance estimates 16,369 (CV=6.1%) in 2000/01, 16,033 (CV=6.9%) in 2001/02, and 19,126 (CV=7.1%) in 2006/07.with a minimum population estimate of 18,017; the calculated PBR for this stock is 360 gray whales (Allen and Angliss 2011).

Distribution and habitat preferences: The gray whale migration covers 8,000-10,000 km each way (Rugh et al. 1999), perhaps the longest migration of any mammalian species. Most eastern North Pacific gray whales spend the summer in the shallow waters of the northern and western Bering Sea and in the adjacent waters of the Arctic Ocean; however, as mentioned above, some remain throughout the summer and fall along the Pacific coast as far south as southern California. These whales are designated as the Pacific Coast Feeding Aggregation and have been shown by photo-identification studies to 1) move widely within and between areas on the Pacific coast to feed in the summer and fall, 2) are not always observed in the same area each year, and 3) may have several year gaps between resightings in studied areas (Quan 2000). Gray whales are by far the most coastal of all the great whales, and inhabit primarily inshore or shallow, offshore continental shelf waters of the North Pacific. They tend to be nomadic, highly migratory, and tolerant of climate extremes (Jones and Swartz 2009).

Behavior and life history: Female gray whales usually breed once every two years. The breeding season is limited primarily to a three-week period in late November and early December near the start of the southward migrations. However, if no conception occurs at that time, a second estrus cycle can occur within 40 days (Rice and Wolman 1971), such that a few females may breed as late as the end of January on the winter grounds (Jones and Swartz 2009). Gray whale calves are born in the winter after a gestation period of about 13.5 months. Killer whale predation may be

the most significant cause of mortality (ibid). The gray whales that feed within Puget Sound typically use shallow areas close to shore for feeding on herring eggs and larvae, crab larvae, ghost shrimp, amphipods and crustaceans.

Acoustics and hearing: As summarized in Jones and Swartz (2009) and DON (2008b, and references therein), gray whales produce broadband signals ranging from 100 Hz to 4 kHz (and up to 12 kHz). The most common sounds on the breeding and feeding grounds are knocks which are broadband pulses from about 100 Hz to 2 kHz and most energy at 327 to 825 Hz (Richardson et al. 1995). The source level for knocks is approximately 142 dB re 1 μPa-m. During migration, individuals most often produce low-frequency moans. The structure of the gray whale ear is evolved for low-frequency hearing. Gray whale responses to noise include changes in swimming speed and direction to move away from the sound source; abrupt behavioral changes from feeding to avoidance, with a resumption of feeding after exposure; changes in calling rates and call structure; and changes in surface behavior, usually from traveling to milling.

PINNIPEDS

4.1.23 California Sea Lion (*Zalophus californianus*) U.S. Stock

Description: California sea lions are highly sexually dimorphic; the weight and length of males is about 350 kg and 2.4 m compared to females at 100 kg and 1.8 m, respectively (Heath and Perrin 2009). Male and female pups weigh 6-9 kg. Adult males usually are a dark brown, but can range from light brown to black; females are dark brown to black (Heath and Perrin 2009). Males typically have a distinguishing sagittal crest on top of the head often topped with white fur.

Status and trends: The California sea lion belongs to the Order Carnivora, Suborder Pinnipedia, Family Otariidae and includes three subspecies of which *Z. c. californianus* (found from southern Mexico to southwestern Canada) occurs in the California Current Ecosystem. California sea lions breed on islands in three geographic regions which are used to separate this subspecies into three stocks: (1) the United States stock begins at the United States/Mexico border and extends northward into Canada; (2) the Western Baja California stock which extends from the United States/Mexico border to the southern tip of the Baja California Peninsula; and (3) the Gulf of California stock which includes the Gulf of California from the southern tip of the Baja California peninsula (Carretta et al. 2012). Based on extrapolations from pup counts, the population is estimated at 296,750 sea lions, and it is growing at 5.6 percent per year (Carretta et al. 2012). The minimum population estimate for the U.S. stock is 153,337 sea lions. The calculated PBR for this stock is 9,200 animals (Carretta et al. 2012).

As summarized in Carretta et al. (2011), a generalized logistic growth model of pup counts obtained during 1975-2005 (excluding El Niño years) indicated that the population reached its Maximum Net Productivity Level (MNPL) of 39,800 pups in 1997 and has reached carrying capacity (K) at 46,800 pups per year. This determination should be taken with caution until more years of data have been collected to verify whether the flattening of the generalized logistic curve persists in future years. California sea lions in the U.S. are not listed as "endangered" or "threatened" under the ESA or as "depleted" under the MMPA. California sea lions are not considered a "strategic" stock under the MMPA because (based on historical takes in the set gillnet fishery and current levels of fishing effort) total human-caused mortality is still likely to

be less than the PBR (9,200). The total fishery mortality and serious injury rate (337 animals/year) for this stock is less than 10% of the calculated PBR and, therefore, is considered to be insignificant and approaching a zero mortality and serious injury rate.

Distribution and habitat preferences: The primary rookeries are located on the California Channel Islands of San Miguel, San Nicolas, Santa Barbara, and San Clemente. As summarized in Carretta et al. (2011) and DON (2008b, and references therein), their distribution shifts to the northwest in fall and to the southeast during winter and spring, probably in response to changes in prey availability. In the non-breeding season, adult and subadult males migrate northward along the coast to central and northern California, Oregon, Washington, and Vancouver Island and return south the following spring; they are occasionally sighted hundreds of kilometers offshore. Females and juveniles tend to stay closer to the rookeries. They also enter bays, harbors, and river mouths and often haul out on man-made structures such as piers, jetties, offshore buoys, and oil platforms (Riedman 1990). California sea lions in the Puget Sound haul out on log booms and U.S. Navy submarines, and are often seen rafted off river mouths (Jeffries et al. 2000). They are occasionally sighted up to several hundred kilometers offshore. California sea lions frequently travel up river systems in search of prey and are common at Bonneville Dam, 230 miles upriver from the mouth of the Columbia River, consuming migrating salmonids during winter and spring (NMFS 2008b).

Behavior and life history: California sea lion numbers ashore increase rapidly in May when males establish breeding territories. Birth to a single pup occurs from May through June and pups are weaned in about 10-12 months (Heath and Perrin 2009). While near rookeries in California, females typically feed over the continental shelf and travel within 54 km from the islands but are known to travel as far north as Monterey Bay to feed during the breeding season (Antonelis et al. 1990; Melin and DeLong 2000). California sea lions feed primarily on Pacific whiting, Pacific herring, salmonids, dogfish sharks, and squid. Dives off rookeries in California typically last about 2 minutes but can be as long as 10 minutes; dive depths average about 26-98 m, but can be well over 200 m (Heath and Perrin 2009). Females are known to dive to a maximum depth of 482 m for up to 16 minutes while foraging during the non-breeding period (Melin et al. 2008).

Acoustics and hearing: California sea lions are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007). Vocalizations range from <4 to 120 kHz (DON 2008a) (Table 4.1).

4.1.24 Steller Sea Lion (Loughlin's Northern Sea Lion; *Eumetopias jubatus monteriensis*) Eastern Subspecies

Description: Steller sea lions exhibit significant sexual dimorphism with males larger. Average length of males is 2.8 m and females 2.4 m (maximum of about 3.3 m and 2.9 m, respectively). Estimated average weight of males is 566 kg and of females 263 kg (maximum of about 1,120 kg and 350 kg, respectively). Pup weight at birth is 16-23 kg and may be slightly larger in the western part of their range. Pups are born with a wavy, chocolate brown fur that molts after 3-6 months of age. Adult fur color varies between a light buff to reddish brown with most of the under parts and flippers a dark brown to black; naked parts of the skin are black. Both sexes

become blonder with age. Adult males have long, coarse hair on the chest, neck, and shoulders that are massive and muscular (Loughlin 2009).

Status and trends: Steller sea lions belong to the Order Carnivora, Suborder Pinnipedia, Family Otariidae. A recent paper has proposed that the two recognized Steller sea lion stocks (eastern and western) be formally designated as two subspecies (Phillips et al. 2009). Presently the eastern subspecies (*Eumetopias jubatus monteriensis*), which includes those that occur from California to Prince William Sound, Alaska, is listed as threatened under the ESA; the western subspecies (*E. j. jubatus*) is listed as endangered. NMFS is presently reviewing a petition to remove the eastern subspecies (aka stock) from the Endangered Species list. The vernacular name for the eastern subspecies has been proposed as Loughlin's northern sea lion; the western subspecies is to remain as Steller sea lion. The geographic separation for the subspecies designation is at 144° W, near Cape Suckling, AK (Loughlin 1997). However since the vernacular designation of the eastern subspecies as Loughlin's northern sea lion is new, the vernacular Steller sea lion will be used in this document.

Based on extrapolations from non-pup and pup surveys, the total population of the eastern stock of Steller sea lions is estimated to be within the range of 58,334-72,223 with a minimum population estimate of 52,847 and a PBR of 2,378 (Allen and Angliss 2011). This stock is listed as threatened under ESA. Overall the stock has been increasing at about 3.1 percent per year since the 1970s with the population more than doubling in size by 2004, principally in Southeast Alaska (Pitcher et al. 2007).

Critical habitat in California and Oregon is defined as an area 3,000 feet from important rookeries and haulout sites and 3,000 above these sites; in Alaska it is defined as a 20 nm buffer around all major haul-out sites and rookeries, as well as associated terrestrial, air, and aquatic zones, plus three large offshore foraging zones.

Distribution and habitat preferences: Steller sea lions occur throughout the North Pacific Ocean rim from Japan to southern California. They abound on numerous breeding sites (rookeries) in the Russian Far East, Alaska, and British Columbia with fewer numbers in Oregon and California. Seal Rocks in Prince William Sound, Alaska is the northernmost (60° 09 'N) rookery and Año Nuevo Island, California, the southernmost (37^{0} 06'N) (Loughlin et al. 1987, Loughlin 2009). The eastern subspecies occurs year round in the CCE, with peak numbers in late summer, fall, and winter (Carretta et al. 2012). The species does not breed in Washington although pups have been observed at one haulout site in 1997 and 1998; rookeries are in northern British Columbia, central Oregon, and central and northern California where pupping occurs from late May through early July.

Unlike their more gregarious cousin the California sea lion, Steller sea lions tend to avoid people and prefer isolated offshore rocks and islands to breed and rest. Although rookeries and rest sites occur in many areas, principally on exposed rocky shorelines and wave-cut platforms, the locations used are specific and change little from year to year. Steller sea lions tend to return to their birth island as adults to breed, but they range widely (some yearlings have been seen > 1,000 km from their birth rookery) during their first few years and during the non-breeding season (Loughlin 2009).

Steller sea lions exhibit two general types of distribution at sea: 1) less than 20 km from rookeries and haulout sites for adult females with pups, pups, and juveniles, and 2) larger areas (greater than 20 km) where these and other animals may range to find optimal foraging conditions once they are no longer tied to rookeries and haulout sites for nursing and reproduction (Call and Loughlin 2004). Telemetry studies show that in winter, adult females may travel far out to sea into water greater than 1,000 m deep (Merrick and Loughlin 1997), and juveniles less than 3 years of age travel nearly as far (Loughlin et al. 2003). Sea lions commonly occur near and beyond the 200 m depth contour. Some individuals may enter rivers in pursuit of prey.

Critical habitat: Critical habitat is defined as a 20 nm buffer around all major haul-out sites and rookeries, as well as associated terrestrial, air, and aquatic zones, plus three large offshore foraging zones (58 FR 45269). Critical habitat for the Steller sea lion does not include Puget Sound or the Strait of Juan de Fuca.

Behavior and life history: Steller sea lions breed from late May to early July throughout the range at rookeries located on remote islands and rocks. One pup is born annually after a 9 month gestation period. As with most pinnipeds, embryo implantation typically is delayed 3 months. Pups are weaned prior to the breeding season but some may remain with their mothers for 2-3 years (Loughlin 2009). They are opportunistic predators, feeding primarily on a wide variety of fishes and cephalopods. Some of the more important prey species include Pacific whiting, walleye pollock, Atka mackerel, Pacific herring, capelin, Pacific sand lance, Pacific cod, and salmon (ibid). Steller sea lions have been known to prey infrequently on harbor seal, fur seal, ringed seal, and possibly sea otter pups.

Compared to other pinnipeds, Steller sea lions tend to make relatively shallow dives, with few dives recorded to depths greater than 250 m. Maximum depths recorded for individual adult females in summer are in the range from 100 to 250 m; maximum depth in winter is greater than 250 m. The maximum depth measured for yearlings in winter was 72 m and average depths are near 18 m and in shallow near-shore waters (Loughlin et al. 2003).

Acoustics and hearing: Steller sea lions have similar hearing thresholds in-air and underwater to other otariids. Hearing in air ranges from 0.250–30 kHz, with a region of best hearing sensitivity from 5–14.1 kHz (Muslow and Reichmuth 2010). The underwater audiogram shows the typical mammalian U-shape. The range of best hearing was from 1 to 16 kHz. Higher hearing thresholds, indicating poorer sensitivity, were observed for signals below 16 kHz and above 25 kHz (Kastelein et al. 2005). Like other pinnipeds, sea lions are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007). Vocalizations range from <4 to 120 kHz (DON 2008a) (Table 4.1).

4.1.25 Guadalupe Fur Seal (*Arctocephalus townsendi*)

Description: Adult female Guadalupe fur seals weigh about 49 kg and males 124 kg (Arnould 2009). Fur seals in general can be distinguished from sea lions by the presence of a dense under fur and their smaller size. Pelage color is generally uniform dark brown to dark gray on the

dorsal surface with a grizzled appearance caused by the tips of guard hairs being pale or white (ibid).

Status and trends: Guadalupe fur seals belong to the Order Carnivora, Suborder Pinnipedia, Family Otariidae. These fur seals were harvested for their pelts in the 19th century but size of the population prior to the commercial harvests is unknown; estimates range from 20,000 to 100,000 animals (Carretta et al. 2012, and citations therein). The population was estimated by Gallo (1994) to be about 7,408 animals in 1993. The population estimate was derived by multiplying the number of pups (counted and estimated) by a factor of 4.0. The minimum size of the population in Mexico can be estimated as the actual count of 3,028 hauled out seals with a PBR of 91 Guadalupe fur seals. The Guadalupe fur seal occurs in low numbers seasonally in California waters.

The state of California lists the Guadalupe fur seal as a fully protected mammal and it is listed also as a threatened species in the Fish and Game Commission California Code of Regulations. It is listed as a threatened species under the ESA, which automatically qualifies this as a "depleted" and "strategic" stock under the Marine Mammal Protection Act. There is insufficient information to determine whether the fishery mortality in Mexico exceeds the PBR for this stock. The total U.S. fishery mortality and serious injury for this stock is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. The population is growing at approximately 13.7% per year.

Distribution and habitat preferences: Guadalupe fur seals pup and breed mainly at Isla Guadalupe, Mexico (Arnould 2009; Carretta et al. 2012 and citations therein). In 1997, a second rookery was discovered at Isla Benito del Este, Baja California and a pup was born at San Miguel Island, California. Individuals have stranded or been sighted as far north as central California, inside the Gulf of California, and as far south as Zihuatanejo, Mexico. The population is considered to be a single stock because all are recent descendants from one breeding colony at Isla Guadalupe, Mexico.

Behavior and life history: Definitive data are lacking on life history of Guadalupe fur seals but most species in the genus reach sexual maturity at 3-5 years of age; males also mature at about the same age but are unable to attain reproductive status (obtain a reproductive territory) until 7-10 years of age. Timing of pupping is variable for the genus but for Guadalupe fur seals it is June-July. Southern fur seals, including the Guadalupe fur seal, feed on a variety of prey including fish, cephalopods and crustaceans, depending on prey abundance and location. Most southern fur seals forage in upwelling zones, oceanic fronts, or continental shelf-edge regions (Arnould 2009). Specific foraging and dive information is not known for the Guadalupe fur seal, but other species in this genus forage mainly in the surface mixed layer (<50-60 m) at night (Arnould 2009).

Acoustics and hearing: Like other pinnipeds, these fur seals are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007). Vocalizations range from <4 to 120 kHz (DON 2008a) (Table 4.1).

4.1.26 Northern Fur Seal (*Callorhinus ursinus*) San Miguel Island and Pribilof Islands Stocks

Description: The northern fur seal is a moderate sized pinniped and shows a marked difference in size with males two to three times larger than females. Northern fur seal males weigh 200-250 kg and are up to 1.9 m long; females weigh up to 45 kg and are 1.3 m long. Pups are black, weigh about 10 kg and are about 0.6 m long at birth (Gentry 2009). The under-fur is brown, very dense, and covered by coarser guard hair that in males varies from black to reddish, with a mane over the shoulders that is often a different color; females are typically brown to gray and lack the mane.

Status and trends: Fur seals belong to the Order Carnivora, Suborder Pinnipedia, Family Otariidae. The genus *Callorhinus* contains one species, the northern fur seal, *C. ursinus*. Northern fur seals are divided into two stocks in U.S. waters: eastern Pacific stock (Pribilof Islands and Bogoslof Island) and San Miguel Island stock. The Pribilof Islands northern fur seal population was designated as depleted pursuant to the Marine Mammal Protection Act on 17 June 1988 because it declined to less than 50 percent of levels observed in the late 1950s and there was no compelling evidence that the northern fur seal carrying capacity of the Bering Sea had changed substantially since the late 1950s (NMFS 2007). The San Miguel Island stock is not designated as depleted.

The Eastern Pacific stock has declined by about 60% in recent decades from a historical high of over 2 million in the 1970s to an estimated 687,902 in 2009 (Allen and Angliss 2011). The San Miguel Island population originated from colonization by individuals from the Pribilof Islands population during the 1950s or early 1960s (DeLong 1982). The colony has increased steadily, since its discovery in 1968, except for severe declines in 1983 and 1998 associated with El Niño Southern Oscillation events in 1982-1983 and 1997-1998 (DeLong and Antonelis 1991). The San Miguel Island stock reached a high in 1997 when pup production was estimated at just over 3,000, with a 2007 total population estimate of 9,968 (Carretta et al. 2012). The minimum population estimate for the Pribilof Islands stock is 642,265 fur seals and for the San Miguel Island stock it is 5,395 fur seals. The calculated PBR for the San Miguel Island stock is 324 fur seals per year; the calculated PBR for the Pribilof Islands stock is 13,809 fur seals per year (Carretta et al. 2012; Allen and Angliss 2012).

Distribution and habitat preferences: NMFS (2007) summarized northern fur seal distribution. They are endemic to the North Pacific Ocean. During the winter the southern limit of their range extends across the Pacific Ocean from southern California to the Okhotsk Sea and Honshu Island, Japan. In the spring most northern fur seals migrate north to breeding colonies in the Bering Sea. The largest breeding colonies are located on St. Paul and St. George islands in the Pribilof Islands and compose approximately 74 percent of the worldwide fur seal population. Other breeding colonies are located in the Commander Islands (Russia) in the western Bering Sea and on Robben Island (Russia) in the Okhotsk Sea that compose approximately 15 and 9 percent of the population, respectively. Small breeding colonies are also located on the Kuril Islands in the western North Pacific, Bogoslof Island in the central Aleutian Islands, and on San Miguel Island off the southern California coast. The subpolar continental shelf and shelf break from the Bering Sea to California are feeding grounds while fur seals are at sea. Highest fur seal densities in the open ocean occur in association with major oceanographic frontal features such as sea mounts, valleys, canyons and along the continental shelf break (NMFS 2007). Fur seals from San Miguel Island may also spend their winter months feeding at sea in the eastern North

Pacific Ocean. Northern fur seals are primarily pelagic in the winter months, but occasionally haul-out onto land for brief periods.

Behavior and life history: Northern fur seals are the most pelagic of pinnipeds with females spending all but 35 days per year at sea and males 45 days (Gentry 2009). From November to March they remain north of about 35° N latitude without coming ashore. In March and April they gather along continental shelf breaks and begin to migrate to their respective breeding islands (Gentry 2009). Males come ashore and acquire breeding territories in late May and June and most pups are born in July, nursed for about 4 months and weaned in October or November. They are a highly migratory species and typically return to their natal sites to breed.

Northern fur seals prey primarily on schooling fish and gonatid squid, although the species consumed vary with location and season (Sinclair et al. 1996). Northern fur seals collected in continental shelf waters off the California and Washington coast between 1958 and 1972 fed primarily on fishes, while those collected beyond the shelf fed primarily on squids (Kajimura 1984). Adult female northern fur seals breeding on San Miguel Island fed on Pacific whiting, northern anchovy, juvenile rockfish, and several squid species in the oceanic zone northwest of the island. Pacific herring was consumed by fur seals in neritic areas off the coast of Washington during December-January and May-June. Rockfishes, northern anchovy, and squid were more prominent in fur seal stomachs off Washington during February and March (NMFS 2007). Dive behavior of northern fur seals is well studied and shows that females from the Pribilof Islands often dive to 200 m or more for at least 5-6 minutes with some to 11 minutes. Similar foraging behavior has been documented for fur seals foraging from San Miguel Island, CA (Gentry 2009).

Acoustics and hearing: Fur seals are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007). Vocalizations range from <4 to 120 kHz (DON 2008a) (Table 4.1).

4.1.27 Harbor Seal (*Phoca vitulina richardsi*) California, Oregon and Washington Coastal, and Inland Washington Waters Stocks

Description: Harbor seals are relatively small pinnipeds compared to sea lions and elephant seals. Males tend to be slightly larger than females. Both sexes weigh about 90-120 kg but can be as large as 180 kg and can be 1.2-1.8 m long (Burns 2009). They are covered with short, stiff hair with variable color pattern and two basic color phases. Background color ranges from yellowish (light phase) to black (dark phase), which is then covered with dark spots, and light rings (Burns 2009).

Status and trends: Harbor seals belong to the Order Carnivora, Suborder Pinnipedia, Family Phocidae. There are five presently recognized subspecies of harbor seal; *P.v. richardsi* occurs along the west coast of North America (Burns 2009). Three harbor seal stocks are recognized within the *P. v. richardsi* subspecies designation, including the California stock, outer coast of Oregon and Washington coastal stock, and Washington inland waters stock (Carretta et al. 2012, Lamont et al. 1996). The California stock is estimated to number 30,196 seals with a minimum population estimate of 26,667 seals, the calculated PBR is 1,600 California harbor seals per year. The Oregon/Washington coastal stock was estimated to number 24,732 harbor seals over ten years ago but because the most recent abundance estimate is >8 years old, there is no current

estimate of abundance and consequently no estimate of PBR. Similarly, the number of seals in the Washington inland waters stock was estimated to be 14,612 but because the population estimates are over 8 years old there is currently no estimate for the minimum population size and consequently no estimate of PBR (Carretta et al. 2012).

Harbor seals are not considered to be "depleted" under the MMPA or listed as "threatened" or "endangered" under the ESA. Based on currently available data, the level of human-caused mortality and serious injury is not known to exceed the PBR for any of the three stocks. Therefore, none of the three stocks of harbor seals are classified as a "strategic" stock. At present, the minimum estimated fishery mortality and serious injury appears to be less than 10% of the calculated PBR and, therefore, appears to be insignificant and approaching zero mortality and serious injury rate.

Distribution and habitat preferences: The species is widespread in temperate and arctic waters of the northern hemisphere of both the Atlantic and Pacific Oceans; it is the most widespread of any pinniped. It occurs year-round in Washington. They occur principally in the near shore zone. Harbor seals use hundreds of sites to rest or haulout along the coast and inland waters, including intertidal sand bars and mudflats in estuaries, intertidal rocks and reefs, sandy, cobble, and rocky beaches, islands, log-booms, docks, and floats in all marine areas of the state. Group sizes typically range from small numbers of animals on some intertidal rocks to several thousand animals found seasonally in coastal estuaries (Burns 2009).

Behavior and life history: Harbor seals are considered a non-migratory species, breeding and feeding in the same area throughout the year. They give birth on shore and nurse their single pup for 4 to 5 weeks. After the pups are weaned, they disperse widely in search of food. Pupping seasons vary by geographic region, with pups born in coastal estuaries from mid-April through June; Olympic Peninsula coast from May through July; San Juan Islands and eastern bays of Puget Sound from June through August; southern Puget Sound from mid-July through September; and Hood Canal from August through January (Jeffries et al. 2000). Breeding occurs in the water shortly after the pups are weaned. Common prey include sole, flounder, sculpins, hake, cod, herring, squid, octopus, and, to a lesser degree, salmon (Orr et al. 2004). Harbor seals can dive to over 400 m and stay submerged over 20 minutes, but the average depth is less than 100 m and about 2 minutes in duration (Eguchi and Harvey 2005).

Acoustics and hearing: Harbor seals are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007). Vocalizations range from 25 Hz to 4 kHz (DON 2008a) (Table 4.1).

4.1.28 Northern Elephant Seal (*Mirounga angustirostris*) California Breeding Stock

Description: Northern elephant seals are the largest pinniped in the California Current Ecosystem. The species is sexually dimorphic with males weighing about 1,800 kg with a length of 4.8 m; females weigh about 900 kg and are about 2.5 m in length (Hindell and Perrin 2009). Males have a large inflatable proboscis and a pronounced chest shield associated with fighting with other males on land to acquire females. Females lack the proboscis and chest shield (ibid). Both males and females are gray to brown in color.

Status and trends: Northern elephant seals belong to the Order Carnivora, Suborder Pinnipedia, Family Phocidae. Elephant seal population size is typically estimated by counting the number of pups produced and multiplying by the inverse of the expected ratio of pups to total animals. Based on the estimated 35,549 pups born in California in 2005 and a 3.5 multiplier, the California stock was approximately 124,000 in 2005, with a minimum population estimate of 74,913 elephant seals (Carretta et al. 2012). The California population is slowly increasing. Elephant seals are not listed as either threatened or endangered under the ESA or by WA State nor designated as depleted under the MMPA. The calculated PBR for this stock is 4,382 (Carretta et al. 2012).

Distribution and habitat preferences: After the breeding season, immature and adult male northern elephant seals move northward to feed from Baja California to northern Vancouver Island and far offshore of the Gulf of Alaska and Aleutian Islands; adult females typically feed in the western North Pacific (Carretta et al. 2012). Northern elephant seals breed at about 15 colonies on the mainland and on islands off the California coast from the Farallon Islands, CA, south to islands off Mexico during winter. When not on the islands to breed or molt they tend to occur in deep offshore waters from central California north to the Aleutian Islands and west to Japan. Females tend to go farther northwest and males farther north (Hindell and Perrin 2009). However it is not uncommon to see male and female northern elephant seals hauled out on land alongside harbor seals, California and Steller sea lions, and northern fur seals throughout the North Pacific.

Behavior and life history: Adult males haulout onto deserted beaches in November/December; adult females arrive soon thereafter and a single pup is born about 2-5 days later. Elephant seals are highly polygynous with large dominant males presiding over large aggregations of females, known as harems consisting of up to 100 animals (Hindell and Perrin 2009). Males feed near the eastern Aleutian Islands and in the Gulf of Alaska, and females typically feed south of 45° N latitude. Elephant seals prey on deepwater and bottom dwelling organisms, including fish, squid, crab, and octopus. They are extraordinary divers with some dive depths exceeding 1500 m and 120 minutes (Hindell and Perrin 2009).

Acoustics and hearing: Like other pinnipeds, elephant seals are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007). Vocalizations range from <4 to 120 kHz (DON 2008a) (Table 4.1).

4.2 Eastern Tropical Pacific (ETP) Ecosystem

Cetaceans

4.2.1 Risso's Dolphin (*Grampus griseus*)

Description: Refer to section 4.1.4 for species description.

Status and trends: Risso's dolphins commonly occur in the ETP and are regularly sighted during surveys of the area. Abundance was estimated after each survey, with the most recent being in 2003 and 2006. The estimated abundance in 2006 was 110,457 (52,510-209,008; 95% confidence intervals; c.i.) and was 81,474 (48,140-122,422; 95% c.i.) in 2003 (Gerrodette et al.

2008). The estimated rate of change from 1986 to 2006 was 0.011 and was 0.039 from 1998 to 2006; density in the ETP was estimated to be 5.173 dolphins/1,000 km^2 (Gerrodette et al. 2008).

Risso's dolphins are not listed under the ESA.

Distribution and habitat preferences: Risso's dolphins are broadly distributed throughout the ETP (Hamilton et al. 2009). However, they most commonly occur in nearshore shelf waters off Mexico, Guatemala, the Gulf of Panama, and in the Peru Current (Wade and Gerrodette 1993). They generally associate with areas of upwelling (Ballance et al. 2006).

Behavior and life history: Refer to section 4.1.4

Acoustics and hearing: Refer to section 4.1.4

4.2.2 Short-Beaked Common Dolphin (*Delphinus delphis*)
Description: Refer to section 4.1.7 for species description

Status and trends: Short-beaked common dolphins are divided into northern, central and southern stocks (Dizon et al. 1994). A hiatus at 13-20° N and at about 3° N divide the offshore populations into the respective stocks. The central form occurs at 3-18° N and the southern common dolphin ranges from 3° N to at least 13° S (Dizon et al. 1994). Short-beaked common dolphins are frequently encountered in the ETP and were the most abundant dolphin in the ETP survey area in 2006. The 2006 ETP abundance estimates for short-beaked common dolphins included parts of the northern and southern stocks, and all of the central stock (Gerrodette et al. 2008). The 2006 estimate was 3,127,203 (1,620,370-4,876,096; 95% c.i.), which was much larger than the 2003 estimate of 1,197,168 (709,369-2,669,497; 95% c.i.) (Gerrodette et al. 2008). The estimated rate of change from 1986 to 2006 was 0.047 and from 1998 to 2006, was -0.006 (Gerrodette et al. 2008). Density in the ETP was estimated to be 146.453dolphins/1,000 km^2 (Gerrodette et al. 2008).

Short-beaked common dolphins are not listed under the ESA.

Distribution and habitat preferences: Short-beaked common dolphins occur worldwide in warm-temperate and tropical waters from about 40-60° N to about 50° S latitude (Perrin 2009c). In the ETP, they commonly occur along the coast of Baja California, near the Costa Rica Dome, and in the eastern equatorial Pacific. They are most abundant in cold, upwelling-modified waters (Ballance et al. 2006; Wade and Gerrodette 1993). Common dolphins feed on a wide assortment of prey, including small mesopelagic fish and squid and epipelagic schooling species of fish and squid. Diet varies seasonally and geographically (Perrin 2009c).

Behavior and life history: Refer to section 4.1.7

Acoustics and hearing: Refer to section 4.1.7

4.2.3 Long-Beaked Common Dolphin (*Delphinus capensis*)
Description: Refer to section 4.1.8 for species description.

Status and trends: Few abundance estimates are available for long-beaked common dolphins, other than for select localized areas. The IUCN (cited in Perrin 2009c) estimated an abundance of 55,000 long-beaked common dolphins off the Pacific coast of Mexico. Although sighted during several SWFSC ETP surveys (e.g., Jackson et al. 2004; Kinzey et al. 1999, 2001), no long-beaked common dolphins were seen during the 2006 surveys (Gerrodette et al. 2008). However, sightings during SWFSC surveys conducted 1998-2000, 2000 and 2003 allowed estimation of population abundance (372,429) and density (0.0194/km^2) for the study area.

Long-beaked common dolphins are not listed under the ESA.

Distribution and habitat preferences: Distribution in the ETP is disjunctive. Long-beaked common dolphins are found from southern California to central Mexico and along the coast of Peru (Hamilton et al. 2009; Perrin 2009c). In contrast to short-beaked common dolphins, long-beaked common dolphins prefer shallower, warmer water nearer to the coast.

Behavior and life history: Refer to section 4.1.8

Acoustics and hearing: Refer to section 4.1.8

4.2.4 Rough-Toothed Dolphin (*Steno bredanensis*)

Description: The rough toothed dolphin is so named because of unique vertical ridges on the teeth. They are distinctive in appearance, with a smooth sloping forehead and long beak, tall dorsal fin, and long flippers. They are generally dark in coloration, with a white belly and dark gray to black back. The mouth area and lower sides often have white spots or patches. They can weigh up to 155 kg and be up to 2.6 m in length. Males are larger than females (Jefferson 2009b).

Status and trends: Rough-toothed dolphins belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. Global estimates of abundance are lacking for this species and little is known about rough-toothed dolphin population or stock structure (Jefferson 2009b). The ETP is one of the few places for which abundance has been estimated. The most recent estimates available are for 2006 (107,633; 66,891-153,970: 95% c.i.) and 2003 (47,593; 27,218-92,670: 95% c.i.) (Gerrodette et al. 2008). The estimated rate of change from 1986 to 2006 was 0.026 and from 1998 to 2006, was 0.081 (Gerrodette et al. 2008). Density in the ETP was estimated to be 5.042 rough toothed dolphins/1,000 km^2 (Gerrodette et al. 2008).

Rough-toothed dolphins are not listed under the ESA.

Distribution and habitat preferences: This is a tropical to warm temperate species found in oceanic waters worldwide, as well as over continental shelf and coastal waters in some areas, including the ETP (Jefferson 2009b; May-Collado 2005). In the ETP, they generally associate with warm tropical waters without major upwelling (Jefferson 2009). Wade and Gerrodette (1993) noted that rough-toothed dolphins were seen in low densities throughout much of the area, except in the coldest parts of the Peru and California currents. Little is known about the ecology of the species. Rough-toothed dolphins feed on a variety of fish and cephalopods, and may take some large fish (Jefferson 2009b).

Behavior and life history: Rough-toothed dolphins commonly occur in mixed schools with other delphinids in the ETP. They have, in addition, been observed associating with flotsam (Jefferson 2009b). School size is variable, but commonly in the range of 10-20 (Jefferson 2009b). The maximum recorded dive is 70 m. Rough-toothed dolphins, however, appear well adapted for deeper dives (Jefferson 2009b). The only life history information available is from Japan, where males reach sexual maturity at about 14 years of age and females at about 10 years old. The maximum recorded age was 32-36 years (Jefferson 2009b).

Acoustics and hearing: Rough-toothed dolphins are classified in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz-160 kHz (Southall et al. 2007) (Table 4.1). Directional clicks and pulses up to 200 kHz have been recorded (Jefferson 2009b).

4.2.5 Striped Dolphin (*Stenella coeruleoalba*)

Description: Refer to section 4.1.6 for species description.

Status and trends: Striped dolphins are among the most commonly sighted dolphin species in the ETP (Wade and Gerrodette 1993). It was previously thought that geographical stocks existed, but that has since been discounted and all striped dolphins in the ETP are considered one stock (Dizon et al. 1994). The 2006 estimated abundance of striped dolphins in the ETP was 964,362 (616,898-1,404,055; 95% c.i.). This was down from an estimated 1,617,012 in 2003 (Gerrodette et al. 2008). The estimated rate of change from 1986 to 2006 was -0.004 and from 1998 to 2006, was 0.012 (Gerrodette et al. 2008). Density in the ETP was estimated to be 45.163 dolphins/1,000 km^2 (Gerrodette et al. 2008).

Striped dolphins are not listed under the ESA.

Distribution and habitat preferences: Striped dolphins are cosmopolitan and range widely throughout the ETP (Ballance et al. 2006; Hamilton et al. 2009). They commonly occur outside the continental shelf, over the continental slope and out to oceanic waters (Archer 2009). They are rare in the warmest Tropical Surface Water off southern Mexico and in eastern boundary current coastal upwelling regions. Striped dolphins associate with convergence zones, areas with year-round or seasonal upwelling, weak thermoclines, surface temperatures <25° C and surface salinities >34.5 psu (practical salinity units) (Ballance et al. 2006).

Striped dolphins in the ETP prey primarily on mesopelagic species, such as myctophids, a melamphaeid and the enoploteuthid squid. Prey varies by area, with fish dominating the diet in more southerly areas and fish and squid of equal importance closer to the northern tropical convergence (Perrin et al. 2008). Most feeding occurred at night or early in the morning (Perrin et al. 2008).

Behavior and life history: Refer to section 4.1.6

Acoustics and hearing: Refer to section 4.1.6

4.2.6 Spinner Dolphin (*Stenella longirostris orientalis*); Central American Spinner Dolphin (S. *l. centroamericana*) and White-belly Stocks

Description: Spinner dolphins are readily identifiable by their external features and highly acrobatic "spinning" behavior. They have long slender beaks, tipped with black or dark gray, a dark gray cape, light gray sides, light belly, and a dark band that goes from the eye to the flipper. In the eastern and Central American subspecies (see below), the bands of color are muted and the dolphins appear uniformly gray. The dorsal fin on adult males of these subspecies may cant forward, so that it appears to be on backwards (Perrin 2009a). Adults are 1.3-2.4 m long and weigh 23-80 kg. Males are larger than females (Perrin 2009a).

Status and trends: Spinner dolphins belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. Three recognized stocks of spinner dolphins occur in the ETP. The eastern spinner (*Stenella longirostris orientalis*) and the Central American spinner (*S. l. centroamericanus*) are subspecies. Whitebelly spinners are considered hybrids of the eastern spinner and the Gray's spinner (*S. l. longirostris*), which occur in the central and southern Pacific (Perrin 2009a). The whitebelly stock of spinner dolphin is considered a stock for management purposes; however, it should be noted that morphological differentiation from the eastern stock of spinner dolphin was not the basis for stock delineation.

Spinner dolphins, particularly the eastern spinner, suffered significant population declines as a result of high levels of incidental take in the yellowfin tuna (*Thunnus albacares*) purse-seine fishery in the ETP beginning in the 1950s. Yellowfin tuna tend to associate with mixed schools of spinner and spotted dolphins (see below), which makes the tuna more conspicuous to fishermen, but resulted in unprecedented levels of dolphin bycatch (Gerrodette 2009). The spinner dolphin population purportedly decreased to less than half its original size (Gerrodette and Forcada 2005; Perrin 2009a). Through a series of combined actions, including passage of the MMPA in 1972, subsequent amendments, regulations, and mitigation measures, dolphin bycatch in the ETP has since decreased 99% in the international fishing fleet, and was eliminated by the U.S. fleet (Gerrodette and Forcada 2005).

The SWFSC has been conducting research, mandated by the MMPA, on the status of dolphin stocks impacted by the yellowfin tuna fishery in the ETP since the 1970s. A congressional directive in 1997 created the International Dolphin Conservation Program Act (IDCPA). The major objective of the act was to estimate abundance and population trends of affected dolphin stocks in order to assess population recovery since incidental mortality dropped to low levels. A three-year series of surveys in 1998-2000 resulted (Ballance et al. 2002). Data from those surveys indicated that eastern spinner dolphin populations were not recovering as expected (Gerrodette and Forcada 2005). This led to additional population monitoring surveys in 2003 and 2006, from which the most recent estimates were determined (Gerrodette et al. 2008).

The population estimate for eastern spinner dolphins in 2003 was 673,943 and for 2006 it was 1,062,879 (607,428-1,727,235: 95% c.i.) (Gerrodette et al. 2008). The 2006 estimate was 73% higher than the mean estimates from 1998 to 2000. The estimated rate of change from 1986 to 2006 was 0.019 and was 0.092 from 1998 to 2006 (Gerrodette et al. 2008).

The higher estimates for 2003 and 2006 could indicate that the stock is starting to recover. There are, however, several caveats and other factors to consider when interpreting the data. These are being addressed through additional assessment modeling (Gerrodette et al. 2008).

Some of the reasons for higher estimates in 2006 include adjustments to correction factors used and changes to computer code. In addition, unidentified spinner dolphin sightings were included in population estimates for eastern and whitebelly spinners (Gerrodette et al. 2008).

The population estimate for whitebelly spinner dolphins was 531,496 in 2003 and 734,837 in 2006 (154,246-1,802,469; 95% c.i.) (Gerrodette et al. 2008). The estimated rate of change from 1986 to 2006 was -0.005 and from 1998 to 2006 was 0.062 (Gerrodette et al. 2008).

Density in the ETP was estimated to be 34.414 white belly dolphins/1,000 km^2 and 49.777 eastern spinner dolphins/1,000 km^2; no density estimate was available for the Central American stock (Gerrodette et al. 2008). Abundance estimates were not available for the Central American spinner dolphin population in the ETP.

The eastern spinner dolphin is listed as depleted under the MMPA (NOAA Office of Protected Resources website: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/). At the time of the MMPA depleted listing, the eastern spinner dolphin was estimated to be at 44 percent of its pre-exploitation population size. It is not listed under the Endangered Species Act (ESA).

Distribution and habitat preferences: Spinner dolphins occur in all tropical and most sub-tropical waters between 30-40° N and 20-40° S latitude, generally in areas with a shallow mixed layer, shallow and steep thermocline, and little variation in surface temperatures (Perrin 2009a). The ranges of eastern and whitebelly spinner dolphins overlap considerably. Eastern spinners, however, predominate in the northeastern portion of the ETP in the Eastern Pacific Warm Pool, characterized by high surface temperature (>25° C) and chlorophyll, low surface density, and shallow thermoclines (<50 m) (Ballance et al. 2006; Hamilton et al. 2009; Reilly et al. 2002). Whitebelly spinner dolphins range farther south and offshore, to the west and south of the Eastern Pacific Warm Pool, where surface temperature is cooler, surface density is higher, and the thermocline deeper (Ballance et al. 2006; Hamilton et al. 2009). The Central American stock occurs in shallow, nearshore waters within 80 km of the Central American coast (Wade and Gerrodette 1993; Perrin 2009a).

Behavior and life history: The most conspicuous behavior of the spinner dolphin – the spinning for which the species is named – is a mystery. Theories as to why spinners spin include communication, play, and knocking off remoras (Perrin 2009a). School size varies from a few animals to over a thousand. Mixed schools with other species, particularly pantropical spotted dolphins, are common (Perrin 2009a). Mating appears to be promiscuous. Gestation is about 10 months and breeding is seasonal. Females reach sexual maturity at 4-7 years, and males at 7-10 years. Calving interval is 3 years and calves nurse for 1-2 years (Perrin 2009a).

Acoustics and hearing: Spinner dolphins produce an array of whistles and burst pulses that vary by activity and geographically (Perrin 2009a). Spinner dolphins are in the mid-frequency functional hearing group of Southall et al. (2007), with an estimated auditory bandwidth of 150 Hz to 160 kHz (Table 4.1).

4.2.7 Pantropical Spotted Dolphin (*Stenella attenuata*); Offshore and Coastal Stocks

Description: Spotted dolphins are characterized by a long, clearly defined beak, prominent falcate dorsal fin, slender body and spots on adults. The larger coastal spotted dolphin is heavily spotted. Adult can be 1.7-2.6 m and up to 119 kg, with a great deal of geographic variation (Perrin 2009b).

Status and trends: Spotted dolphins belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. In the ETP they are represented by the offshore form (*S. attenuata attenuata*) and the coastal form (*S. attenuata graffmani*). The offshore form is further divided into northeastern offshore and western/southern offshore (Dizon et al. 1994; Perrin 2009b).

The northeastern offshore spotted dolphin population was depleted in previous years due to high levels of bycatch in yellowfin tuna purse-seining operations in the eastern tropical Pacific beginning in the 1950s. Yellowfin tuna often associate with mixed schools of spinner and spotted dolphins, which resulted in unprecedented levels of dolphin bycatch (Gerrodette 2009). (Refer to spinner dolphin section above for details). The northeastern offshore spotted dolphin population declined roughly 80% as a result (Perrin 2009b). Annual mortality in the fishery is currently in the 100s due to mitigation measures to decrease bycatch. Chasing and encirclement could, however, still affect fecundity and survival (Perrin 2009b). A congressional directive in 1997 resulted in large scale surveys in 1998-2000 to estimate abundances of dolphins affected by the fishery. Results suggested the population was recovering as expected (Gerrodette and Forcada 2005). This led to additional surveys in 2003 and 2006, from which the most recent estimates were determined (Gerrodette et al. 2008).

The 2006 population estimate for the northeastern offshore spotted dolphins was 857,884 (551,852-1,274,019: 95% c.i.). This was 27% higher than the mean estimates from 1998 to 2000. The rate of change from 1986 to 2006 was 0.010, and was estimated as 0.035 for the period 1998-2006 (Gerrodette et al. 2008). The higher estimate for 2006 compared to 1998-2000 could indicate that the stock is starting to recover. There are, however, several caveats and other factors to consider when interpreting the data. These are being addressed through additional assessment modeling (Gerrodette et al. 2008).

In 2006, the estimated abundance for the western/southern offshore spotted dolphins was 439,208 (227,055-724,675; 95% c.i.). The estimated rate of change from 1986 to 2006 was -0.023 and from 1998 to 2006, was -0.080 (Gerrodette et al. 2008). The decline in abundance of the western/southern stock of offshore spotted dolphin while the northeastern offshore stock increased may indicate dolphins moving across the geographic boundaries that define the two stocks at 120º W and 5º N (Gerrodette et al. 2008).

Density in the ETP was estimated to be 122.625 northeast offshore spotted dolphins/1,000 km^2 , 30.592 western/southern spotted dolphin/1,000 km^2, and 43.435 coastal spotted dolphins/1,000 km^2 (Gerrodette et al. 2008).

The estimated abundance of coastal spotted dolphins in 2006 was 278,155 (31,150-656,534; 95% c.i.). The estimated rate of exponential change from 1986 to 2006 was 0.104 and was 0.077 for 1998 to 2006 (Gerrodette et al. 2008). The coastal and northeastern offshore spotted dolphin stocks are designated as depleted under the MMPA (NOAA Office of Protected Resources

website: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/). At the time of the MMPA depletion listing, the northeastern offshore spotted dolphin was estimated to be between 19 and 28 percent of its pre-exploitation population size and the coastal stock was estimated to be at 42 percent of its pre-exploitation population size. Neither stock is listed under the ESA.

Distribution and habitat preferences: Distribution of spotted dolphins is worldwide in tropical and some sub-tropical waters between 30-40° N latitude to 20-40° S latitude. The coastal subspecies has a narrow distribution along the Pacific coasts of southern Mexico to northern Peru (Perrin 2009b). Offshore spotted dolphin habitat is characterized by well-stratified water, warm (>25° C) surface temperatures, low salinity, and a sharp, but shallow, thermocline at approximately 50 m (Ballance et al. 2006; Perrin 2009b; Reilly et al. 2002). This overlaps extensively with eastern and whitebelly spinner dolphins. Offshore spotted dolphins primarily eat small epipelagic fish, squid, crustaceans, and flying fish in some areas (Perrin 2009b).

Behavior and life history: Pantropical spotted dolphins often occur in large multi-species schools, particularly with spinner dolphins (Perrin 2009b). In 2006, >50% of the offshore spotted dolphins recorded were in mixed species schools (Jackson et al. 2008). School size ranges from a few hundred to several thousand, with mean school size of 120 in the ETP (Perrin 2009b). Females become sexually mature at 9-11 years old and males at 12-15 years of age. The calving interval is approximately 2-3 years. Gestation ranges from 11.2-11.5 months and weaning occurs between 9 months and 2 years (Perrin 2009b).

Acoustics and hearing: Spotted dolphins are classified in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz-160 kHz (Southall et al. 2007) (Table 4.1).

4.2.8 Dusky Dolphin (*Lagenorhynchus obscurus*)

Description: The dusky dolphin has a short beak; dark back and white belly; light gray thoracic and two-pronged flank patches; a two-toned, falcate dorsal fin; and dark lips and eye patches. Average adult size is about 1.85m. They rarely weigh more than 100 kg. Sexual dimorphism is subtle. The male dorsal fin is more curved and broader at the base (Van Waerebeek and Würsig 2009).

Status and trends: Dusky dolphins belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. No abundance estimates are available for the entire population (Van Waerebeek and Würsig 2009); however, sightings during SWFSC surveys conducted 1998-2000, 2003 and 2006 allowed estimation of population abundance (40,211) and density (0.0021/km^2) for the ETP.

Distribution and habitat preferences: Dusky dolphins are distributed around South America. On the Pacific side, they range from northern Peru to Cape Horn. They are one of the most abundant species in Peruvian coastal waters (Van Waerebeek and Würsig 2009). Dusky dolphins usually associate with continental shelves and slopes, but may occur over deeper water near continents or islands. Preferred sea surface temperature is in the 10-18°C range (Van Waerebeek and Würsig 2009).

Prey of dusky dolphins includes a variety of fish and squid species, predominantly small schooling fish, such as anchovies. They are, however, opportunistic feeders and will prey upon what is available in the absence of anchovies off the coast of Peru (Van Waerebeek and Würsig 2009).

Behavior and life history: Dusky dolphins commonly surface feed in large groups. Off the coast of Peru, they often co-occur with long-beaked common dolphins in large feeding aggregations of 100s to 1000s of animals (Van Waerebeek and Würsig 2009). Females off Peru reach sexual maturity at 3.4-5 years of age and males become sexually mature at 3.8-4.7 years. Most calving off Peru occurs in late winter (August-October) after a nearly 13 month gestation period. Calves nurse for approximately a year (Van Waerebeek and Würsig 2009).

Acoustics and hearing: Dusky dolphins are classified in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz-160 kHz (Southall et al. 2007) (Table 4.1). Echolocation signals of dusky dolphins have both a low-frequency peak (40-50 kHz) and a high frequency peak (80-110 kHz) (Au and Würsig 2004 cited in Van Waerebeek and Würsig 2009).

4.2.9 Fraser's Dolphin (*Lagenodelphis hosei*)

Description: Fraser's dolphins are stocky dolphins with a short beak, small triangular to falcate dorsal fin, small flukes and flippers and striking black head stripe that is prominent in adult males, variable in adult females and absent in calves. The back is brownish gray, the lower body cream colored and the belly pink or white. The largest male recorded was 2.7 m and the largest female 2.6 m. Large males could be up to 210 kg (Dolar 2009).

Status and trends: Fraser's dolphins belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. The only available abundance estimate for Fraser's dolphins in the ETP was based on data from 1986 to 1990. The resulting estimate was 289,300 (138,000-508,100; 95% c.i.) (Wade and Gerrodette 1993). Gerrodette et al. (2008) considered the species sufficiently rare in the core study area to not warrant attempting to estimate abundance. However, density in the ETP was estimated to be 13.548 dolphins/1,000 km^2 (Gerrodette et al. 2008).

Fraser's dolphins are not listed under the ESA.

Distribution and habitat preferences: Fraser's dolphins are a tropical species generally found between 30° N and 30° S (Dolar 2009). All of the sightings used in above abundance estimate were south of 7° N and far offshore, primarily west of 100° W longitude (Wade and Gerrodette 1993). They are typically oceanic and commonly occur in water depths of 1500-2500 m. They prey primarily on mesopelagic fish, cephalopods, and crustaceans and, in the ETP, are thought to feed at 250 to 500 m depth (Dolar 2009).

Behavior and life history: Fraser's dolphins often occur in tightly grouped, fast moving schools of 100-1,000 individuals. They commonly occur in large mixed-species schools with melon-headed whales in the ETP (Dolar 2009, Wade and Gerrodette 1993). They are deep divers and capable of diving to >600 m (Dolar 2009). Life history data is available for Fraser's dolphins off Japan. The age of sexual maturity appears to be 7-10 years for males and 5-8 years for females (Dolar 2009).

Acoustics and hearing: Fraser's dolphins are classified in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz-160 kHz (Southall et al. 2007) (Table 4.1).

4.2.10 Melon-Headed Whale (*Peponocephala electra*)

Description: The melon-headed whale is predominantly gray with a darker gray dorsal cape and a distinct eye patch. They often have white lips and light coloration on the throat region. This species is hard to distinguish from pygmy killer whales at sea. Length for males is 2.5 m and for females is 2.4 m. There is some sexual dimorphism. Males have longer flippers, taller dorsal fins, broader flukes, and are more robust than females (Perryman 2009).

Status and trends: Melon-headed whales belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. The only available abundance estimate for melon-headed whales in the ETP was calculated by Wade and Gerrodette (1993) and was 45,400 (34,200-110,300; 95% c.i.). Density in the ETP was estimated to be 2.126 melon-headed whales/1,000 km^2 (Gerrodette et al. 2008).

This species is not listed under the ESA.

Distribution and habitat preferences: Melon-headed whales are distributed worldwide in tropical and subtropical waters. They generally occur offshore in deep oceanic waters. Nearshore distribution is generally associated with deep water areas near to the coast (Perryman 2009). Squid appear to be the preferred prey, along with some fish and shrimp (Perryman 2009).

Behavior and life history: Melon headed whales are often in large schools (mean school size is about 200), including in mixed schools with Fraser's dolphins (Perryman 2009, Wade and Gerrodette 1993). They may also form mixed schools with spinner, bottlenose, and rough-toothed dolphins (Perryman 2009). Females reach sexual maturity at approximately 11.5 years of age and males at about 15 years (Perryman 2009).

Acoustics and hearing: Melon-headed whales are classified in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz-160 kHz (Southall et al. 2007) (Table 4.1).

4.2.11 Bottlenose Dolphin (*Tursiops truncatus*)

Description: Refer to section 4.1.5 for a species description

Status and trends: Bottlenose dolphins in the ETP are considered of one stock. It was previously suggested that offshore and coastal forms may occur there, but that has not been sufficiently examined (Wade and Gerrodette 1993). Bottlenose dolphins are often the second or third most commonly sighted dolphin species during surveys of the ETP (Jackson et al. 2004, 2008; Kinzey et al. 1999, 2001). The estimated abundance of bottlenose dolphins in the ETP in 2006 was 335,834 (231,636-495,304: 95% c.i.) and 312,225 (188,168-509,506; 95% c.i.) in 2003 (Gerrodette et al. 2008). The estimated rate of change from 1986 to 2006 was 0.040 and from 1998 to 2006, was -0.004 (Gerrodette et al. 2008). Density in the ETP was estimated to be 15.728 bottlenose dolphins/1,000 km^2 (Gerrodette et al. 2008).

Bottlenose dolphins are not listed under the ESA.

Distribution and habitat preferences: Bottlenose dolphins occur in all regions of the ETP, but are most concentrated near to the coast (Jackson et al. 2008; Hamilton et al. 2009; Wade and Gerrodette 1993). They commonly frequent coastal waters of Central America, including off Costa Rica and Panama (May-Collado et al. 2005; Rasmussen et al. 2004). Bottlenose dolphins appear to prefer areas of upwelling (Ballance et al. 2006).

Behavior and life history: Refer to section 4.1.5

Acoustics and hearing: Refer to section 4.1.5

4.2.12 Killer Whale (*Orcinus orca*)

Description: Refer to section 4.1.10 for species and ecotype descriptions.

Status and trends: Defined ecotypes have not yet been recognized for the ETP, although observed pursuit and predation on marine mammals would suggest the occurrence of transients in the area (Olson and Gerrodette 2008). Rasmussen et al. (2004) observed killer whales off the coast of Costa Rica pursuing humpback whales in 2003. Pitman et al. (2007) observed a group of 19 killer whales feeding on a blue whale calf about 230 km west of Nicaragua. Genetic analysis from biopsy samples also indicated that the whales differed genetically from northeast Pacific resident killer whales.

The only available estimate of abundance for killer whales in the ETP is 8,500 (4,700-15,900; 95% c.i.) (Wade and Gerrodette 1993). Killer whales are seen in low densities throughout the ETP (Wade and Gerrodette 1993). From 1986 to 2006, 179 groups of killer whales were recorded during SWFSC research cruises (Olson and Gerrodette 2008). Density in the ETP was estimated to be 0.398 killer whales/1,000 km^2 (Gerrodette et al. 2008).

Killer whales in the ETP are not listed under the ESA.

Distribution and habitat preferences: Killer whales are found throughout the ETP, where they occur year-round (Dahlheim et al. 1982 cited in Olson and Gerrodette 2008). They have been sighted both offshore and nearshore, including off the coasts of Costa Rica and Panama (Hamilton et al. 2009; May-Collado et al. 2005; Rasmussen et al. 2004). The distribution and range of killer whales seen in the ETP is not known. Three individually identified killer whales photographed in the ETP matched photographs of whales from Mexico. The whales in Mexico were photographed on both the Pacific side and Gulf of California side of Baja Peninsula (Olson and Gerrodette 2008).

Behavior and life history: Refer to section 4.1.10

Acoustics and hearing: Refer to section 4.1.10

4.2.13 False Killer Whale (*Pseudorca crassidens*)

Description: False killer whales are among the larger members of the dolphin family. Adult males may reach lengths of nearly 6 m and females may be 5 m in length. They are mostly dark gray to black in color, with a rounded head, small falcate dorsal fin, and flippers that distinctively bulge on the leading edge. The common name stems from skull morphology similar to killer whales (Baird 2009).

Status and trends: False killer whales belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. There are no worldwide population estimates for false killer whales that "appear to be naturally uncommon throughout their range" (Baird 2009). Wade and Gerrodette (1993) derived an estimated abundance of 39,800 (11,500-109,500; 95% c.i.) based on data collected from 1986 to 1990 in the ETP. Density in the ETP was estimated to be 1.864 false killer whales/1,000 km^2 (Gerrodette et al. 2008).

False killer whales are not listed under the ESA.

Distribution and habitat preferences: False killer whales occur throughout tropical and warm temperate waters worldwide. They are largely pelagic, but also occur nearshore and in shallow waters around oceanic islands (Baird 2009). Sightings, based on surveys from 1986 to 2005, are distributed across the ETP (Hamilton et al. 2009). They have a diverse diet that includes a variety of squid and fish. They have also been documented preying on smaller dolphins being released from tuna purse-seines in the ETP. There is evidence of false killer whales attacking other marine mammals, including a humpback calf and sperm whales (Barid 2009).

Behavior and life history: They are very social and are often in groups of 20-100 individuals. Not much is known about the diving behavior of false killer whales other than a recorded dive to over 230 m by one tagged animal (Baird 2009). Both males and females reach sexual maturity between 8 and 14 years. A calving interval of 7 years was estimated for one population. False killer whales appear long-lived with males living an estimated 57 years and females for 62 years (Baird 2009).

Acoustics and hearing: False killer whales are classified in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz-160 kHz (Southall et al. 2007) (Table 4.1).

4.2.14 Pygmy Killer Whale (*Feresa attenuata*)

Description: Pygmy killer whales have round, blunt heads and lack the characteristic dolphin beak. They have robust bodies that narrow toward the dorsal fin, and long flippers. The back, parts of the sides and belly are dark gray to black, with a pale area often present on the flank. The lips are edged in white. Average length for both sexes is 2.3 m (Donahue and Perryman 2009).

Status and trends: Pygmy killer whales belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. Abundance estimates for pygmy killer whales in the ETP are from surveys conducted from 1986 to 1990. The derived estimate was 38,990 (18,500-63,100; 95% c.i.) (Wade and Gerrodette 1993). Density in the ETP was estimated to be 1.826 pygmy killer whales/1,000 km^2 (Gerrodette et al. 2008).

Pygmy killer whales are not listed under the ESA.

Distribution and habitat preferences: Pygmy killer whales occur in tropical and subtropical waters worldwide, and are regularly sighted in the ETP (Donahue and Perryman 2009). Sightings are more common in warmer coastal waters near to Central America than offshore (Hamilton et al. 2009; Wade and Gerrodette 1993). The feeding behavior of pygmy killer whales is not well known. Remains of cephalopods and small fish have been found in stomachs of stranded and incidentally caught individuals. They may be one of the species of small whales that attack and sometimes eat smaller dolphins caught in the tuna purse-seine fishery (Donahue and Perryman 2009).

Behavior and life history: Pygmy killer whales are generally in small schools of 12-50 animals, although larger schools have been observed. They are known to bow ride. Pygmy killer whale life history is poorly understood.

Acoustics and hearing: Pygmy killer whales are classified in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz-160 kHz (Southall et al. 2007) (Table 4.1).

4.2.15 Short-Finned Pilot Whale (*Globicephala macrorhynchus*)

Description: Refer to section 4.1.11 for species description.

Status and trends: Pilot whales are considered a single stock in the ETP survey area (Gerrodette and Forcada 2002). In estimating abundance of pilot whales in the ETP over a 15 year period (1986-2000), Gerrodette and Forcada (2002) assumed that all unidentified pilot whale sightings were short-finned pilot whales, since long-finned pilot whales (*G. melas*) have not been recorded in the ETP area. Wade and Gerrodette (1993), however, noted that some long-finned pilot whales may be encountered as extralimital species at the southern extreme of the survey area in the Peru Current.

The most recent available abundance estimate for short-finned pilot whales in the ETP is for the year 2000 and is 589,315 (516,619-1,728,073: 95% c.i.). This is the highest estimated abundance for the period 1986-2000; the lowest was 136,448 (Gerrodette and Forcada 2002). Density in the ETP was estimated to be 27.599 short-finned pilot whales/1,000 km^2 (Gerrodette et al. 2008).

Interpreting temporal changes in abundance is confounded by several factors, not least of which is distribution that extends beyond the survey area. Movement in or out of the study area in response to changing oceanographic conditions could affect distribution and, subsequently, abundance estimates (Gerrodette and Forcada 2002).

Short-finned pilot whales are not listed under the ESA.

Distribution and habitat preferences: Short-finned pilot whales are most abundant in cold, upwelling-modified waters (Wade and Gerrodette 1993). They are conspicuously absent from the warm tropical waters off the coast of Mexico (Hamilton et al. 2009; Wade and Gerrodette 1993). There is a clear separation between pilot whales off the coast of Baja, Mexico and those occurring south of 15° N; this division may represent different stocks (Wade and Gerrodette 1993). Highest concentrations of pilot whales in the ETP are off the coasts of Costa Rica and

Panama (Ballance et al. 2006; May-Collado et al. 2005). Pilot whales were also commonly seen along the equator, between longitudes 85° W and 110° W, during May-July 1981 (Au and Perryman 1985).

Behavior and life history: Refer to section 4.1.11

Acoustics and hearing: Refer to section 4.1.11

4.2.16 Cuvier's Beaked Whale (*Ziphius cavirostris*)
Description: Refer to section 4.1.14 for species description.

Status and trends: Wade and Gerrodette (1993) calculated an abundance of 20,000 (13,800-34,500; 95% c.i.) Cuvier's beaked whales in the ETP based on survey data from 1986 to 1990. The abundance estimate for unidentified Ziphiids was prorated between Cuvier's beaked whales and *Mesoplodon* spp. The estimate of 20,000 animals was likely an underestimated abundance of Cuvier's beaked whales in the ETP, since it was not adjusted for animals missed along the survey track line. The long dive times and short surface duration of beaked whales makes them more difficult to detect (Barlow et al. 2006, Wade and Gerrodette 1993). Density in the ETP was estimated to be 0.937 Cuvier's beaked whales/1,000 km^2 (Gerrodette et al. 2008).

Cuvier's beaked whales are not listed under the ESA.

Distribution and habitat preferences: Cuvier's beaked whales are distributed throughout the ETP (Hamilton et al. 2009; Wade and Gerrodette 1993). Beaked whales in the ETP were found in much deeper waters than seen in other studies. The mean water depth with which Cuvier's beaked whales associated was 3.4 km, with a maximum depth of 5.1 km (Ferguson et al. 2006). Beaked whales, on average, were 1000 km offshore (sightings ranged from 40-3750 km) and in waters that ranged from well-mixed to stratified (Ferguson et al 2006). Feeding ecology and prey preferences are not well known. Species found in stomach contents, however, are characteristic of species that feed in deep oceanic, mesopelagic, or benthic realms. Fish and squid appear to be prey of Cuvier's beaked whales (Heyning and Mead 2009).

Behavior and life history: Refer to section 4.2.14

Acoustics and hearing: Refer to section 4.2.14

4.2.17 Longman's Beaked Whale (*Indopacetus pacificus*)
Description: Longman's beaked whales, sometimes known as "tropical bottlenose" or "Indo-Pacific beaked whales," are one of the rarest and least known members of the beaked whales (Jefferson et al. 1993; Rice 1998; Dalebout et al 2003). As adults, Longman's beaked whales can reach estimated lengths of about 6-9 m; their weight is unknown. Compared to other beaked whales, this species is relatively large.

Longman's beaked whales have a large, robust body with a fairly large, falcate dorsal fin located far down their back. This species has dark, small, rounded, narrow flippers that fit into a depression on either side of the body. They have a well-defined melon that is almost perpendicular to their long, tube-shaped beak. A crease may distinguish the melon from the beak.

As they grow older, the melon develops into a steeper more bulbous shape that may hang over the beak. Like other beaked whales, they have V-shaped paired throat creases. As scientists have learned more about this species' external appearance and physical description, they have resolved confusion in various sightings at sea.

Longman's beaked whales are usually found in tight groups averaging between 10-20 individuals, but occasionally have been seen in larger groups of up to 100 animals. They have sometimes been observed associating with other marine mammals such as pilot whales, spinner dolphins, and bottlenose dolphins. The feeding behavior and prey of these cetaceans is generally unknown, but scientists believe it is similar to that of other beaked whales. Beaked whales are known to dive deep to forage for their food. The analysis of stomach contents from one stranded specimen implies that cephalopods (e.g., squid and octopus) comprise the majority of the whale's diet.

Status and trends: A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 1,007 (CV=1.25) Longman's beaked whales (Barlow 2006). This is currently the best available abundance estimate for this stock. No data are available on current population trend. The status of Longman's beaked whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. Sighting data collected during SWFSC surveys in 1998-2000, 2003 and 2006 allowed estimation of population abundance (1,007) and density (0.000037/km^2) in the ETP study area. It is not listed as threatened or endangered under the ESA, nor as "depleted" under the MMPA.

Distribution and habitat preferences: The distribution of Longman's beaked whales is poorly known and incomplete, but they are believed to occur in the tropical regions of the Indian and Pacific Oceans. Longman's beaked whales live in generally warm (21-31° C), deep (greater than 1,000 m), and pelagic waters of tropical and subtropical regions. In U.S. waters, this species has been sighted in the Hawaiian EEZ and the equatorial tropical Pacific. Strandings (7 total events) have occurred on the coasts of East (Kenya and Somalia) and South Africa, northern Australia, the Maldives, the Philippines, South Japan, and Sri Lanka. Rare sightings have been documented in the eastern tropical Pacific Ocean. Sightings in the waters surrounding the Maldives archipelago and in the western Indian and Pacific Oceans are more frequent.

Behavior and life history: Nothing is known about the reproduction or lifespan of this species. Due to the rarity, behavior, and infrequent encounters with this species, much of the information available is unreliable. A single young neonate calf was measured at 2.9 m.

Acoustics and hearing: Very little is known; however, like other beaked whales anthropogenic noise is thought to be a threat to this species.

4.2.18 Mesoplodont Beaked Whales

Description: Refer to section 4.1.13 for general species descriptions.

Status and trends: The only available estimate for Mesoplodont beaked whales in the ETP was made for one stock of *Mesoplodon* spp. A majority of the sightings from which the estimate derives were unidentified to species. The remaining Mesoplodont sightings were split among three species: *Mesoplodon* sp. 'A'; Blainville's beaked whale, *Mesoplodon densirostris*; and the

Peruvian beaked whale (also called pygmy beaked whale and lesser beaked whale), *Mesoplodon peruvianus* (Wade and Gerrodette 1993). In addition, although not identified during SWFSC ETP surveys, *M. ginkgodens* is also likely present there. The different species have different likelihoods of being correctly identified, so a pooled abundance estimate was made for all combined as *Mesoplodon* spp. The resulting estimate, based on data from 1986 to 1990, was 25,300 (17,400-34,400; 95% c.i.) (Wade and Gerrodette 1993). Density in the ETP was estimated to be 1.185 Mesoplodont beaked whales/1,000 km^2 (Gerrodette et al. 2008).

Pitman and Lynn (2001) subsequently proposed that *Mesoplodon* sp. "A" is likely *M. peruvianus*. At a minimum, size and dentition are comparable and ranges overlap.

None of the Mesoplodont whales in the ETP are listed under the ESA.

Distribution and habitat preferences: Mesoplodont beaked whales in the ETP are broadly distributed. They prefer deep water with mean and maximum depths of 3.5 km and 5.75 km, respectively, that ranges from well-mixed to stratified (Ferguson et al. 2006). They were sighted 1000 km offshore, on average, but distance from shore ranged from 40 to over 3,700 km (Ferguson et al. 2006).

Modeling predictions indicated two high density areas for *Mesoplodon* spp. in the ETP: 1) waters of the equatorial cold tongue that straddle the equator (e.g., Equatorial Countercurrent and South Equatorial Current) and 2) coastal waters off Central America and Mexico. These areas correspond with sighting distributions for Blainville's beaked whales and Peruvian beaked whales, respectively (Barlow et al. 2009; Pitman and Lynn 2001; Wade and Gerrodette 1993).

Behavior and life history: Refer to section 4.1.13

Acoustics and hearing: Refer to section 4.1.13

4.2.19 Sperm Whale (*Physeter macrocephalus*)

Description: Refer to section 4.1.16 for species description.

Status and trends: Sperm whales in the ETP were considered one stock for the purposes of estimating abundance. Genetics data from the ETP and Hawaii is currently inconclusive regarding population differentiation between these two areas (Mesnick et al. 2011). Gerrodette and Forcada (2002) estimated sperm whale abundance in the ETP in 2000 as 4,145 individuals (354-12,114; 95% c.i.). This was down from an estimated 26,652 in 1999 and was the lowest estimate derived between 1986 and 2000 (the highest was 49,653). Reasons for such disparity in abundance estimates include the likelihood of missing sperm whales on the track line due to their prolonged dives, difficulty in accurately estimating group size, and the possibility that whales, whose range extends beyond the survey boundaries, move readily into or out of the survey area depending on varying oceanographic conditions (Gerrodette and Forcada 2002). Density in the ETP was estimated to be 0.194 sperm whales/1,000 km^2 during the 2006 survey (Gerrodette et al. 2008).

Sperm whales are listed as endangered under the ESA. See section 4.1.16 for further information on historical commercial whaling and current status.

Distribution and habitat preferences: Sperm whales are widely distributed in the ETP, although they appear more abundant in the deep nearshore waters than offshore (Wade and Gerrodette 1993). Sperm whale sightings off southeast Costa Rica, however, were predominantly in deep offshore waters, including near Cocos Island (May-Collado et al. 2005).

Sperm whales in the ETP are predominantly females and immature animals. They are capable of extensive movements that they adapt over an array of temporal and spatial scales relative to the distribution of resources. Movements of 1,000 km (e.g., between the Galápagos Islands and mainland Ecuador or Panama) are common (Whitehead et al. 2008). Males are rare in the area, primarily due to their high-latitude non-breeding distribution and late age at which they return to the breeding areas (Whitehead et al. 2008).

Behavior and life history: Refer to section 4.1.16

Acoustics and hearing: Refer to section 4.1.16

4.2.20 Dwarf Sperm Whale (*Kogia sima*)
Description: Refer to section 4.1.15 for species description.

Status and trends: The worldwide population status and trends are unknown for dwarf sperm whales (McAlpine 2009). The best available population estimate for the ETP is 11,200 (7700-16,200; 95% c.i.) (Wade and Gerrodette 1993). Wade and Gerrodette (1993) considered all unidentified *Kogia* sightings south of 24° N to be *K. sima* when estimating abundance. Density in the ETP was estimated to be 0.525 dwarf sperm whales/1,000 km^2 (Gerrodette et al. 2008).

The species is not listed as threatened or endangered under the ESA, nor as “depleted” under the MMPA.

Distribution and habitat preferences: Dwarf sperm whales are thought to have a more southerly distribution than pygmy sperm whales (*K. breviceps*), which appeared to be corroborated by sightings of *K. breviceps* north of 24° N and *K. sima* south of 24° N during ETP surveys (Wade and Gerrodette 1993). Dwarf sperm whales may, thus, have a more tropical distribution and pygmy sperm whales a more temperate distribution. Dwarf sperm whales are found throughout the ETP, but with a higher sighting frequency near the coast identified off Costa Rica from 1979 to 2001 (May-Collado et al. 2005). *Kogia* spp. (dwarf and pygmy sperm whales) generally prey on mid- or deep-water cephalopods, as well as some fish and crustaceans (McAlpine 2009).

Behavior and life history: Refer to section 4.1.15

Acoustics and hearing: Refer to section 4.1.15

4.2.21 Humpback Whale (*Megaptera novaeangliae)*
Description: Refer to section 4.1.17 for species description.

Status and trends: The coastal regions of the ETP—notably, Costa Rica to Peru—include wintering areas for humpback whales from both the northern and southern hemispheres. Costa

Rica is unique as a region of geographic overlap for stocks of humpback whales that feed off California (California/Oregon/Washington stock) and off the Antarctic Peninsula and southern Chile (Breeding Stock G) (Acevedo and Smultea 1995; Calambokidis et al. 2000; Félix and Botero-Acosta 2011; Rasmussen et al. 2007). Although humpback whales are reportedly seen year-round off Costa Rica, peak numbers occur during January to March and August to October, the northern and southern hemisphere humpback whale wintering seasons, respectively (May-Collado et al. 2005; Rasmussen et al. 2004).

Sighting data collected during SWFSC surveys conducted in 1998-2000, 2003 and 2006 allowed estimation of population abundance (2,566) and density (0.000134/km^2) in the ETP study area. As of 2003, 83 humpback whales had been individually identified off Costa Rica during the boreal winter. Of these, 72 (87%) have been seen off California (Rasmussen et al. 2004). The minimum population estimate for the California/Oregon/Washington stock of humpback whales is 1,250 (Carretta et al. 2012). See Section 4.1.17 for further details on this stock. Of 41 humpback whales individually identified off Central America during the austral winters of 2001-2004, 7 were also photographed off the Antarctic Peninsula, a minimum distance of 8,299-8,461 km (Rasmussen et al. 2007). The estimated size of Breeding stock G was 6,500 in 2006 (Félix et al. in press cited in Félix and Botero-Acosta 2011).

Humpback whales are listed as endangered under the ESA.

Distribution and habitat preferences: Humpback whales have a largely coastal distribution in the ETP (Félix and Botero-Acosta 2011; Jackson et al. 2008; May-Collado et al. 2005). Off Costa Rica, all sightings of humpback whales were close to shore within the neritic zone (May-Collado et al. 2005).

As noted above, the ETP is a breeding and calving (wintering) area for humpback whales from both the northern and southern hemisphere. Individuals from both regions undertake lengthy annual migrations between feeding and breeding areas. Peak occurrence in the ETP for northern hemisphere humpbacks is January to March and for southern hemisphere humpbacks, August to early October (May-Collado et al. 2005). The most northerly extent of the southern hemisphere humpbacks off Costa Rica was 11° N (Rasmussen et al. 2007).

Surveys of humpback whale wintering areas worldwide show that they associate with warm water (21.1–28.3^{o} C), regardless of latitude (Rasmussen et al. 2007).

Behavior and life history: Refer to section 4.1.17 for general information on behavior and life history. Behavior of humpback whales on the wintering grounds differs from that on the feeding, or summering, grounds. It is primarily during winter that males sing long, elaborate songs. Males also form competitive groups wherein they compete for access to females (Clapham 2009).

The overall group composition for humpback whales off Costa Rica (1996-2003) was similar to other wintering areas. The proportion of single animals (singing males and non-singers) was 45%, 23% were pairs (non-mother/calf), and 29% were mother/calf pairs or mother/calf/escort trios (Rasmussen et al. 2004). The mean group size for humpback sightings during ETP surveys ranged from 1.5 to 2.5 (Kinzey et al. 1999, 2001; Jackson et al. 2004, 2008).

Acoustics and hearing: Refer to section 4.1.17

4.2.22 Blue Whale (*Balaenoptera musculus*)
Description: Refer to section 4.1.18 for species description.

Status and trends: The blue whales in the ETP appear to belong to the "California/Mexico" or, more appropriately, the eastern North Pacific stock of blue whales (Carretta et al. 2012; Stafford et al. 1999). It was previously thought that blue whales from both the southern and northern hemispheres frequented the Costa Rica Dome during their respective winters, since blue whales were observed there year-round (Ballance et al. 2006; Reilly and Thayer 1990). Acoustic data from moored hydrophones has since revealed that blue whale calls in the ETP are consistent with the A-B call of eastern North Pacific blue whales (Stafford et al. 1999). Additionally, several tagged blue whales moved between California and the Costa Rica Dome (Matteson 2009), further corroborating the inclusion of ETP blue whales in the eastern North Pacific stock.

The most recent estimate of abundance for blue whales in the ETP is 1,415 (1,078-2,501; 95% c.i.) (Wade and Gerrodette 1993). Population abundance and trends for the feeding stock off the U.S. West Coast are described in Section 4.1.18. Density in the ETP was estimated to be 0.194 blue whales/1,000 km^2 (Gerrodette et al. 2008).

The blue whale is listed as endangered under the ESA. Refer to Section 4.1.18 for further information on historical whaling and stock status.

Distribution and habitat preferences: Blue whale distribution in the ETP coincides with colder, nutrient rich waters of the California and Peru currents and the Costa Rica Dome (Wade and Gerrodette 1993). More than 90% of blue whale sightings in the ETP were along the coast of Baja California, Mexico or in the vicinity of the Costa Rica Dome. Other sightings occur near the Galapagos Islands, and along the coasts of Ecuador and Peru (Hamilton et al. 2009, Reilly and Thayer 1990). These colder, upwelling areas are productive regions with relatively large standing stocks of euphausiids (krill), a preferred prey of blue whales (Reilly and Thayer 1990).

Patterns in acoustic detections (Stafford et al. 1999), along with movements of tagged whales (Matteson 2009), suggest a seasonal migration between the ETP and the northeast Pacific. The A-B calls were most frequently recorded during summer/fall on the northeastern Pacific hydrophones and during winter/spring on the ETP hydrophones (Stafford et al. 1999). Although blue whales are seen year-round near the Costa Rica Dome, relative abundance was highest during January to March (Reilly and Thayer 1990). The year-round occurrence of blue whales near the Costa Rica Dome may be due to some of the population not migrating (Stafford et al. 1999).

Behavior and life history: Refer to section 4.1.18

Acoustics and hearing: Refer to section 4.1.18

4.2.23 Fin Whale (*Balaenoptera physalus*)
Description: Please refer to Section 4.1.19 for a full description of the fin whale.

Fin whales sightings are rare in the ETP (Carretta et al. 2012, Wade and Gerrodette 1993). Only one fin whale was recorded during surveys from 1986 to 1990 and it was north of the study area along the coast of Baja California, Mexico (Wade and Gerrodette 1993). Between 1998 and 2008, 10 out of 13 fin whales sighted during surveys were along the Baja coast on either the Pacific or the Gulf of California sides. Two were observed offshore to the west of Baja (1999 and 2003) and one (in 2003) was sighted at the southern extent of the ETP off the coast of Peru (Kinzey et al. 1999, 2000, 2001, Jackson et al. 2004, 2006). From sighting data collected during SWFSC surveys conducted in 1998-2000, 2003 and 2006 population abundance (574) and density (0.00003/km^2) were estimated for the ETP study area.

The fin whale is listed as endangered under the ESA.

Due to their rarity in the survey area, they will not be further discussed in this section.

4.2.24 Sei Whale (*Balaenoptera borealis*)
Description: Please refer to section 4.1.20 for an account of this species.

There were no sightings of sei whales during SWFSC surveys conducted in 1998-2000, 2003 and 2006. Thus, from these data we estimated population abundance and density are both zero for the ETP study area.

The species is listed as endangered on the ESA.

Sei whales are extremely rare in the ETP, generally occurring farther north; there were only 2 confirmed sightings compared to more than 200 confirmed Bryde's whale sightings in the 8 years of data considered (Gerrodette and Forcada 2002). Please see comments below for Bryde's whale and possible confusion in identification of the two species.

4.2.25 Common Minke Whale (*Balaenoptera acutorostrata*)
Description: Please refer to Section 4.1.21 for a full description of the minke whale.

Minke whales are also uncommon in the ETP (Oleson et al. 2003, Wade and Gerrodette 1993). There were six sightings of minke whales during surveys in 1986-1990 (Wade and Gerrodette 1993) and only two sightings since, in 2000 and 2006 (Kinzey et al. 1999, 2000, 2001, Jackson et al. 2004, 2006). Most sightings were in the northern part of the survey area west to southwest of Baja, Mexico (Hamilton et al. 2009). In 2003, minke whales were acoustically detected in that area, but not visually detected. From limited sighting data collected during SWFSC surveys conducted in 1998-2000, 2003 and 2006 population abundance (115) and density (0.000006/km^2) were estimated for the ETP study area.

The species is listed as endangered on the ESA. Due to the infrequency with which minke whales occur in the survey area, they will not be further discussed in this section.

4.2.26 Bryde's Whale (*Balaenoptera edeni*)
Description: Bryde's whales are among the least well known of the larger baleen whales. They are medium sized balaenopterids that may attain lengths of 15.5 m, although most are smaller.

Females are larger than males (Kato and Perrin 2009). Bryde's whales closely resemble, and are often confused with, sei whales. The feature that most readily distinguishes them from other species, including sei whales, is the presence of three prominent ridges on the rostrum. The rostrum is V-shaped and the dorsal fin is strongly falcate. They are dark gray above and white below, although the dark areas extend to the throat grooves and flippers (Kato and Perrin 2009).

Status and trends: Bryde's whales belong to the Order Cetacea, Suborder Mysticeti, and Family Balaenopteridae. The International Whaling Commission (IWC) recognizes three stocks of Bryde's whales in the North Pacific—the eastern, western, and East China Sea stocks—plus the cross-equatorial Peruvian stock (Carretta et al. 2007 and citations therein). Wade and Gerrodette (1993) suggested that Bryde's whales in the ETP may comprise two stocks based on a gap in distribution between 7° N and 9° N. Gerrodette and Forcada (2002), however, considered Bryde's whales in the ETP a single stock when generating population estimates.

The most recent estimate of abundance for Bryde's whales in the ETP was 10,411 (6,531-14,747; 95% c.i.) in 2000 (Gerrodette and Forcada 2002). Sightings recorded as Brydes's/sei whale (*B. edeni/B. borealis*) during surveys were considered to be Bryde's whales and included in the analysis. Sightings were recorded as such when it was not possible to get a good enough view to confirm species identity. As mentioned above at 4.2.24, sei whales are extremely rare in the ETP, generally occurring farther north; there were only 2 confirmed sightings compared to more than 200 confirmed Bryde's whale sightings in the 8 years of data considered (Gerrodette and Forcada 2002). Density in the ETP was estimated to be 0.488 Bryde's whales/1,000 km^2 (Gerrodette et al. 2008).

The species is not listed under the ESA or designated as depleted under the MMPA.

Distribution and habitat preferences: Bryde's whales occur throughout tropical and warm temperate waters (16.3°C and warmer) between 40° N and 40° S worldwide and year-round. They do not undertake long migrations, but show a general movement toward the equator in winter and toward higher latitudes in summer (Kato and Perrin 2009). They are the most commonly sighted baleen whale in the ETP, with a distribution that appears relatively uniform throughout the study area (Barlow et al. 2009, Wade and Gerrodette 1993). An area of concentration exists around the equator east of 110° W (Carretta et al. 2007 and citations therein).

They primarily feed on pelagic schooling fishes, such as pilchard, anchovies, sardines, and herring. As opportunistic feeders, however, they also consume krill and copepods, as well as cephalopods and pelagic red crabs (Kato and Perrin 2009).

Behavior and life history: Female Bryde's whales in the North Pacific attain sexual maturity at approximately 11.6-11.8 m length and males reach sexual maturity at 11.0-11.4 m length. Gestation is approximately 11 months and calves wean at about 6 months of age and the calving interval is 2 years (Kato and Perrin 2009). Similar to other baleen whales, Bryde's whales are often alone or in small groups. The mean group size in the ETP was 1.7 (Wade and Gerrodette 1993).

Acoustics and hearing: Bryde's whales are categorized in the low frequency functional hearing group along with all other baleen whales. The estimated auditory bandwidth is 7 Hz to 22 kHz (Southall et al. 2007) (Table 4.1).

Bryde's whales produce low-frequency tonal and swept calls similar to other balaenopterids (Oleson et al. 2003). Six call types associated with Bryde's whales were recorded in the ETP. Frequencies ranged from 20 to 60 Hz. The calls were separated geographically, with three detected only north of 9° N and three only heard south of 5° N (Oleson et al. 2003).

4.2.27 South American Sea Lion

South American sea lions are one of the largest of the otariids. Adult males can be up to 3 m long and weigh 300-350 kg; the much smaller females reach about 2 m in length and 150 kg (Cappozzo and Perrin 2009). South American sea lions occur along both the Atlantic and Pacific coasts of South America. They range from Cape Horn to northern Peru on the Pacific side. There is no reliable information on the Pacific population, which is assumed to be smaller than that on the Atlantic side. Primary prey off Peru includes anchovy and lobster, but a diverse assemblage of demersal fishes is consumed in the absence of preferred prey. Males reach sexual maturity at 6 years of age and females begin pupping at 5 years. The breeding and pupping season is mid-December to early February (Cappozzo and Perrin 2009).

4.2.28 Other Pinnipeds

Four species of pinnipeds positively identified to species during marine mammal surveys of the ETP between 1998 and 2006 were the California sea lion (*Zalophus californianus*), South American sea lion (*Otaria flavescens*), Guadalupe fur seal (*Arctocephalus townsendi*), and the northern elephant seal (*Mirounga angustirostris*) (Kinzey et al. 1999, 2000, 2001, Jackson et al. 2004, 2006). With the exception of the South American sea lion, all of the other species were sighted at the northern end of the survey area along the coast of Baja California, Mexico. The South American sea lions were observed along the Peruvian coast, with the majority of sightings (31) during 2003; four were sighted in 1998 (Jackson et al. 2004, Kinzey et al. 1999).

For additional information please refer to Sections 4.1.23, 4.1.25, and 4.1.28 for descriptions of California sea lions, Guadalupe fur seals, and northern elephant seals.

4.3 Antarctic Ecosystem

Cetaceans

4.3.1 Spectacled Porpoise (*Phocoena dioptrica)*

Description: Spectacled porpoise are poorly known and few observations of live animals have been recorded; most of what is known is based on examination of stranded animals, mostly from Tierra del Fuego. The following account and information is based on two recent publications on the species, Goodall (2009a) and Sekiguchi et al. (2006). The porpoise is a robust animal with rounded head and no beak; the flippers are small and situated well forward on the body. Spectacled porpoises are known to be strongly sexually dimorphic. Adult males appear to be larger than females. The largest male studied measured 2.24 m and the largest female measured 2.04 m. The dorsal fin is broadly triangular and shows strong sexual dimorphism, being much larger and more rounded in males. In overcast conditions, body color appears mainly dark or

even black. At very close range, the white ventral coloration, including above and below the black lips, and the white 'spectacles' are evident. Under good lighting conditions, females and juveniles appeared lighter in color; grayer than adult males. When viewed from above, the tail stock appears lighter on the sides as well as the dorsal side of the fluke, joining with the white coloration of the ventral part and along the sides of the tail stock. A pale area or saddle is evident around the dorsal fin.

Status and trends: Spectacled porpoise belong to the Order Cetacea, Suborder Odontoceti, and Family Phocoenidae. While data are sparse on abundance and density and this species has not been observed during AMLR visual surveys, the IUCN Red List (iucnredlist.org) assessment of this species allows a calculation of estimated population density of 0.0015/km^2 for the larger Antarctic ecosystem.

The species is not listed under the ESA or designated as depleted under the MMPA.

Distribution and habitat preferences: They have a circumpolar distribution; however, longitudinally they are somewhat concentrated in the Pacific Ocean sector (60°W-130°E) of the Antarctic. Fifteen sighting records (53.6%) are from the region between New Zealand and the Ross Sea. The sea surface temperature recorded at the time of each sighting ranged between 0.9° C and 10.3° C; however, the most frequent ranked temperatures were between 1.0-1.9° C and 5.0-5.9° C, which were recorded in half of the sightings.

Behavior and life history: There is little or no information on spectacled porpoise natural history, food habits, or breeding season. Spectacled porpoises are very difficult to sight at sea, mainly because of their small body and group sizes and inconspicuous behavior. Almost all sightings of spectacled porpoises are recorded close to the vessels and under excellent survey condition. Group size averages 2.0 individuals; the most frequent group size is one followed by three.

Acoustics and hearing: There is no information on the acoustics of the spectacled porpoise although it is assumed that it has much the same characteristics as other species in the family. Harbor porpoise, which are also in the family Phocoenidae, are in the high-frequency functional hearing group, whose estimated auditory bandwidth is 200 Hz to 180 kHz (Southall et al. 2007). Their vocalizations range from 110 to 150 kHz (DON 2008a) (Table 4.1).

4.3.2 Hourglass Dolphin (*Lagenorhynchus cruciger*)

Description: As with spectacled porpoise above, little is known of the hourglass porpoise. A recent summary by Goodall (2009b) is used here as the principal source for information on this species. The dolphin is mainly black to dark gray with two elongated lateral white areas joined in some animals with a white line that resembles an hourglass. It is a rather stocky dolphin with large re-curved dorsal fin that is variable in shape from erect to hooked; the tail stock is often keeled. Total length for males is 1.63-1.87 m and for females 1.42-1.83 m. Males weigh about 100 kg and females 88 kg but sample size is very small and each can be longer and heavier.

Status and trends: Hourglass dolphins belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. Nothing is known of abundance and trends for this species. However, during the 2008/2009 AMLR surveys to estimate abundance and map krill and fish, marine

mammal observers recorded a density of 0.00151 hourglass dolphins/km within the survey area (Santora et al. 2009).

The species is not listed under the ESA or designated as depleted under the MMPA.

Distribution and habitat preferences: This porpoise is pelagic and circumpolar in the Southern Ocean in both Antarctic and sub-Antarctic waters. Most specimens have been found between 45° S and 60° S. Hourglass dolphins are often seen near islands and banks, especially in turbulent waters. They are often seen in the Drake Passage.

Behavior and life history: Hourglass dolphins are commonly seen associated with fin whales and were once used as cues by whalers hunting whales. They bow-ride with ships. School size varies from 1 to 60 animals. Nothing is known of the movements or migratory habits. Prey from stranded animals includes myctophids, hake, small squid, crustaceans, and polychaetes.

Acoustics and hearing: There is no information on the acoustics of the hourglass dolphin, but it is likely that these dolphins exhibit similar acoustic characteristics as other dolphins in the same genus and family, such as the Pacific white-sided dolphin (*L. obliquidens*). As discussed above, vocalizations produced by Pacific white-sided dolphins include whistles and clicks. Whistles are in the frequency range of 2 to 20 Hz. Peak frequencies of the pulse trains for echolocation fall between 50 and 80 kHz; the peak amplitude is 170 dB re 1μPa-m. Underwater hearing sensitivity of the Pacific white-sided dolphin is from 75 Hz through 150 kHz. The greatest sensitivities were from 4 to 128 kHz. Below 8 Hz and above 100 kHz, this dolphin's hearing was similar to that of other toothed whales.

4.3.3 Killer Whale (*Orcinus orca*)

Please refer to Section 4.1.10 above for a full description of the killer whale. Recent reports show that three distinct forms of killer whales have been described from Antarctic waters; referred to as types A, B, and C, they are purported prey specialists on Antarctic minke whales (*Balaenoptera bonaerensis*), seals, and fish, respectively (Pitman and Ensor 2003). Information on the status, and population trends, and distribution in the AMLR survey area are scant but suggest that they are an abundant species. Line transect survey have yielded estimates of 25,000 killer whales in the Southern Ocean (Ford 2009). During the 2008/2009 AMLR surveys to estimate abundance and map krill and fish, marine mammal observers recorded a density of 0.00151 killer whales/km within the survey area (Santora et al. 2009).

Killer whales in the Antarctic area are not listed under the ESA or designated as depleted under the MMPA.

4.3.4 Sperm Whale (*Physeter macrocephalus*)

Please refer to Section 4.1.16 above for a full description of the sperm whale. Regarding the status and trends of sperm whales within the SWFSC AMLR survey area, there is no information on status and trends. It is known that female and young sperm whales are not often seen in higher latitudes; males can be found over almost any ice-free deep water area including waters within the SWFSC AMLR survey area (Whitehead 2009), though they have not been observed during these surveys. Based on data reported by Whitehead (2002) the density of this population is estimated to be $0.00065/km^2$ for the larger Antarctic ecosystem.

The species is listed as endangered under the ESA and depleted under the MMPA.

4.3.5 Arnoux's Beaked Whale (*Berardius arnuxii*)

Description: Arnoux's beaked whales (as with Baird's beaked whale described at 4.1.12) are one of the largest members of the family Ziphiidae. The entire body is dark brown with the ventral side paler with irregular white patches; tooth marks of conspecifics are numerous on the back, particularly on adult males (Kasuya 2009). The body is slender with a small head, low falcate dorsal fin and small flippers that fit into depressions on the body. The melon is small and its front surface is almost vertical with a slender projecting rostrum (ibid). Mean body length is somewhat smaller than Baird's beaked whale with length of whales 8.5-9.6 m.

Status and trends: Arnoux's beaked whales belong to the Order Cetacea, Suborder Odontoceti, and Family Ziphiidae. Data on population abundance and density for the AMLR study area are limited, and this species has not been identified during past surveys. However, the IUCN Red List Assessment (iucnredlist.org) for this species allows calculation of an estimated density of $0.0006/km^2$ using the available information from the larger Antarctic ecosystem.

The species is not listed under the ESA or designated as depleted under the MMPA.

Distribution and habitat preferences: Arnoux's beaked whales inhabit vast areas of the Southern Hemisphere outside the tropics reaching northward to the shores of the Southern Hemisphere continents (Kasuya 2009). Specific information on habitat preferences is not known but likely is similar to that for Baird's beaked whale, discussed at 4.1.12.

Behavior and life history: Most of what is known for the genus is based on information on Baird's beaked whale in the Northern Hemisphere. Please refer to section 4.1.12 for a summary of behavior, diet and dive behavior for the genus.

Acoustics and hearing: Please refer to section 4.1.12 for information on Baird's beaked whale.

4.3.6 Southern Bottlenose Whale (*Hyperoodon planifrons*)

Description: The southern bottlenose whale is a large, robust beaked whale distinguished by their large bulbous forehead and short dolphin-like beak (Gowans 2009). They may be 6-9 m long. They are chocolate brown to yellow in color, and lighter on the flanks and belly (ibid). Males possess a single pair of conical teeth at the tip of the lower jaw; they do not erupt in females (ibid).

Status and trends: Southern bottlenose whales belong to the Order Cetacea, Suborder Odontoceti, and Family Ziphiidae. There is no information on population status or trends in the Southern Hemisphere. However, during the 2008/2009 AMLR surveys to estimate abundance and map krill and fish, marine mammal observers recorded a density of 0.00061 southern bottlenose whales/km within the survey area (Santora et al. 2009).

The species is not listed under the ESA or designated as depleted under the MMPA.

Distribution and habitat preferences: Southern bottlenose whales are found throughout the Southern Hemisphere, from ice edges to 30° S; there are no known areas of concentration (Gowans 2009).

Behavior and life history: Bottlenose whales are typically found in small groups of 1-4 individuals but groups up to 20 have been observed. There is no information on the life history of southern bottlenose whales. They are believed to be deep divers feeding primarily on squid, with fish and benthic invertebrates infrequently consumed (Gowans 2009). Northern bottlenose whales have been recorded to dive to 1,400 m (ibid).

Acoustics and hearing: There is no information on acoustics for this species. However, DON (2008b) reviewed the literature on beaked whale acoustics and reported that beaked whales use frequencies of between 300 Hz and 129 kHz for echolocation, and between 2 and 10 kHz, and possibly up to 16 kHz, for social communication. There is no information on the hearing abilities of southern bottlenose whales. They are likely in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007). Vocalizations ranges are similar at 300 Hz to 135 kHz (DON 2008a) (Table 4.1).

4.3.7 Long-Finned Pilot Whale (*Globicephala melas edwardii*)

Description: Pilot whales appear black or dark gray; the body is robust with a thick tailstock. The melon is exaggerated and bulbous and there is either no beak or a barely discernable one (Olson 2009). They exhibit striking sexual dimorphism with adult males reaching an average length of 6 m and they are larger than females; the broad-based dorsal fin of a male is larger than that of a female (Olson 2009). They are very difficult to distinguish from the short-finned pilot whale discussed at 4.1.11 in that the flippers are marginally longer and they exhibit a noticeable 'elbow' (Olson 2009).

Status and trends: Long-finned pilot whales belong to the Order Cetacea, Suborder Odontoceti, and Family Delphinidae. The long-finned pilot whale population in the Antarctic has been estimated at 200,000 whales in the mid-1990s but no recent estimate exist (Olson 2009). There are no estimates of abundance or information on status and trends of the long-finned pilot whale in the Southern Hemisphere or in the SWFSC AMLR survey area. However, during the 2008/2009 AMLR surveys to estimate abundance and map krill and fish, marine mammal observers recorded a density of 0.00757 long-finned pilot whales/km within the survey area (Santora et al. 2009).

The species is not listed under the ESA or designated as depleted under the MMPA.

Distribution and habitat preferences: Long-finned pilot whales inhabit the cold temperate waters of the North Atlantic and Southern Ocean; those in the Southern Ocean are of the subspecies *G. melas edwardii*. They are circumpolar in the Southern Hemisphere and occur as far north as 14° S in the Pacific and south to the Antarctic Convergence (Olson 2009).

Behavior and life history: Pilot whales are very social and may travel in groups of several to hundreds of animals, often with other cetaceans. They appear to live in relatively stable, female-based groups (DON 2008b). Sexual maturity occurs at 9 years for females and 17 years for

males. The mean calving interval is 4 to 6 years. Pilot whales are deep divers; the maximum dive depth measured is about 971 m (Baird et al. 2002).

Acoustics and hearing: The calls of long-finned pilot whales are of a lower frequency and a narrower frequency range than those of the short-finned pilot whale. The mean frequency for long-finned pilot whales is 4,480 Hz versus 7,870 for short-finned pilot whales (Olson 2009). *Globicephala* spp. are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007) (Table 4.1).

4.3.8 Antarctic Minke Whale (*Balaenoptera bonaerensis*)

Description: Antarctic minke whales are similar in shape and coloration to the common and dwarf minke whales (see section 4.1.21 and 4.4.10) but they lack the characteristic white flipper chevron of the northern species (Perrin and Brownell 2009). Antarctic minke whales are estimated to average 9.0 m at maturity for females and to 8.5 m for males (Perrin and Brownell 2009). The baleen plates are black on the left beyond the first few plates and on the right they are white in the first third and black in the rear two-thirds of the row (ibid).

Status and trends: The Antarctic minke whale belongs to the Order Cetacea, Suborder Mysticeti, and Family Balaenopteridae. Abundance in the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) survey area during 2000, which included the Scotia Sea and Antarctica Peninsula, was estimated to be 18,125 (CV% =28.28) minke whales (Reilly et al. 2004). There are no current estimates of status or trends however the species is considered stable and in good shape. During the 2008/2009 AMLR surveys to estimate abundance and map krill and fish, marine mammal observers recorded a density of 0.00182 minke whales/km within the survey area (Santora et al. 2009).

The species is not listed under the ESA or designated as depleted under the MMPA.

Distribution and habitat preferences: Antarctic minke whales are abundant from 60° S to the ice edge during the austral summer then retreat in the austral winter to breeding grounds in mid-latitudes 10°-30° S in the Pacific and other locations off Australia and South Africa (Perrin and Brownell 2009). In these regions they are distributed beyond the continental shelf break and oceanic.

Behavior and life history: Little is known of the natural history of Antarctic minke whales but they are assumed to have similar traits as the common minke whale. They are assumed to breed in winter in warm waters of low latitudes, give birth to a single calf every other year, and reach sexual maturity when 7-9 m long (Perrin and Brownell 2009). Antarctic minke feed mainly on euphausiids (ibid). There are no data on dive depth for minke whales. Antarctic minke whales are predated upon by Type A killer whales (Pitman and Ensor 2003).

Acoustics and hearing: Minke whales are in the low-frequency functional hearing group with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007). Vocalizations range from 60 Hz to 20 kHz (DON 2008a) (Table 4.1).

4.3.9 Southern Right Whale (*Eubalaena australis*)

Description: As summarized in Kenney (2009), right whales have an extremely robust body form with a thick blubber layer and the girth at times exceeding 60% of total body length. The head is relatively large, comprising about one quarter to one third of the body length and the upper jaw is arched. The body is mostly black, sometimes with irregular white ventral patches. There is no dorsal fin and the pectoral flippers are large, broad, and blunt; the flukes are very broad. Baleen plates are relatively narrow and 2-2.8 m long. The most conspicuous external characteristic of right whales are the callosities on the head which are irregular patches of keratinized tissue inhabited by dense populations of specialized amphipod crustaceans, known as cyamids or 'whale lice'. Adults are typically 13-16 m long.

Status and trends: The Southern right whale belongs to the Order Cetacea, Suborder Mysticeti, and Family Balaenidae, however the taxonomic name and position of the three right whale species and of bowhead whales is equivocal and under investigation. The total abundance of Southern right whales in 1997 was 7,571 whales with those in some areas increasing at 7-8% annually. Assuming continued increase during the period from 1997 to the present, the total abundance could currently exceed 15,000 animals (Kenney 2009). Abundance in the CCAMLR survey area during 2000, which included the Scotia Sea and Antarctica Peninsula, was estimated to be 1,755 (CV% =61.67) right whales (Reilly et al. 2004). This species has been sighted as recently as 2010 during AMLR visual surveys. Estimates of status and trends specific to the SWFSC AMLR survey area are not available.

The species is listed as endangered under the ESA and designated as depleted under the MMPA.

Distribution and habitat preferences: Southern right whales are found in the middle latitudes of the Southern Ocean between approximately 20° and 60° S. Multiple stocks have been hypothesized off Argentina/Brazil, South Africa, east Africa, western Australia, southeastern Australia, New Zealand, and Chile. They migrate annually between high-latitude feeding grounds and low-latitude calving and breeding grounds. Feeding grounds for this species appears to be offshore, pelagic regions in areas of high productivity (Kenney 2009). Calving often occurs in shallow coastal waters and bays.

Behavior and life history: Right whales have a three-year reproductive cycle; mating likely occurs in or near the calving grounds. DON (2008a) summarized the literature on northern right whale foraging behavior; likely southern right whale foraging behavior is similar. Dives of 5-15 min or longer have been reported, but can be much shorter when feeding. Foraging dives in the known feeding high-use areas are frequently near the bottom and the average depth of a dive was strongly correlated with both the average depth of peak copepod abundance and the average depth of the mixed layer. Right whale feeding dives are characterized by a rapid descent from the surface to a particular depth between 80 and 175 m, remarkable fidelity to that depth for 5 to 14 min, and then rapid ascent back to the surface. Longer surface intervals have been observed for reproductively active females and their calves. Killer whales and large sharks are likely predators of Southern right whales.

Acoustics and hearing: DON (2008a) summarized acoustics and hearing for northern right whales that may be analogous to that of the southern right whale. Sounds can be divided into three main categories: (1) blow sounds; (2) broadband impulsive sounds; and (3) tonal call types.

Blow sounds are those coinciding with an exhalation; broadband sounds include non-vocal slaps (when the whale strikes the surface of the water with parts of its body) and the "gunshot" sound; data suggests that the latter serves a communicative purpose. Tonal calls can be divided into simple, low-frequency, stereo-typed calls and more complex, frequency-modulated, higher-frequency calls. Most of these sounds range in frequency from 0.02 to 15 kHz (dominant frequency range from 0.02 to less than 2 kHz; durations typically range from 0.01 to multiple seconds) with some sounds having multiple harmonics. Source levels for some of these sounds have been measured as ranging from 137 to 192 dB root-mean-square (rms) re 1 μPa-m (decibels at the reference level of one micro Pascal at one meter). Morphometric analyses of North Atlantic right whale inner ears estimate a hearing range of approximately 0.01 to 22 kHz based on established marine mammal models. In addition, the estimated functional hearing range for right whales may be 15 Hz to 18 kHz. Right whales are, thus, in the low-frequency functional hearing group of Southall et al. (2007). Their vocalizations range from 20 Hz to 15 kHz (DON 2008b) (Table 4.1).

4.3.10 Fin Whale (*Balaenoptera physalus*)

Please refer to Section 4.1.19 for a full description of the fin whale. Abundance in the CCAMLR survey area during 2000, which included the Scotia Sea and Antarctica Peninsula, was estimated to be 4,672 (CV% = 42.37) fin whales (Reilly et al. 2004). Population status and trend information for this species within the SWFSC AMLR survey area are lacking. However, during the 2008/2009 AMLR surveys to estimate abundance and map krill and fish, marine mammal observers recorded a density of 0.08391 fin whales/km within the survey area (Santora et al. 2009).

The species is listed as endangered under the ESA and designated as depleted under the MMPA.

4.3.11 Blue Whale (*Balaenoptera musculus*)

Please refer to Section 4.1.18 for a full description of the blue whale. There is no information regarding the status and trends of blue whales within the SWFSC AMLR survey area. In the Southern Ocean, where the blue whale was historically most abundant, it is rare today with abundance estimates at 1,700 whales and that discrete feeding stocks exist (Sears and Perrin 2009). Branch et al. (2007) reported a range of densities for blue whales in the Antarctic ecosystem based on trackline sightings, the low end of which is 0.00012/km. There are no estimates of blue whale density within the AMLR survey area, and there have been no recent sightings of this species during AMLR surveys.

The species is listed as endangered under the ESA and designated as depleted under the MMPA.

4.3.12 Humpback Whale (*Megaptera novaeangliae*)

Please refer to Section 4.1.17 for a full description of the humpback whale. In the Southern Hemisphere, humpbacks feed in circumpolar waters around the Antarctic and migrate to relatively discrete breeding grounds in tropical waters to the north (Clapham 2009). Abundance in the CCAMLR survey area during 2000, which included the Scotia Sea and Antarctica Peninsula, was estimated to be 9,484 (CV% = 27.92) humpback whales (Reilly et al. 2004). There is no information on the status and population trends for humpback in the Antarctic. However, during the 2008/2009 AMLR surveys to estimate abundance and map krill and fish,

marine mammal observers recorded a density of 0.03605 humpback whales/km within the survey area (Santora et al. 2009).

The species is listed as endangered under the ESA and designated as depleted under the MMPA.

PINNIPEDS

4.3.13 Antarctic Fur Seal (*Arctocephalus gazella*)

Description: Antarctic fur seals are similar in size and appearance to Guadalupe fur seals described above. Adult females weigh about 45 kg and adult males 188 kg (Arnould 2009; Forcada and Stanland 2009). Fur seals in general can be distinguished from sea lions by the presence of a dense under fur and their smaller size. Pelage color is generally uniform dark brown to dark gray on the dorsal surface with a grizzled appearance caused by the tips of guard hairs being pale or white (ibid). Some individuals on South Georgia Island have a white (not albino) pelage.

Status and trends: Antarctic fur seals belong to the Order Carnivora, Suborder Pinnipedia, Family Otariidae, and Subfamily Otariinae. Presently the species numbers about 1,600,000 animals throughout its range and is increasing at about 9.8%/year (Arnould 2009). The species was thought to be extinct until a small colony was discovered in 1950 at Bird Island, near South Georgia Island in the South Atlantic Ocean (Arnould 2009). The species now breeds at colonies from South Georgia to Macquarie Island off New Zealand. The SWFSC maintains a research site at Cape Shirreff, Livingston Island, where it monitors Antarctic fur seal status and trends. Pup production there during the 2008/2009 field season totaled 1569 pups born, a decrease of 13.3% from the 2007/2008 field season (Goebel et al. 2009). Leopard seal predation is significant and may be an important top-down factor controlling recovery of fur seal populations as well as penguin populations, in the South Shetland Islands (ibid). During the 2008/2009 AMLR surveys to estimate abundance and map krill and fish, marine mammal observers recorded a density of 0.09996 fur seals/km within the survey area (Santora et al. 2009).

The species is not listed under the ESA or designated as depleted under the MMPA.

Distribution and habitat preferences: Large-scale hunting during the commercial sealing era severely depleted the populations of many southern fur seal species, including the Antarctic fur seal; pre-sealing distribution and population size is not known for many species especially those whose range overlap such as the Antarctic and Subantarctic fur seals (Arnould 2009; Forcada and Stanland 2009).

Behavior and life history: Most species in the genus reach sexual maturity at 3-5 years of age; males also mature at about the same age but are unable to attain reproductive status (obtain a reproductive territory) until 7-10 years of age. Timing of pupping is variable for the genus but for Antarctic fur seals it is November-January. Southern fur seals, including the Antarctic fur seal, feed on a variety of prey including fish, cephalopods and crustaceans, depending on prey abundance and location. Most southern fur seals forage in upwelling zones, oceanic fronts, or continental shelf-edge region; however female Antarctic fur seals on foraging trips originating at Cape Shirreff forage mostly over the shelf and rarely use the shelf edge (M. Goebel, SWFSC, personal communication, March 2011). Species in this genus forage mainly in the surface mixed

layer (<50-60 m) at night (Arnould 2009). Antarctic fur seals at Cape Shirreff feed mainly on krill, cephalopods, and fish; females there have feeding trips that last about 2-4 days and dive to <100 m (Arnould 2009; M. Goebel, SWFSC, personal communication, March 2011).

Acoustics and hearing: Like other pinnipeds, these fur seals are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007). Vocalizations range from <4 to 120 kHz (DON 2008a) (Table 4.1).

4.3.14 Southern Elephant Seal (*Mirounga leonina*)

Description: Southern elephant seals are the largest of all pinnipeds. The species is sexually dimorphic with males weighing as much as 3,700 kg and females weighing about 800 kg (Hindell and Perrin 2009). Males have a large inflatable proboscis and a pronounced chest shield associated with fighting with other males on land to acquire females. Females lack the proboscis and chest shield (ibid). Both males and females are gray to brown in color.

Status and trends: Southern elephant seals belong to the Order Carnivora, Suborder Pinnipedia, Family Phocidae. Status and trend information for this species at specific sites within the SWFSC survey area is not available. Between the 1950s and 1990s the southern elephant seal underwent large decreases in population size throughout most of its breeding range in the Southern Ocean. While current population estimates suggest a recent recovery, some breeding populations have continued to decrease in recent years (Macquarie and Marion Islands), others have either remained stable (South Georgia, Kerguelen and Heard Island) or have increased (Peninsula Valdés, Argentina) (McMahon et al. 2005). The total population size in 2000 was 640,000 southern elephant seals (Hindell and Perrin 2009). During the 2008/2009 AMLR surveys to estimate abundance and map krill and fish, marine mammal observers recorded a density of 0.0003 elephant seals/km within the survey area (Santora et al. 2009).

The species is not listed under the ESA or designated as depleted under the MMPA.

Distribution and habitat preferences: Southern elephant seals breed on islands around the subantarctic with pups occasionally born on the Antarctic mainland (Hindell and Perrin 2009). The range extends north from Patagonia and the Falkland Islands; when ashore for the annual molt or for breeding they utilize most of the Southern Ocean north of the Antarctic Polar Front to the high Arctic pack ice (ibid). They spend as much as 80% of their annual cycle at sea, migrating long distances to favorable foraging locations (ibid).

Behavior and life history: Adult breeding males haulout onto deserted beaches in August; adult females arrive soon thereafter and a single pup is born about 2-5 days later. Elephant seals are highly polygynous with large dominant males presiding over large aggregations of females, known as harems consisting of up to 100 animals (Hindell and Perrin 2009). Males tend to feed in shallower water over the shelf while females forage in deep water. In the Antarctic, juvenile males remain in the pack ice to forage (Hindell and Perrin 2009). Elephant seals prey on deepwater and bottom dwelling organisms, including fish, squid, crab, and octopus. They are extraordinary divers with some dive depths exceeding 1,500 m and 120 minutes (Hindell and Perrin 2009).

Acoustics and hearing: Like other pinnipeds, elephant seals are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007). Vocalizations range from <4 to 120 kHz (DON 2008a) (Table 4.1).

4.3.15 Crabeater Seal (*Lobodon carcinophaga*)

Description: Crabeater seals weigh about 200 kg (males) to 215 kg (females) and are 2.05 to 2.40 m long (Bengtson 2009). They are medium brown to silver over most of the body with darker coloration and spotting on the flippers and flank and a high incidence of scarring, likely caused by leopard seals (ibid). They have finely divided lobed teeth (hence the scientific name lobodon) with multiple cusps that interlock to filter crustaceans.

Status and trends: Crabeater seals belong to the Order Carnivora, Suborder Pinnipedia, Family Phocidae. They may be the most abundant pinniped in the world, numbering in the millions around Antarctica (Bengtson 2009). There is presently no reliable eatimate of overall abundance but past estimates range from 2 million to 75 million, with 5-10 million a more likely estimate (Bengtson 2009). While they have not been recorded at sea during SWFSC AMLR surveys, the IUCN Red List Assessment (iucnredlist.org) indicates a population density estimate of 0.649/km^2 for the AMLR study area may be reasonable.

The species is not listed under the ESA or designated as depleted under the MMPA.

Distribution and habitat preferences: Crabeater seals have a circumpolar Antarctic distribution, spending the entire year in the pack ice zone; occasional they can be found along the southern fringes of South America, Australia, New Zealand, and Africa (Bengtson 2009). They migrate over large distances in association with the annual advance and retreat of pack ice (ibid).

Behavior and life history: Crabeater seals form ‘family groups’ of a female, her pup, and an attending male during the breeding season; peak pupping is mid to late October with some pups born into December. After weaning the male and female form a mated pair and remain together for 1-2 weeks (Bengtson 2009). As summarized in Burns et al. (2004), crabeater seals often dive to 92 m or greater with dive duration of 5 min (up to 23 min), haul out during the night rather than the day, and show seasonal shifts in foraging patterns consistent with foraging on vertically migrating prey. Some animals made long distance movements (furthest movements 664 km to northeast, 1,147 km to southwest), but most seals remained within 300 km of their tagging location. Within the Marguerite Bay/Crystal Sound region, seals appeared to favor foraging locations on the continental shelf within the 50 to 450 m depth range, with a tendency to avoid depths of 600 m or greater. Seals remained deep within the pack ice throughout the winter, and did not move into regions with less ice cover. Seals were more likely to be located in shallow water where the bathymetric gradients were greatest, and in areas of higher sea-ice concentration. Crabeater seal diet is almost exclusively Antarctic krill with an occasional fish and squid consumed (Bengtson 2009).

Acoustics and hearing: As above, crabeater seals are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated

auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007). Vocalizations range from <4 to 120 kHz (DON 2008a) (Table 4.1).

4.3.16 Weddell Seal (*Leptonychotes weddelli*)

Description: Weddell seals are rather large pinnipeds but do not exhibit sexual dimorphism; both sexes weigh 400-500 kg and are 2.5-3.3 m in length with females slightly larger; only the leopard seal and elephant seal are larger (Kooyman 1981a; Thomas and Terhune 2009). The fur covers the entire body except a small portion of the underside of the fore and hind flippers; they are black with grayish silver streaks; they do not have an under-fur (ibid). The canine and incisor teeth are robust and project forward, used perhaps as an ice ream, which allows the animal to maintain breathing holes and remain in the ice year-round (Kooyman 1981a).

Status and trends: Weddell seals belong to the Order Carnivora, Suborder Pinnipedia, Family Phocidae. There have been no systematic, large-scale population census studies but it is known that the Weddell seal is abundant with the estimated number of seals ranging from 500,000 to 1 million (Thomas and Terhune 2009). There are no estimates of abundance within the SWFSC AMLR survey areas nor have they been recorded at sea during SWFSC AMLR surveys so density estimates at sea within the SWFSC survey area are not available. However, the IUCN Red List Assessment (iucnredlist.org) indicates a population density estimate of 0.054/km^2 around Antarctic. Because this is the best information available, we have applied this density to the AMLR study area as well.

The species is not listed under the ESA or designated as depleted under the MMPA.

Distribution and habitat preferences: The Weddell seal has a circumpolar distribution around Antarctica, preferring land-fast ice habitats that have access to open water (Thomas and Terhune 2009). They haul out through cracks in the ice. Occasionally seals are seen at subantarctic islands and single animals have been seen on the Falkland Islands, Australia, New Zealand, and elsewhere (ibid).

Behavior and life history: Weddell seals breed and pup on the fast ice; males establish underwater territories and exhibit a variation of harem defense polygamy; mating takes place in the water (Kooyman 1981a; Thomas and Terhune 2009). Females give birth on the fast ice in late September to early November. There is no predictable migration. Weddell seals diet includes Antarctic cod and smaller fish. They forage in the upper water column but may dive to 600 m for up to 82 min, although shallow dives are more typical (Kooyman 1981a; Thomas and Terhune 2009). They may range out to 5 km from a breathing hole and return on a single dive (ibid). Type B or ‘pack ice’ ecotype killer whales are known to consume Weddell seals off the western Antarctic Peninsula (Pitman and Durban 2012).

Acoustics and hearing: Males patrol their territories using loud trills (up to 193 dB re 1 µPa) to advertise and defend their underwater territories (Thomas and Terhune 2009). As above, Weddell seals are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007). Vocalizations range from <4 to 120 kHz (DON 2008a) (Table 4.1).

4.3.17 Leopard Seal (*Hydruga leptonyx*)

Description: Leopard seals are large, sexually dimorphic mammals with females larger than males. Females can be up to 3.8 m in length and weigh 500 kg relative to males, which are generally 3.3 m long and weigh 300 kg (Rogers 2009). They are the second largest seal in Antarctica behind the elephant seal. Leopard seals have a dark gray back and light gray on its stomach. Its throat is whitish with the black spots that give the seal its common name. Compared to most phocids, the leopard seal is highly evolved for its role as a predator. Although it is a true seal and swims with its hind limbs, it has powerful and highly developed forelimbs similar to sea lions, giving it a similar maneuverability. The leopard seal has an unusually loose jaw that can open more than 160 degrees allowing it to bite larger prey (Kooyman 1981b).

Status and trends: Leopard seals belong to the Order Carnivora, Suborder Pinnipedia, Family Phocidae. There have been no systematic, large-scale population census studies but it is known that the leopard seal is abundant with the estimated population size ranging from 220,000 to 440,000 seals (Rogers 2009). Population densities are greatest in areas of abundant cake ice and least in areas with larger floes; densities range from 0.003-0.051 seals/square km (Rogers 2009). During the 2008/2009 AMLR surveys to estimate abundance and map krill and fish, marine mammal observers recorded a density of 0.0003 leopard seals/km within the survey area (Santora et al. 2009).

The species is not listed under the ESA or designated as depleted under the MMPA.

Distribution and habitat preferences: The leopard seal has a circumpolar distribution around Antarctica, preferring pack ice habitats although they are regular visitors to the subantarctic islands with juveniles typically more mobile (Rogers 2009). Because they do not rely on pack ice to breed they can escape food shortages in winter by dispersing northward (ibid).

Behavior and life history: Leopard seals breed on the outer fringes of the pack ice where females give birth during October to mid-November; mating occurs December to early January (Rogers 2009). Lactation lasts about 4 weeks (ibid). Leopard seals consume a variety of prey including fish, cephalopods, seabirds, and seals (Kooyman 1981b; ibid).

Acoustics and hearing: Acoustics play an important role in the mating system and they become highly vocal prior to and during breeding. As above, leopard seals are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007). Vocalizations range from <4 to 120 kHz (DON 2008a) (Table 4.1).

5. TYPE OF INCIDENTAL TAKE AUTHORIZATION REQUESTED AND THE METHOD OF INCIDENTAL TAKING

Regulations and Letters of Authorization (LOA) for the incidental taking of marine mammals is requested pursuant to Section 101 (a) (5) (A) of the MMPA.

The term "take", as defined in Section 3 (16 U.S. Code [U.S.C.] 1362) of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of "harassment", "Level A" (potential non-serious injury) and "Level B" (potential disturbance).

The SWFSC requests an LOA to authorize potential lethal and non-lethal incidental takes during its planned scientific operations. The requested numbers of authorized lethal and serious injury[1] takes and non-serious injury "Level A" and "Level B" harassment takes per year are discussed in Section 6. Although serious injury or mortality are rare during Center research activities, the SWFSC requests that the regulations and subsequent LOAs authorize a small number of incidental, non-intentional, injurious or lethal takes of marine mammals in the event that they might occur, and in spite of the monitoring and mitigation efforts described in Sections 11, 13, and 14.

As discussed in Section 1, SWFSC surveys involve the use of gear that has the potential to take marine mammals, including mid-water trawl-nets (CCE), pelagic longlines (CCE/ETP), and bottom trawl nets (AMLR). Bottom trawl nets deployed in AMLR are not expected to take marine mammals, in part, due to SWFSC having no historical interactions with these species in bottom trawl gear used in the Scotia Sea Antarctic ecosystem. Researchers conduct visual and acoustic surveys prior to deploying bottom trawl gear to assess the bathymetry and whether marine mammals are present in the area. These visual and acoustic surveys have resulted in very few detections of marine mammals during trawling operations, possibly because there is infrequent spatial-temporal overlap between bottom trawl surveys and significant densities of protected species. This may help to explain the absence of marine mammal interactions with this gear during past AMLR surveys.

The possible take during SWFSC surveys using modified Cobb mid-water trawl nets and the Northeast Trawl Systems (NETS) Nordic 264 two-warp rope trawl net may occur in two forms: (1) take by accidental entanglement that may cause mortality and serious injury, and (2) take by accidental entanglement that may cause non-serious injury ("Level A" harassment take). The surveys using these nets are conducted to assess coastal pelagic species (e.g. sardines), juvenile salmon, and juvenile rockfish in the CCE. Incidental take resulting in mortality and serious injury and "Level A" harassment may also occur by longline gear sampling highly migratory species, swordfish and sharks within the CCE and the ETP (longline surveys are being considered for use in the ETP over the next 5-6 years).

[1] NMFS interprets the regulatory definition of serious injury (i.e., "any injury that will likely result in mortality") as any injury that is "more likely than not" to result in mortality, or any injury that presents a greater than 50 percent chance of death to a marine mammal. Thus, the definition does not require that all such injured animals actually die, but rather requires only that the animal is more likely than not to die. Further, an injury must directly contribute to the death or likely death of the animal to be classified as a serious injury.

The “Level B” harassment may occur in the Antarctic when pinnipeds hauled out on ice are incidentally disturbed by close approaches of the survey vessel and as the result of acoustic gear used during survey operations in all three ecosystems surveyed by the SWFSC. Level B harassment by acoustic sources may be manifested as a temporary threshold shift (Southall et al. 2007) within the zone of audibility where the received levels of sound exposure are high enough that a marine mammal can hear it, or in the zone of responsiveness where the received level is such that the animal responds by causing behavioral modifications (Holt 2008). No hearing loss or physiological damage (permanent threshold shift, Southall et al. 2007) is expected to occur to marine mammals by the acoustic gear or vessel movements during SWFSC surveys in the CCE, the ETP, or the AMLR regions.

6. POTENTIAL TAKE OF MARINE MAMMALS

6.1 Estimated Number of Potential Marine Mammal Takes by Mortality, Serious Injury, or 'Level A' Harassment and Derivation of the Number of Potential Takes

6.1.1 Introduction

As stated in the response to Question 5 above, potential take during SWFSC surveys using Modified Cobb mid-water trawl nets and the NETS Nordic 264 two-warp rope trawl net may occur in two forms: (1) take by accidental entanglement that may cause mortality and serious injury, and (2) take by accidental entanglement that may cause non-serious injury ("Level A" harassment take). The surveys using these nets are conducted to assess coastal pelagic species (e.g., sardine), juvenile salmon, and juvenile rockfish in the CCE. Incidental take resulting in mortality and serious injury and "Level A" harassment may also occur by longline gear sampling highly migratory species and sharks within the CCE and ETP. Although not anticipated, incidental take is also possible during bottom trawls used to sample benthic invertebrates and fish during the Antarctic survey. The justification for potential take of marine mammal species and the estimated mortalities and injuries is discussed below.

Use of historical interactions as a basis for take estimates

It was anticipated that all species that interacted with SWFSC survey gear historically could potentially be taken in the future. For the duration of the regulations, we estimated the numbers of marine mammals that may be caught during SWFSC surveys based on historic interaction data for a species. Historical interactions with marine mammals during SWFSC surveys (Table 6.1) were input into NOAA's Protected Species Incidental Take (PSIT) database, a real-time internal monitoring tool for reporting interactions with marine mammals. The discussion below describes how SWFSC estimated potential encounters with survey gear based on historical interactions during 2008-2012 in mid-water trawl nets and in longline gear. These estimates are based on the assumption that annual effort (e.g., total annual trawl tow time) over the requested 5-year authorization period will not exceed the annual effort during the period 2008-2012.

For purposes of estimating potential serious injury/mortality takes and Level A harassment takes, the SWFSC calculated the average number of reported interactions for each marine mammal species in both trawl and longline gear deployed during 2008-2012. The SWFSC take estimates (for serious injury/mortality and Level A harassment) for historically captured species for this request was determined by rounding the annual average of take for a particular species by gear interaction up to the nearest whole number (to reflect a value that was representative of an entire animal) and multiplying by 5 to account for the 5-year authorization period (Table 6.2). For example, if a species interacted with SWFSC mid-water trawl gear 1.2 times per year, on average, this number was rounded up to 2 and then multiplied by 5 to determine a take request of 10. Based on past experience, the SWFSC expects there to be some variability in the actual number of annual gear interactions. By using an average based approach, it is expected to capture the variability that may occur on an annual basis over the period of this authorization. Furthermore, mitigation measures have been developed and implemented subsequent to some of the years upon which the take estimates are based, further reducing the likelihood that these estimates would be exceeded.

Because there is a very fine line between the two take categories (serious injury/mortality and Level A harassment) and insufficient data exist to understand the circumstances that lead to one event or the other, the SWFSC believes it would be unjustified to estimate potential takes in each category based only on historic interactions in that category; a Level A harassment take could easily have been a serious injury or mortality under a slightly different set of circumstances and vice versa. For example, during 2008 fifteen California sea lions interacted with SWFSC trawl gear; however, two of those animals were released alive (Table 6.1). It is believed that these two animals were released alive uninjured; however, insufficient information was collected during 2008-2012 to determine the nature and extent of injuries resulting from these interactions. Therefore, rather than use 13 serious injury/mortality events as a basis for estimating take, SWFSC used 15 in Table 6.2 because were similar interactions to recur, they could result in different numbers of serious injury/mortality and non-serious injury. Therefore as a worst-case scenario, these estimates are considered in this document as potential incidences of serious injury/mortality. However, the estimates realistically represent potential interactions, which would likely result in an unknown number of both non-serious injury and serious injury/mortality. Therefore, these take estimates are conservative in that they are likely higher than the actual number of animals that could potentially be killed or seriously injured during SWFSC fisheries research activities.

Historical interaction: summary of potential mid-water trawl survey efforts

Marine mammals have the potential to be caught in modified Cobb mid-water and NETS Nordic 264 trawl nets. These nets are used in the juvenile rockfish, juvenile salmon and sardine surveys at fixed stations from southern California to Washington annually from April-July and in August-September. The tows are conducted near the surface down to approximately 15-30 m deep, mainly at night using a charter vessel or a NOAA vessel (Table 1.1). In addition, these nets are used in juvenile salmon surveys between southern California and Oregon during daytime trawls that last at the target depth for approximately 30 min. In total, these surveys deploy about 250 tows per year. During the past 5 years about 1,250 tows using these trawl nets captured 58 marine mammals, of which 50 were killed and eight were released alive (Table 6.1). It should be noted that most of the mortalities occurred during 2008 and have not been repeated before or since that year (including 2012). Furthermore, several mitigation measures intended to further minimize potentially adverse interactions with protected species during SWFSC research surveys were initiated after 2008. The SWFSC predicts that about the same number of tows will be deployed using these nets over the duration of the authorization period.

The species that have been historically caught in these trawl nets include California sea lions, northern fur seals, northern right whale dolphins, and Pacific white-sided dolphins. Given the timing and geographic scope of its trawl surveys, the SWFSC believes it could take any age class of marine mammal for which it estimates potential take. California sea lions pup and breed at California Channel Islands during May-June (section 4.1.23) so adult females caught in close proximity to these islands during this period could be pregnant or nursing a pup. Males could be of breeding age and participate in the breeding population. Similarly northern fur seals pup and breed during June-August at San Miguel Island and animals caught near this location may be part of the breeding population (section 4.1.26); Pribilof Islands fur seals (which are designated as ‘depleted’ under the MMPA) would likely be at or near the breeding islands in Alaska during SWFSC surveys and less susceptible to incidental capture. Pacific white-sided dolphins calve

during May-September (section 4.1.3) so animals caught during this period may be part of the California-Oregon-Washington stock and actively engaged in breeding activities. Northern right whale dolphin calving seasonality is unknown, but small calves are seen in winter and early spring (section 4.1.9). In addition to these species, which SWFSC has historically captured, other species SWFSC requests to take in the course of this research have similar distributions, life histories and/or vulnerabilities to these gears, so it follows that multiple age classes of these species could be susceptible to take.

Historical interaction: summary of potential longline survey efforts

Five California sea lions were caught and released in the SWFSC longline surveys for thresher sharks and highly migratory species (HMS) during 2008-2012 (Table 6.1). These surveys occur in the Southern California Bight (thresher shark) and from southern to central California (HMS). The thresher shark surveys are conducted in September each year from a charter vessel and the HMS surveys are conducted June-July from a NOAA vessel or a charter vessel. Each uses pelagic longline consisting of 2-4 mile mainline with 10-15 foot gangions (i.e., a unit consisting of a leader, a monofilament line, and a baited hook attached to the line) 50-100 feet apart using 200-400 9/0 J-type or 16/0 circle-type hooks with a soak time of 2-4 hours; however, when targeting swordfish a number of modifications to the longline gear are made (Table 1.1). The SWFSC currently does not conduct longline surveys in the ETP, but the SWFSC take estimates reflect the possibility that these surveys may occur over the next five-year period.

Over the past 5 years the SWFSC deployed on average over 200-400 hooks/set on longline gear which was under water for over 2-4 hours for each longline set. There are typically about 40 (thresher shark survey) to 60 (HMS survey) sets per year (~100 total) resulting in 400-1,600 hook hours (hooks x hours) per set, or 40,000-160,000 hook hours /year. The SWFSC expects to deploy about the same number of sets for the duration of the authorization, but as noted above it may deploy additional sets in the ETP. If longline surveys are conducted in the ETP, the SWFSC anticipates that it will deploy an equal number (or less) of longline sets in the ETP relative to the number of sets currently being deployed in the CCE. This deployment may result in the incidental capture (and release) of California sea lions and other species which are believed to have similar vulnerabilities to longlines and/or which are taken in commercial longline gear. In general, marine mammal interactions in SWFSC longline surveys have been isolated events never exceeding one animal per set. As with marine mammal interactions in trawl gear, SWFSC believes potential take in longline gear could include animals of multiple age classes.

Approach for estimating take of species captured historically

To date, interactions of trawl and longline gear with marine mammals have only occurred in the CCE. The SWFSC does not trawl in the ETP and currently does not conduct longline surveys in the region, but may over the next five-year period. Historically, there have been no marine mammal interactions with SWFSC bottom trawls in the Antarctic Ecosystem. The SWFSC interaction rates in the CCE have exhibited some inter-annual variation in numbers, possibly due to changing marine mammal densities and distributions and dynamic oceanographic conditions. Excluding the isolated event where northern right whale dolphins were captured by trawl gear in the CCE in 2008, the same species tend to interact with certain gear types during SWFSC surveys (Tables 6.1 and 6.2). Occurrences when more than 10 marine mammals per year may be caught during survey operations are possible, as in 2008, but are rare. Thus, the SWFSC

estimates take based on the average number of historical marine mammal species interactions during 2008-2012 to account for the fluctuations in inter-annual variability observed during that time period.

During 2008-2012, the SWFSC interacted with marine mammals on longline and mid-water trawl surveys in the CCE, including: Pacific white-sided dolphins (trawl), northern right whale dolphins (trawl), California sea lions (trawl and longline) and northern fur seals (trawl). Sixty three marine mammals interacted with SWFSC research gears during 2008-2012, of which, 13 were released alive and 50 were killed. As described above, an average based approach (Level A and serious injury/mortality combined) for each species in each gear was used as a basis for estimating potential take (Table 6.2). The 5-year serious injury/mortality and Level A harassment take request for the CCE is as follows (Table 6.3): 35 Pacific white-sided dolphins, 20 California sea lions, 10 northern right whale dolphins, and 5 northern fur seals (all stocks combined) in trawls along with 5 California sea lions on longlines. Assuming a similar rate of interaction with longline gear is possible for California sea lions in the ETP due to a lack of information to indicate otherwise, the SWFSC requests 5 takes of California sea lions on longlines in the ETP. The SWFSC requests no take for Northern fur seals on longlines in the CCE due to lack of previous interactions with SWFSC longline gear and little evidence to suggest this species interacts with commercial longline fisheries gear based on recent stock assessment reports and the 2012 List of Fisheries (NMFS 2012; http://www.nmfs.noaa.gov/pr/interactions/lof/).

Although the SWFSC take estimates for species captured historically are based on an average take during 2008-2012, it should be emphasized that there is still an inherent level of uncertainty in estimating potential take both in terms of numbers and species of marine mammals that may actually be taken. Further, the SWFSC continues to invest significant resources in better understanding the factors that contribute to interactions and developing mitigation measures and evaluating its operations to minimize these occurrences in the future.

Approach for estimating take of 'other' species (i.e., those not historically taken by the SWFSC)

In addition to those species SWFSC has interacted with in longlines and trawl nets over the last 5 years, the SWFSC believes it is possible that other species with similar vulnerabilities to these gears – due to similar behaviors, distributions, etc. – may be taken in the future. While such take could potentially occur, the SWFSC believes that any occurrences in the CCE would likely be rare given that no such take has occurred over the past five years (2008-2012). Given the infrequent and low number of historical marine mammal interactions with longline gear in the CCE, the SWFSC predicts a similar pattern of interactions of marine mammals may occur if regular longline surveys for highly migratory species are conducted in the ETP with the same amount of effort as are currently being conducted in the CCE.

The approach outlined below reflects: (1) concern that some species with which we have not had historical interactions may interact with these gears, (2) acknowledgment of variation between sets, and (3) understanding that many marine mammals are not solitary, so in many cases if a set results in take, the take is likely to be greater than one animal particularly with trawl gear. The approach takes into account the possibility that additional species could interact with SWFSC surveys, while also reflecting that, absent significant range shifts or changes in habitat usage,

such events would likely remain rare occurrences at most. As for the ETP, the approach addresses the uncertainty of potential takes on longline gear in an ecosystem where surveys have not historically been conducted by the SWFSC, making it more difficult to estimate potential take. Recognizing these uncertainties, additional mitigation measures may be implemented if take far exceeds the maximum number estimated per year, such that it appears that the total estimated take over the 5 year authorization period may be exceeded.

In the CCE, several species were deemed to have a similar vulnerability to trawl gear as some historically taken species. A number of factors were taken into account to determine whether another species may have a similar vulnerability (e.g., density, abundance, behavior, feeding ecology, travel in groups, commonly associated with other species historically taken, prior interactions with similar gear in the 2012 List of Fisheries (NMFS 2012) or reported interactions with other NMFS Science Center surveys etc.) to certain types of gear as historically taken species. In these particular instances, the SWFSC estimates the annual take of these 'other' species to be equal to the maximum interactions per any given set of a similar species that was historically taken during 2008-2012 (Table 6.4). Several species were deemed to have a similar vulnerability to trawl gear as the Pacific white-sided dolphin. For this species, the maximum take in any set during 2008-2012 was 11 individuals (Table 6.4). Therefore, the SWFSC requests 11 potential takes over the authorization period for each of the following species in trawls in the CCE: Risso's dolphin, striped dolphin, short-beaked common dolphin, long-beaked common dolphin, and bottlenose dolphin (Table 6.3). In addition, several pinniped species are similar in vulnerability to trawl gear as California sea lions, which have interacted as many as 9 times in a single set during the past five years (Table 6.2). For the effective period of the regulations, the SWFSC requests 9 takes in mid-water trawl gear for the following species in the CCE: Steller sea lion and harbor seal (Table 6.3).

For the remaining species that were deemed likely to be taken in trawls in the CCE, the SWFSC estimates 5 potential takes during the 5-year authorization period: Northern elephant seal, harbor porpoise, and Dall's porpoise (Table 6.3). An estimate of 5 potential takes for these last three species takes into account the higher likelihood that more than one individual may be taken in a trawl at any given time, high pinniped densities in survey locations, and documented takes of porpoises in trawls by commercial fisheries and other NMFS Science Centers. The SWFSC does not anticipate take of Guadalupe fur seals in trawls due to their lower abundance and limited distribution in the CCE. Furthermore, the SWFSC is not requesting the take of large whales and several other cetaceans by trawl gear due to lack of historical interactions and the low probability of take in a trawl due to several factors (e.g., density, abundance, behavior, etc.).

Steller sea lions and South American sea lions may be vulnerable to longline gear in the CCE and ETP, respectively. Steller sea lions have previously been taken in commercial longline fisheries. As California sea lions have never interacted more than one time in a single set during the previous five years in SWFSC longline gear in the CCE (Table 6.4), it was assumed that no more than one Steller sea lion would likely be caught at a time on longline gear. Therefore, the SWFSC requests 1 potential Steller sea lion take in longline gear in the CCE. However, given that there is no history to inform the estimate of potential interactions of South American sea lions with SWFSC longline gear in the ETP, the SWFSC requests a higher number of potential takes of South American sea lions assuming that the rate of interaction could equal that observed

by California sea lions in the CCE. Therefore, the SWFSC requests 5 potential takes of South American sea lions in the ETP. Adaptive management would be employed as necessary should it turn out that catch rates are higher in the ETP than have been recorded in CCE. For example, the SWFSC may implement additional mitigation measures if the number of actual takes in the ETP is higher than expected.

While the SWFSC has not historically interacted with large whales or other cetaceans in its longline gear, it is well documented that some of these species are taken in commercial longline fisheries. The 2012 List of Fisheries (NMFS 2012) classifies commercial fisheries based on prior interactions with marine mammals. Although the SWFSC used this information to help make an informed decision on the probability of specific cetacean and large whale interactions with longline gear, many other factors were also taken into account (e.g., relative survey effort, survey location, similarity in gear type, animal behavior, prior history of SWFSC interactions with longline gear etc.). Therefore there are several species that have been shown to interact with commercial longline fisheries but for which SWFSC is not requesting take. For example, the SWFSC is not requesting take of large whales in longline gear. Although large whale species could become entangled in longline gear, the probability of interaction with SWFSC longline gear is extremely low considering a lower level of survey effort relative to that of commercial fisheries. Although data on commercial fishing effort are not publically available, based on the amount of fish caught by commercial fisheries versus SWFSC fisheries research, the "footprint" of research effort compared to commercial fisheries is very small.

There were several species of cetaceans that were identified to have a higher probability of interaction with SWFSC longline gear based on the factors outlined previously. Since these interactions would probably be rare occurrences and groups of marine mammals are less likely to be taken on longlines (relative to trawls), the SWFSC requests only one potential take per ecosystem for each cetacean species (all stocks included) outlined below. The SWFSC requests the potential take of the following cetaceans during the 5-year authorization period in longline gears in both the ETP and CCE: Risso's dolphin, bottlenose dolphin, striped dolphin, short-beaked common dolphin, long-beaked common dolphin, and short-finned pilot whale. Additionally, the SWFSC also estimates one potential take of either a pygmy or dwarf sperm whale in the CCE plus the following species in the ETP: Pantropical spotted dolphin, false killer whale, and dwarf sperm whale. As discussed previously, there is no history to inform the interaction of these species with longline gear in the ETP. Therefore, adaptive management and additional mitigation measures may be implemented if catch rates are higher than expected in the ETP.

Undetermined species

There are situations when a caught animal cannot be identified to species with certainty. One such case might occur if a female California sea lion was caught in longline gear and quickly released. Those animals are very difficult to differentiate at sea in poor lighting from other otariids or large phocids making exact identification difficult. Similarly some cetacean species are difficult to identify to species under poor field conditions. Thus, under those situations, the SWFSC requests a small number of potential takes of undetermined pinniped and delphinid species per year based on gear type. In all, the SWFSC requests one potential undetermined pinniped take and one undetermined delphinid take in trawl gear in the CCE as well as one

potential undetermined pinniped take in longline gear in both the CCE and the ETP ecosystems (Table 6.3).

Surveys for which SWFSC Anticipates no Level A, Serious Injury or Mortality Takes

AMLR Surveys

The SWFSC has no historical interactions with marine mammals in bottom trawl gear used in the Scotia Sea Antarctic ecosystem. AERD researchers conduct visual and acoustic surveys prior to deploying bottom trawl gear to assess the bathymetry and whether marine mammals are present in the area. These visual and acoustic surveys have resulted in very few detections of marine mammals during trawling operations, possibly because there is infrequent spatial-temporal overlap between bottom trawl surveys and significant densities of protected species. This may help to explain the absence of marine mammal interactions with this gear during past AMLR surveys. Given this history and little future planned survey effort, no take of marine mammals resulting from gear interaction is anticipated while conducting fisheries research in the Antarctic ecosystem. As a result, SWFSC is requesting no injury, serious injury or mortality takes for these research activities.

Deep-Set Buoy Gear Surveys

Based on the proposed gear and methods to be utilized, SWFSC does not anticipate deep-set buoy surveys to results in any marine mammal takes. This determination is based on the following factors:

- The history of this gear not resulting in marine mammal takes, as well as in similar gear used in the Atlantic, both of which have been designed specifically to eliminate protected species interactions. In the Pacific, no takes have occurred during the previous 54 sets (approximately 2,200 hook hours). In the Atlantic no protected species interactions have occurred in the Swordfish Buoy Fishery using similar gear configuration and higher effort levels than surveys conducted in the Pacific.
- The minimal visual and/or sensory attractants to the gear in the upper water column (e.g., no surface chumming or offal discharge, no visual cues from multiple hooks that are sinking to depth slowly) SWFSC believes minimizes hooking and entanglement risk.
- This gear features a single weighted monofilament line with virtually no slack or sag that is expected to minimize entanglement risk.

Sablefish Life History Surveys

SWFSC does not anticipate that sablefish life history surveys will result in any marine mammal takes. A primary factor in this determination is this survey's extremely small scale and low level of effort (approximately 200 hooks per month), which further reduces likelihood of taking marine mammals (an already rare event). In addition, because this gear fishes at the bottom it poses a significantly reduced risk of hooking and entanglement relative to surface gears. To date, this gear has resulted in no marine mammal takes.

Mitigation and minimization of takes

Following marine mammal interaction events in 2008, the SWFSC initiated a series of discussions and workshops to better understand the factors contributing to gear interactions and to implement mitigation measures to reduce potential gear interactions. These discussions were summarized by Hewitt (2009). Because of the suite of mitigation measures SWFSC has

implemented since 2008, it expects the total number of marine mammals taken in these gears to decrease in the future and be substantially less than the estimated level of take when summed across all species. Current mitigation protocols are described elsewhere, so they are just mentioned briefly here: use of a marine mammal excluder device in the Nordic 264 trawl, use of acoustic pingers on mid-water trawls, limits on trawl tow times, and visual watches and a "move-on" rule to minimize opportunities for gear to be deployed with marine mammals and other protected species closer than 1nm. The SWFSC is currently reviewing historical fisheries research data to determine whether sufficient information exists to examine any links between various variables (e.g., pinger presence, trawl speed, etc.) and observed marine mammal bycatch (see Section 11 of this application for more details).

Additionally, a marine mammal excluder device is being tested by the SWFSC to eliminate marine mammal captures in the Modified Cobb mid-water trawl net. The SWFSC continues to look for additional ways to minimize marine mammal takes during the course of its fisheries research, such as conducting retrospective analyses to pinpoint the most significant contributors to take in each gear and to develop new sampling methods that eliminate the possibility of marine mammal mortalities (e.g., video and acoustic sampling). The results of these studies are expected to influence future sampling protocols and gear development.

6.1.2 Conclusion

The SWFSC has used its historical interactions with marine mammals in fisheries research surveys as a basis for estimating potential takes of these species and of other species it hasn't interacted with, but which it believes shares similar vulnerabilities to longline and mid-water trawl gears. Because of the low level of survey effort, the survey's small geographic footprint, historical interactions, and predicted takes (lethal, serious injury, and non-serious injury combined) relative to population size, and the fact that take will likely be minimized through the implementation of the Center's proposed mitigation measures, the SWFSC believes that its activities will have a negligible impact on marine mammals in the California Current Ecosystem, Eastern Tropical Pacific, and Antarctic Ecosystem. The basis for this statement is discussed in greater detail in Section 7 of this application.

Further, the SWFSC notes that despite its best efforts to estimate realistic potential marine mammal takes it believes actual takes will be substantially lower than its take estimates. Nevertheless, the SWFSC considers the take estimates presented here as the best approximation of future events because they are based on the best information available. There is substantial inherent uncertainty in estimating numbers and species that could be potentially taken, and the SWFSC's take estimates reflect this uncertainty. Our understanding of the potential effects of SWFSC activities on marine mammals is continually evolving. Reflecting this, the Center proposes to include an adaptive management component within the application (see Section 13 of this application). This allows the Center, in concert with NMFS' Office of Protected Resources, to consider, on a case-by-case basis, new data to determine whether mitigation should be modified.

Table 6.1. Historical number of interactions with marine mammals during SWFSC surveys from 2008 to 2012.

Survey Name	Protected Species Taken	Gear	# Killed	# Released Alive[1]	Total # of Animals
2012					
Sardine	Pacific White-Sided Dolphin	NETS Nordic 264	2	0	2
Sardine	Pacific White-Sided Dolphin	NETS Nordic 264	1	0	1
Sardine	Pacific White-Sided Dolphin	NETS Nordic 264	0	1	1
Highly Migratory Species	California Sea Lion	Longline	0	1	1
2011					
Sardine	Pacific White-Sided Dolphin	NETS Nordic 264	1	0	1
Juvenile Salmon	California Sea Lion	NETS Nordic 264	1	0	1
Juvenile Salmon	Pacific White-Sided Dolphin	NETS Nordic 264	6	0	6
2010					
Sardine	Pacific White-Sided Dolphin	NETS Nordic 264	0	1	1
Sardine	Pacific White-Sided Dolphin	NETS Nordic 264	1	0	1
Highly Migratory Species	California Sea Lion	Longline	0	1	1
Juvenile Rockfish	Pacific White-Sided Dolphin	Cobb mid-water trawl	1	0	1
2009					
Juvenile Rockfish	California Sea Lion	Cobb mid-water trawl	0	1	1
Sardine	Pacific White-Sided Dolphin	NETS Nordic 264	0	3	3
Thresher Shark	California Sea Lion	Longline	0	1	1
2008					
Sardine	California Sea Lion	NETS Nordic 264	1	0	1
Sardine	California Sea Lion	NETS Nordic 264	1	0	1
Sardine	Pacific White-Sided Dolphin	NETS Nordic 264	2	0	2
Sardine	Pacific White-Sided Dolphin	NETS Nordic 264	1	0	1
Highly Migratory Species	California Sea Lion	Longline	0	1	1
Highly Migratory Species	California Sea Lion	Longline	0	1	1
Juvenile Rockfish	California Sea Lion	Cobb mid-water trawl	1	2	3
Sardine	Northern Fur Seal (San Miguel	NETS Nordic 264	1	0	1
Sardine	California Sea Lion	NETS Nordic 264	9	0	9
Sardine	Northern Fur Seal (San Miguel	NETS Nordic 264	1	0	1
Sardine	California Sea Lion	NETS Nordic 264	1	0	1
Sardine	Pacific White-Sided Dolphin	NETS Nordic 264	1	0	1
Sardine	Northern Right Whale Dolphin	NETS Nordic 264	6	0	6
Sardine	Pacific White-Sided Dolphin	NETS Nordic 264	11	0	11
Sardine	Northern Fur Seal (Eastern Pacific)	NETS Nordic 264	1	0	1
Total			**50**	**13**	**63**

[1] During 2008-2012 insufficient information was collected to determine the nature and extent of injuries resulting from these interactions. As outlined in Section 11 of this application, SWFSC will implement a data collection protocol that will facilitate serious injury determinations for any future interactions.

Table 6.2. The estimated number of potential interactions of historically taken marine mammal species by gear type that may be taken on SWFSC surveys during the authorization period. Each interaction represents the incidental take of one animal.

	Historical Interactions							Estimated Number of Interactions Over 5 years
	2008	2009	2010	2011	2012	Average	Round-Up	
Trawl								
Pacific White-Sided Dolphin	15	3	3	7	4	6.4	7	**35**
California Sea Lion	15	1	0	1	0	3.4	4	**20**
Northern Right Whale Dolphin	6	0	0	0	0	1.2	2	**10**
Northern Fur Seal	3	0	0	0	0	0.6	1	**5**
Longline								
California Sea Lion	2	1	1	0	1	1	1	**5**

Table 6.3. The potential number of animals of each marine mammal species (unless otherwise noted, all stocks have been combined) that could be taken by mortality and serious injury (M&SI) and Level A harassment in each ecosystem over the next 5 years. The take estimates are based on the following gear types: trawl and longline. It should be noted that longline gear is not presently being used in the ETP but may be used in the next 5 years.

	Historical Interactions (2008-2012)	**Potential Take (2013-2018) M&SI and Level A**	
		Trawl	**Longline**
California Current Ecosystem			
Harbor Porpoise		5	
Dall's Porpoise		5	
Pacific White-sided Dolphin	Trawl	35	
Risso's Dolphin		11	1
Bottlenose Dolphin (All stocks)			1
Bottlenose Dolphin (Coastal)		3	
Bottlenose Dolphin (OR, WA Offshore)		8	
Striped Dolphin		11	1
Short-Beaked Common Dolphin		11	1
Long-Beaked Common Dolphin		11	1
Northern Right Whale dolphin	Trawl	10	
Short-Finned Pilot Whale			1
Pygmy and Dwarf Sperm Whale			1
California Sea Lion	Trawl, Longline	20	5
Steller Sea Lion		9	1
Northern Fur Seal	Trawl	5	
Harbor Seal		9	
Northern Elephant Seal		5	
Undetermined Pinniped Species		1	1
Undetermined Delphinid Species		1	
Eastern Tropical Pacific			
Risso's Dolphin			1
Short-Beaked Common Dolphin			1
Long-Beaked Common Dolphin			1
Striped Dolphin			1
Pantropical Spotted Dolphin			1
Bottlenose Dolphin			1
False Killer Whale			1
Short-Finned Pilot Whale			1
Dwarf Sperm Whale			1
California Sea Lion			5
South American Sea Lion			5
Undetermined Pinniped Species			1

Table 6.4. The maximum number of interactions (mortality, serious injury, and Level A harassment) for marine mammal species in any given set of trawl and longline gear deployed during 2008-2012. Each interaction represents the incidental take of one animal.

	Maximum interactions per any given set*	
Species with past interactions (2008-2012)	**Trawl**	**Longline**
Pacific White-sided Dolphin	11	0
Northern Right Whale dolphin	6	0
California Sea Lion	9	1
Northern Fur Seal (San Miguel Islands Stock)	1	0
Northern Fur Seal (Eastern Pacific Stock)	1	0

*The maximum interactions per any given *set* was used in the approach for estimating take of ('other') species *with no historic interactions*.

6.2 Estimated Level B Harassment of Marine Mammals due to Acoustic Sources and Derivation of the Estimate

Estimating sound exposures leading to behavioral and physical effects of intermittent high frequency sounds from active acoustic devices used in fisheries research is challenging for a variety of reasons. Among these are the wide variety of operating characteristics of these devices, variability in sound propagation conditions throughout the typically large areas in which they are operated, uneven (and often poorly understood) distribution of marine species, differential (and often poorly understood) hearing capabilities in marine species, and the uncertainty in the potential for effects from different acoustic systems on different species. The SWFSC took a dual approach in assessing the impacts of high-frequency active acoustic sources used in fisheries research in three different geographical areas where it operates these devices (California Current, Eastern Tropical Pacific, and the Antarctic).

The first approach was a qualitative assessment of potential impacts across species and sound types. This analysis considers a number of relevant biological and practical aspects of how marine species likely receive and may be impacted by these kinds of sources. This assessment (described in greater detail in section 7.2) considered the best available current scientific information on the impacts of noise exposure on marine life and the potential for the types of acoustic sources used in SWFSC surveys to have behavioral and physiological effects. The results indicate that a subset of the sound sources used are likely to be entirely inaudible to all marine species, that some of the lower frequency and higher power systems will be detectable over moderate ranges for some species (although this depends strongly on inter-specific differences in hearing capabilities). As discussed in more detail (see section 7.2), current scientific information supports the conclusion that direct physiological harm is quite unlikely but behavioral avoidance may occur to varying degrees in different species. Consequently, any potential direct injury (as defined by NMFS relative to the U.S. Marine Mammal Protection Act as Level A harassment and currently estimated as 180 and 190 dB RMS received levels respectively for cetaceans and pinnipeds) from these fisheries acoustic sound sources was deemed highly unlikely and were not directly calculated.

Building on this assessment to attempt to quantify behavioral impacts, an analytical framework was derived and applied to estimate potential Level B harassment by acoustic sources (as defined relative to the MMPA). This analysis used characteristics of active acoustic systems, their expected patterns of use in each of the three SWFSC operational areas, and characteristics of the marine mammal species that may interact with them to estimate Level B harassment of marine mammals. This approach is relatively straightforward and (although certain adaptations enable a more realistic spatial depiction of exposed animals in the water column) relies on average density values of marine species. While the SWFSC believes this quantitative assessment benefits from its simplicity and consistency with the current NMFS guidelines regarding estimates of Level B harassment by acoustic sources, based on a number of deliberately precautionary assumptions, the resulting take estimates should be seen as a very likely substantial overestimate of behavioral harassment from the operation of these systems. Additional details on the approach used and the assumptions made that result in a conservative estimate (i.e., higher numbers of exposures at received levels identified as Level B harassment) are described below.

6.2.1 Framework for quantitative estimation of potential Level B harassment by acoustic sources

The discussion in section 7.2 considers the differential frequency bands of hearing in marine animals in deriving a qualitative assessment of the probable risk of particular acoustic impacts from general categories of active acoustic sources, and is likely a more appropriate means of assessing their overall impact from a limited set of deployments given the level of scientific uncertainty in a variety of areas. However, in order to meet the compliance requirements for assessing the potential environmental impact of SWFSC operations, in this case acoustic impacts, a quantitative estimate of individual Level B harassment was required.

Different sound exposure criteria are typically used for impulsive and continuous sources (Southall et al., 2007). Under the current NMFS guidelines for calculating Level B harassment, an animal is taken if it is exposed to continuous sounds at a received level of 120 dB RMS or impulsive sounds at a received level of 160 dB RMS. These are simple step-function thresholds that do not consider the repetition or sustained presence of a sound source nor does it account for the known differential hearing capabilities between species. Sound produced by the fisheries acoustic sources here are very short in duration (typically on the order of milliseconds), intermittent, have high rise times, and are operated from moving platforms. They are consequently considered impulsive sources, which would be subject to the 160 dB RMS criterion. A mathematical method for estimating Level B harassment according to this step-function was derived and applied in each of the SWFSC ecosystem areas of operation - the California Current, Eastern Tropical Pacific, and Scotia Sea/Antarctic - to calculate Level B harassment by acoustic sources.

The assessment paradigm for active acoustic sources used in SWFSC fisheries research is relatively straightforward and has a number of key simplifying assumptions, most of which are deliberately precautionary given the known areas of uncertainty. These underlying assumptions (described in greater detail below) very likely lead to an overestimate of the number of animals that may be exposed at the 160 dB RMS level in any one year on average for each area. Conceptually, Level B harassment may occur when a marine mammal interacts with an acoustic signal. Estimating the number of exposures at the specified received level requires several determinations, each of which is described sequentially below:

1) A detailed characterization of the acoustic characteristics of the effective sound source or sources in operation;
2) The operational areas exposed to levels at or above those associated with Level B harassment when these sources are in operation;
3) A method for quantifying the resulting sound fields around these sources; and
4) An estimate of the average density for marine mammal species in each ecosystem area of operation.

Quantifying the spatial and temporal dimension of the sound exposure footprint (or “swath width”) of the active acoustic devices in operation on moving vessels and their relationship to the average density of marine mammals enables a quantitative estimate of the number of individuals for which sound levels exceed NMFS’ Level B harassment threshold for each area. The number of Level B harassment events is ultimately estimated as the product of the volume of water insonified at 160 dB RMS or higher and the volumetric density of animals determined from

simple assumptions about their vertical stratification in the water column. Specifically, reasonable assumptions based on what is known about diving behavior across different marine mammal species were made to segregate those that predominately remain in the upper 200m versus those that regularly dive deeper during foraging and transit. Methods for estimating each of these calculations are described in greater detail in the following sections, along with the simplifying assumptions made, and followed by the take estimates for each region.

6.2.2 SWFSC Sound source characteristics

An initial characterization of the general source parameters for the primary SWFSC vessels operating active acoustic sources was conducted (Appendix A). This process enabled a full assessment of all sound sources, including those within the category 1 sources (identified in section 7.2) that are entirely outside the range of marine mammal hearing (not shown here). This auditing of the active sources also enabled a determination of the predominant sources that, when operated, would have sound footprints exceeding those from any other simultaneously used sources. These sources were effectively those used directly in acoustic propagation modeling to estimate the zones within which the 160 dB RMS received level would occur.

The full range of sound sources used in fisheries acoustic surveys were considered (Appendix A). Many of these sources can be operated in different modes and with different output parameters. In modeling their potential impact areas for these vessels when used and also when they are operated from non-NOAA vessels used for SWFSC survey operations, those features among those given below that would lead to the most precautionary estimate of maximum received level ranges (i.e. largest ensonified area) were used (e.g., lowest operating frequency). The effective beam patterns took into account the normal modes in which these sources are typically operated. While these signals are very brief and intermittent, a very conservative assumption was taken in ignoring the temporal pattern of transmitted pulses in calculating Level B harassment events. This assumption would not be appropriate in the context of assessing potential auditory effects. These operating characteristics of each of the predominant sound sources were used in the calculation of effective line km (section 6.2.3) and area of exposure (section 6.2.4) for each source in each survey.

Sources operating at frequencies above the functional hearing range of any marine mammal (typically above 180 kHz; see section 7.2) were excluded from quantitative analysis. Among those operating within the audible band of marine mammal hearing, five predominant sources were identified as having the largest potential impact zones during operations, based on their relatively lower output frequency, higher output power, and their operational pattern of use. In determining the effective line km for each of these predominant sources (Table 6.5) the operational patterns of use relative to one another were further applied to determine which source was the predominant one operating at any point in time for each survey. When multiple sound sources were used simultaneously, the one with the largest potential impact zone in each relevant depth strata was used in calculating takes. For example, when species (e.g., sperm whales) regularly dive deeper than 200m, the largest potential impact zone was calculated for both depth strata and in some cases resulted in a different source being predominant in either depth strata. This enabled a more comprehensive way of accounting for maximum exposures for animals diving in a complex sound field resulting from simultaneuous sources with different spatial profiles. This overall process effectively resulted in three sound sources (SX90, EK60, and

ME70) comprising the total effective line km, their relative proportions depending on the nature of each survey in each region (see Tables 6.6a to 6.8b).

Table 6.5. Output characteristics for five predominant SWFSC acoustic sources.

Acoustic system	Operating frequencies (kHz)	Source level (dB re 1 µPa at 1 m)	Nominal beam width (deg)	Effective exposure area: Sea surface to 200 m depth (km^2)	Effective exposure area: Sea surface to depth at which sound is 160 dB SPL (km^2)
Simrad EK500 and EK60 Narrow Beam Scientific Echo Sounders	18, 38, 70, 120, 200	224	7	0.013072	0.135404
Simrad ME70 Multi-Beam Echo Sounder	70-120	205	130	0.018184	0.018184
Teledyne RD Instruments Acoustic Doppler Current Profiler (ADCP), Ocean Surveyor	75	223.6	30	0.0086	0.0187
Simrad MS70 Multi-Beam Sonar	75-112	206	60	0.007952*	0.007952
Simrad SX90 Narrow Beam Sonar	20-30	219	7	0.065275*	0.1634

6.2.3 Calculating effective line km for each survey

As described below, based on the operating parameters for each source type, an estimated volume of water insonified to above a 160 dB RMS received level was determined. In all cases where multiple sources are operated simultaneously, the one with the largest estimated acoustic footprint (and thus leading to higher estimated Level B harassment) was used as the effective source. This was calculated for each depth strata (0-200m and below 200m), which in some cases resulted in different sources being predominant in each depth strata for all line km when multiple sources were in operation; this was accounted for in estimating overall exposures for species that utilize both depth strata (deep divers). For each ecosystem area, the total number of line km that would be surveyed was determined, as was the relative percentage of surveyed linear km associated with each source type. The total line km for each vessel in each region, the effective percentages associated with each of the resulting three predominant source types (SX90, EK60, and ME70), and the effective total line km of operation for each source type in each region is given below.

* *NOTES:* MS70-Effective exposure areas from 0-200m depth were not separately calculated because it operates in a side-looking mode. The estimated area ensonified to the maximum range of the 160 dB received level was used for this source in determining the effective exposure area for both depth strata. SX90- Exposure area varies greatly depending on the tilt angle setting of this system. To approximate the varied usage this system might receive, the exposure area for each depth strata was averaged by assuming equal usage at tilt angles of 5, 20, 45, and 80 degrees.

Table 6.6a. Annual linear survey km for each vessel type and its predominant sources within the two depth strata for the California Current ecosystem.

Vessel	Line kms/ Vessel	Source	Overall % Source Usage	% Time Source Dominant (0-200m)	Line km/ Dominant Source (0-200m)	% Time Source Dominant (>200m)	Line km/ Dominant Source (>200m)
Lasker	67760	SX90	50%	50%	33880	50%	33880
		EK60	100%	50%	33880	50%	33880
Shimada	39456	ME70	50%	50%	19728	0%	0
		EK60	100%	50%	19728	100%	39456
Other	26304	EK60	100%	100%	26304	100%	26304

Table 6.6b. Effective total annual survey km for which each source type is the predominant acoustic source in each of the two depth strata for take calculations for the California Current ecosystem.

Source	Summed line kms/source (0-200m)	Summed line kms/source (>200m)	Summed Dominant Source % of total line km (0-200m)	Summed Dominant Source % of total line km (>200m)
SX90	33880	33880	25%	25%
EK60	79912	99640	60%	75%
ME70	19728	0	15%	0%

Table 6.7a. Annual linear survey km for each vessel type and its predominant sources within the two depth strata for the Eastern Tropical Pacific ecosystem.

Vessel	Line kms/ Vessel	Source	Overall % Source Usage	% Time Source Dominant (0-200m)	Line km/ Dominant Source (0-200m)	% Time Source Dominant (>200m)	Line km/ Dominant Source (>200m)
Lasker	37710	SX90	25%	25%	9428	25%	9428
		EK60	100%	75%	28283	75%	28283
Shimada	37710	ME70	25%	25%	9428	0%	0
		EK60	100%	75%	28283	100%	37710
Other	18985	EK60	100%	100%	18985	100%	18985

Table 6.7b. Effective total annual survey km for which each source type is the predominant acoustic source in each of the two depth strata for take calculations for the Eastern Tropical Pacific ecosystem.

Source	Summed line kms/source (0-200m)	Summed line kms/source (>200m)	Summed Dominant Source % of total line km (0-200m)	Summed Dominant Source % of total line km (>200m)
SX90	9428	9428	10%	10%
EK60	75550	84978	80%	90%
ME70	9428	0	10%	0%

Table 6.8a. Annual linear survey km for each vessel type and its predominant sources within the two depth strata for the Scotia Sea/Antarctic ecosystem.

Vessel	Line kms/ Vessel	Source	Overall % Source Usage	% Time Source Dominant (0-200m)	Line km/ Dominant Source (0-200m)	% Time Source Dominant (>200m)	Line km/ Dominant Source (>200m)
Other	20846	EK60	100%	100%	20846	100%	20846

Table 6.8b. Effective total annual survey km for which each source type is the predominant acoustic source in each of the two depth strata for take calculations for the Scotia Sea/Antarctic ecosystem.

Source	Summed line kms/source (0-200m)	Summed line kms/source (>200m)	Summed Dominant Source % of total line km (0-200m)	Summed Dominant Source % of total line km (>200m)
EK60	20846	20846	100%	100%

6.2.4 Calculating volume of water insonified to 160 dB RMS received level

The cross-sectional area of water insonified to 160+ dB RMS received level was calculated using a simple model of sound propagation loss, which accounts for the loss of sound energy over increasing range. We used a spherical spreading model (where propagation loss = 20 * log (range) - such that there would be 60 dB of attenuation over 1000 m), a reasonable approximation over the relatively short ranges involved, and accounted for the frequency dependent absorption coefficient and beampattern of the highly directional nature of most of these sound sources. The lowest frequency was used for systems that are operated over a range of frequencies. The vertical extent of this area is calculated for two depth strata (surface to 200 m and surface to range at which the on-axis received level reaches 160 dB RMS). This was applied

differentially based on the typical vertical stratification of marine mammals (see Tables 6.9-6.11). A simple visualization of a 2-dimensional slice of modeled sound propagation is shown below to illustrate the predicted area ensonified to the 160 dB level by an EK-60 operated at 18 kHz.

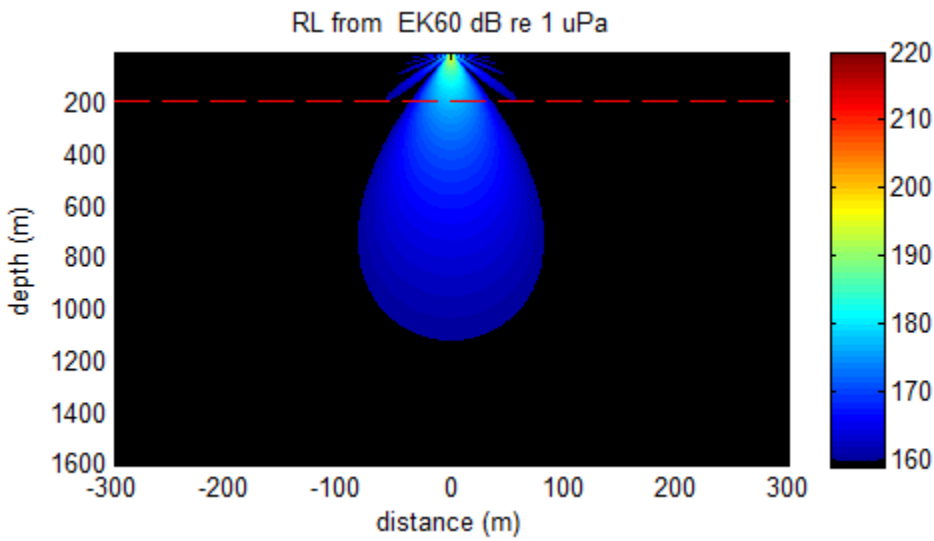

Figure 6.1. Visualization of a 2-dimensional slice of modeled sound propagation to illustrate the predicted area ensonified to the 160 dB level by an EK-60 operated at 18 kHz. The dashed red line marks the transition between the two depth strata (0-200m and >200m).

Following the determination of effective sound exposure area for transmissions considered in two dimensions, the next step was to determine the effective volume of water insonified >160 dB RMS for the entirety of each survey in each region. For each of the three predominant sound sources, the volume of water insonified is estimated as the athwartship cross-sectional area (in km^2) of sound above 160 dB RMS (as shown in the figure above) multiplied by the total distance traveled by the ship. Where different sources operating simultaneously would be predominant in each different depth strata (e.g. ME70 and EK60 operating simultaneously may be predominant in the shallow and deeper bins respectively), the resulting cross sectional area calculated took this into account. Specifically, for shallow-diving species this cross-sectional area was determined for whichever was predominant in the shallow strata whereas for deeper diving species this area was calculated from the combined effects of the predominant source in the shallow strata and the (sometimes different) source predominating in the deeper strata) This creates an effective total volume characterizing the area insonified when each predominant source is operated and accounts for the fact that deeper diving species may encounter a complex sound field in different portion of the water column.

6.2.5 Species-specific marine mammal densities

One of the primary limitations to traditional estimates of behavioral harassment takes from acoustic exposure is the assumption that animals are uniformly distributed in time and space across very large geographical areas, such as those being considered here. There is ample evidence that this is in fact not the case and marine species are highly heterogeneous in terms of

their spatial distribution, largely as a result of species-typical utilization of heterogeneous ecosystem features. Some more sophisticated modeling efforts have attempted to include species typical behavioral patterns and diving parameters in movement models that more adequately assess the spatial and temporal aspects of distribution and thus exposure to sound. While simulated movement models were not used to mimic individual diving or aggregation parameters in the determination of animal density in this estimation, the vertical stratification of marine mammals based on known or reasonably assumed diving behavior was integrated into the density estimates used.

First, typical two-dimensional marine mammal density estimates (animals/km^2) were obtained from various sources for each ecosystem area. These included marine mammal Stock Assessment Reports for the California Current (Table 3.1), from abundance estimates using ship-based surveys of marine mammals in the ETP (Gerrodette et al. 2008; Table 3.2), and from ship-based surveys in the Antarctic (Table 3.3). There are a number of caveats associated with these estimates:

(1) They are often calculated using visual sighting data collected during one season rather than throughout the year. The time of year when data were collected and from which densities were estimated may not always overlap with the timing of SWFSC fisheries surveys (see section 1.6 or Table 1.1 for survey dates). ETP and California Current marine mammal densities are calculated from sightings collected during August – November. Antarctic densities were calculated from sightings collected during January – March.

(2) The densities used for purposes of estimating acoustic harassment takes do not take into account the patchy distributions of marine mammals in an ecosystem, at least on the moderate to fine scales over which they are known to occur. Instead, animals are considered evenly distributed throughout the assessed area and seasonal movement patterns are not taken into account.

In addition and to account for at least some coarse differences in marine mammal diving behavior and the effect this has on their likely exposure to these kinds of sometimes highly directional sound sources, a volumetric density of marine mammals of each species was determined. This value is estimated as the abundance averaged over the two-dimensional geographic area of the surveys and the vertical range of typical habitat for the population. Habitat ranges were categorized in two generalized depth strata (0-200 m, and 0 to >200 m) based on gross differences between known generally surface-associated and typically deep-diving marine mammals (Reynolds and Rommel, 1999; Perrin et al., 2008). Animals in the shallow diving strata were reasonably estimated, based on empirical measurements of diving with monitoring tags and reasonable assumptions of behavior based on other indicators to spend a large majority of their lives (>75%) at depths of 200 m or shallower. Their volumetric density and thus exposure to sound is thus limited by this depth boundary. In contrast, species in the deeper diving strata were reasonably estimated to regularly dive deeper than 200 m and spend significant time at these greater depths. Their volumetric density and thus potential exposure to sounds up to the 160 dB RMS level is extended from the surface to the depth at which this received level condition occurs.

The volumetric densities are estimates of the three-dimensional distribution of animals in their typical depth strata. For shallow diving species the volumetric density is the area density divided by 0.2 km (i.e., 200 m). For deeper diving species, the volumetric density is the area density divided by a nominal value of 0.5 km (i.e., 500 m). The two-dimensional and resulting three-dimensional (volumetric) densities for each species in each ecosystem area are shown in the tables below.

Table 6.9. Volumetric densities for each species in the California Current ecosystem.

	Typical Depth Strata		Area Density (#/km^2)	Volumetric Density (#/km^3)
	0-200 m	0-200m & >200 m		
CC Cetaceans				
Harbor porpoise	X		0.03775	0.18873
Dall's porpoise	X		0.07553	0.37765
Pacific white-sided dolphin	X		0.02093	0.10465
Risso's dolphin	X		0.01046	0.05230
Bottlenose dolphin	X		0.00178	0.00890
Striped dolphin	X		0.01667	0.08335
Short-beaked common dolphin	X		0.30935	1.54675
Long-beaked common dolphin	X		0.01924	0.09620
Northern right-whale dolphin	X		0.00975	0.04875
Killer whale	X		0.00071	0.00355
Short-finned pilot whale		X	0.00031	0.00062
Baird's beaked whale		X	0.00088	0.00176
Mesoplodont beaked whales		X	0.00103	0.00206
Cuvier's beaked whale		X	0.00382	0.00764
Pygmy sperm whale		X	0.00109	0.00218
Dwarf sperm whale		X	0.00109	0.00218
Sperm whale		X	0.00170	0.00340
Humpback whale	X		0.00083	0.00415
Blue whale	X		0.00136	0.00680
Fin whale	X		0.00184	0.00920
Sei whale	X		0.00009	0.00045
Common Minke whale	X		0.00072	0.00360
Gray whale	X		0.01913	0.09565
CC Pinnipeds				
California sea lion	X		0.23800	1.19000
Steller sea lion, eastern subspecies	X		0.05833	0.29165
Guadalupe fur seal	X		0.00741	0.03705
Northern fur seal	X		0.33655	1.68275
Harbor seal	X		0.05040	0.25200
Northern elephant seal		X	0.12400	0.24800

Table 6.10. Volumetric densities for each species in the Eastern Tropical Pacific ecosystem.

	Typical Depth Strata		Area Density (#/km^2)	Volumetric Density (#/km^3)
	0-200 m	**0-200m & >200 m**		
ETP Cetaceans				
Risso's Dolphin	X		0.00517	0.02587
Short beaked common dolphin	X		0.14655	0.73277
Long beaked common dolphin	X		0.01945	0.09726
Rough toothed dolphin	X		0.00504	0.02521
Striped dolphin	X		0.04516	0.22582
Spinner dolphin	X		0.04978	0.24889
Pantropical spotted dolphin	X		0.12263	0.61313
Dusky dolphin	X		0.00210	0.01050
Fraser's dolphin	X		0.01355	0.06774
Melon headed whale	X		0.00213	0.01063
Bottlenosed dolphin	X		0.01573	0.07864
Killer whale	X		0.00040	0.00199
False killer whale	X		0.00186	0.00932
Pygmy killer whale	X		0.00183	0.00913
Short finned pilot whale		X	0.02760	0.05520
Cuvier's beaked whale		X	0.00094	0.00187
Longman's beaked whale		X	0.00004	0.00007
Mesoplodont beaked whale		X	0.00119	0.00237
Sperm whale		X	0.00019	0.00039
Dwarf sperm whale		X	0.00053	0.00105
Humpback whale	X		0.00013	0.00067
Blue whale	X		0.00019	0.00097
Fin whale	X		0.00003	0.00015
Sei whale	X		0.00000	0.00000
Minke whale	X		0.00001	0.00003
Bryde's whale	X		0.00049	0.00244

Table 6.11. Volumetric densities for each species in the Scotia Sea/Antarctic ecosystem.

	Typical Depth Strata		Area Density (#/km^2)[1]	Volumetric Density (#/km^3)
	0-200 m	0-200m & >200 m		
Antarctic Cetaceans				
Spectacled porpoise	X		0.00150	0.00750
Hourglass porpoise	X		0.00150	0.00750
Killer whale	X		0.00150	0.00750
Sperm whale		X	0.00065	0.00130
Arnoux's beaked whale		X	0.00060	0.00120
Southern bottlenose whale		X	0.00060	0.00120
Long-finned pilot whale		X	0.00760	0.01520
Antarctic minke whale	X		0.00180	0.00900
Southern right whale	X		0.00041	0.00203
Fin whale	X		0.08390	0.41950
Blue whale	X		0.00012	0.00062
Humpback whale	X		0.03610	0.18050
Antarctic Pinnipeds				
Antarctic fur seal	X		0.09990	0.49950
Southern elephant seal		X	0.00030	0.00060
Crabeater seal	X		0.64865	3.24324
Weddell seal	X		0.05405	0.27027
Leopard seal	X		0.01622	0.08108

6.2.6 Using areas insonified and volumetric density to calculate Level B harassment by acoustic sources

Level B harassment by acoustic sources, according to current NMFS guidelines, could be calculated for each area by using (1) the combined results from output characteristics of each source and identification of the predominant sources in terms of acoustic output (6.2.2); (2) their relative annual usage patterns for each operational area (6.2.3); (3) a source-specific determination made of the area of water associated with received sounds at either the extent of a depth boundary or the 160 dB RMS received sound level (6.2.4); and (4) determination of a biologically-relevant volumetric density of marine mammal species in each area (6.2.5). Estimates of Level B harassment by acoustic sources are the product of the volume of water insonified at 160 dB RMS or higher for the predominant sound source for each portion of the total line km for which it is used and the volumetric density of animals for each species. These annual estimates are given in the tables below for each ecosystem area.

[1] Densities for the hourglass dolphin, killer whale, southern bottlenose whale, long finned pilot whale, humpback whale, Antarctic fur seal, southern elephant seal and leopard seal were estimated using data from visual surveys conducated at sea during AMLR 2008/2009 season. These density estimates were made using strip transect methods rather than the line transect methods used in many marine mammal visual surveys.

Table 6.12a. Estimated annual Level B harassment by acoustic sources by sound type for each marine mammal species in the California Current ecosystem. For each species and sound source, the cross sectional area for the relevant depth strata (Table 6.5) was multiplied by the effective line km for each respective depth strata for the relevant survey area (from tables 6.6b, 6.7b, or 6.8b) and the volumetric density (shown here) to estimate Level B harassment.

	Volumetric density (#/km^3)	**Estimated Level B Harassment (#s of animals) in 0-200m depth stratum**			**Estimated Level B Harassment in >200m depth stratum**		**Total Take**
		EK60	**ME70**	**SX90**	**EK60**	**SX90**	
CC Cetaceans							
Harbor porpoise	0.18873	197	68	417	0	0	**682**
Dall's porpoise	0.37765	394	135	835	0	0	**1365**
Pacific white-sided dolphin	0.10465	109	38	231	0	0	**378**
Risso's dolphin	0.05230	55	19	116	0	0	**189**
Bottlenose dolphin	0.00890	9	3	20	0	0	**32**
Striped dolphin	0.08335	87	30	184	0	0	**301**
Short-beaked common dolphin	1.54675	1616	555	3421	0	0	**5591**
Long-beaked common dolphin	0.09620	100	35	213	0	0	**348**
Northern right-whale dolphin	0.04875	51	17	108	0	0	**176**
Killer whale	0.00355	4	1	8	0	0	**13**
Short-finned pilot whale	0.00062	1	0	1	8	2	**12**
Baird's beaked whale	0.00176	2	1	4	21	6	**34**
Mesoplodont beaked whales	0.00206	2	1	5	25	7	**39**
Cuvier's beaked whale	0.00764	8	3	17	93	25	**146**
Pygmy sperm whale	0.00218	2	1	5	27	7	**42**
Dwarf sperm whale	0.00218	2	1	5	27	7	**42**
Sperm whale	0.00340	4	1	8	41	11	**65**
Humpback whale	0.00415	4	1	9	0	0	**15**
Blue whale	0.00680	7	2	15	0	0	**25**
Fin whale	0.00920	10	3	20	0	0	**33**
Sei whale	0.00045	0	0	1	0	0	**2**
Common Minke whale	0.00360	4	1	8	0	0	**13**
Gray whale	0.09565	100	34	212	0	0	**346**
CC Pinnipeds							
California sea lion	1.19000	1243	427	2632	0	0	**4302**
Steller sea lion, eastern subsp.	0.29165	305	105	645	0	0	**1054**
Guadalupe fur seal	0.03705	39	13	82	0	0	**134**
Northern fur seal	1.68275	1758	604	3721	0	0	**6083**
Harbor seal	0.25200	263	90	557	0	0	**911**
Northern elephant seal	0.24800	259	89	548	3023	824	**4744**

Table 6.12b. Estimated annual Level B harassment by acoustic sources by sound type for each marine mammal species in the Eastern Tropical Pacific ecosystem. For each species and sound source, the cross sectional area for the relevant depth strata (Table 6.5) was multiplied by the effective line km for each respective strata (from tables 6.6b, 6.7b, or 6.8b) and the volumetric density (shown here) to estimate Level B harassment.

	Volumetric density (#/km^3)	**Estimated Level B Harassment (#s of animals) in 0-200m depth stratum**			**Estimated Level B Harassment in >200m depth stratum**		**Total Take**
		EK60	**ME70**	**SX90**	**EK60**	**SX90**	
ETP Cetaceans							
Risso's Dolphin	0.02587	26	4	16	0	0	**46**
Short beaked common dolphin	0.73277	724	126	451	0	0	**1300**
Long beaked common dolphin	0.09726	96	17	60	0	0	**173**
Rough toothed dolphin	0.02521	25	4	16	0	0	**45**
Striped dolphin	0.22582	223	39	139	0	0	**401**
Spinner dolphin	0.24889	246	43	153	0	0	**442**
Pantropical spotted dolphin	0.61313	605	105	377	0	0	**1088**
Dusky dolphin	0.01050	10	2	6	0	0	**19**
Fraser's dolphin	0.06774	67	12	42	0	0	**120**
Melon headed whale	0.01063	10	2	7	0	0	**19**
Bottlenosed dolphin	0.07864	78	13	48	0	0	**140**
Killer whale	0.00199	2	0	1	0	0	**4**
False killer whale	0.00932	9	2	6	0	0	**17**
Pygmy killer whale	0.00913	9	2	6	0	0	**16**
Short finned pilot whale	0.05520	55	9	34	574	51	**723**
Cuvier's beaked whale	0.00187	2	0	1	19	2	**25**
Longman's beaked whale	0.00007	0	0	0	1	0	**1**
Mesoplodont beaked whale	0.00237	2	0	1	25	2	**31**
Sperm whale	0.00039	0	0	0	4	0	**5**
Dwarf sperm whale	0.00105	1	0	1	11	1	**14**
Humpback whale	0.00067	1	0	0	0	0	**1**
Blue whale	0.00097	1	0	1	0	0	**2**
Fin whale	0.00015	0	0	0	0	0	**0**
Sei whale	0.00000	0	0	0	0	0	**0**
Minke whale	0.00003	0	0	0	0	0	**0**
Bryde's whale	0.00244	2	0	2	0	0	**4**

Table 6.12c. Estimated annual Level B harassment by acoustic sources by sound type for each marine mammal species during surveys in the Scotia Sea/Antarctica ecosystem. For each species and sound source, the cross sectional area for the relevant depth strata (Table 6.5) was multiplied by the effective line km for each respective strata (from tables 6.6b, 6.7b, or 6.8b) and the volumetric density (shown here) to estimate Level B harassment.

	Volumetric density (#/km^3)	**Estimated Level B Harassment (#s of animals) in 0-200m depth stratum**	**Estimated Level B Harassment in >200m depth stratum**	**Total**
		EK60	**EK60**	
Antarctic Cetaceans				
Spectacled porpoise	0.00750	2	0	**2**
Hourglass porpoise	0.00750	2	0	**2**
Killer whale	0.00750	2	0	**2**
Sperm whale	0.00130	0	3	**4**
Arnoux's beaked whale	0.00120	0	3	**3**
Southern bottlenose whale	0.00120	0	3	**3**
Long-finned pilot whale	0.01520	4	39	**43**
Antarctic minke whale	0.00900	2	0	**2**
Southern right whale	0.00203	1	0	**1**
Fin whale	0.41950	114	0	**114**
Blue whale	0.00062	0	0	**0**
Humpback whale	0.18050	49	0	**49**
Antacartic Pinnipeds				
Antarctic fur seal	0.49950	136	0	**136**
Southern elephant seal	0.00060	0	2	**2**
Crabeater seal	3.24324	884	0	**884**
Weddell seal	0.27027	74	0	**74**
Leopard seal	0.08108	22	0	**22**

6.2.7 Summary of the total estimates of Level B harassment due to acoustic sources

The results given in Tables 6.12a-c were based on the approach taken here to estimate marine mammal Level B harassment under the MMPA and should be interpreted with considerable caution. This method is prescribed by the current definition of acoustic thresholds associated with Level B harassment given in NMFS policy guidelines for acoustic impacts with several modifications specific to the directional nature of high-frequency fisheries acoustic sources and the vertical stratification of marine species applied. Given the simplistic step-function approach and lack of species-specific hearing parameters inherent in the NMFS prescribed approach, significant uncertainty in some areas, and a number of underlying assumptions based on how these sources may be used variably in the field, this approach should be considered to result in a highly precautionary estimate of impact (e.g., higher number of estimated Level B harassment than are in fact likely). Factors believed to result in the estimated Level B harassment by acoustic sources being conservative (i.e., higher than what may actually occur *in situ*) include the following:

- Based on current NMFS guidelines, the known differences in hearing sensitivities of different marine mammal species (see section 7.2 below) are not considered in SWFSC estimates of Level B harassment by acoustic sources; all species are assumed to be equally sensitive to all acoustic systems below 180 kHz.
- Other known aspects of hearing as they relate to transient sounds (specifically auditory integration times) are also not taken into account in this estimation. Specifically, sounds associated with these fisheries acoustic sources are typically repetitive and quite brief in duration. While some animals may potentially hear these signals well (e.g. odontocete cetaceans), for other animals, the perceived sound loudness will be considerably reduced based on their brief nature and the fact that auditory integration times in many species likely exceed the duration of individual signals.
- Density estimates underlying take calculations presume a uniform distribution of animals, while in reality for more species they are considerably patchy. The use of vertical stratification and volumetric density here is an improvement over simple geographical density estimates, although a homogenous distribution (albeit in three dimensions) is still used.
- Several other precautionary assumptions are made, including a fairly conservative interpretation of beamwidth of these directional sources and the use of the lowest frequencies (with greatest potential propagation to higher received levels) in cases where multiple frequencies are used.

In conclusion, the estimated Level B harassment likely overestimates the actual magnitude of behavioral impacts of these operations for the reasons given above. This approach is deemed appropriate, however, given some of the uncertainties in terms of response thresholds to these types of sounds, overall density estimates, and other complicating factors.

6.3 Estimated number of potential marine mammal takes by incidental harassment of animals on ice due to Antarctic survey transects during austral winter

During Antarctic ecosystem surveys conducted in the austral winter (i.e., June 1 – through August 31) it is anticipated that pinniped species hauled out on ice may be disturbed. These studies do not entail intentional approaches to pinnipeds on ice, only behavioral disturbance incidental to shipboard activities. Behavioral disturbance may include visible reactions of hauled out animals to the ship, such as some animals leaving haulout locations and entering the water. To account for this source of incidental harassment, we have estimated the number of individuals of each pinniped species that may react to vessel movements and activities using the vessel distance traveled (20,846 km) during a typical AMLR survey, an effective strip width of 200 m (animals are assumed to react if they are less than 100 m from the vessel – see below), and the estimated population density for each species. Population densities are the same as those to estimate acoustic harassment takes using a similar approach and are listed in Table 6.13. We believe the SWFSC approach to calculating these estimates is justifiable, though we acknowledge there is likely to be variation between individuals and species in reactions to a passing research vessel. In other words, some animals assumed to react in this calculation will not react, and others assumed not to react because they are outside the effective strip width may in fact react. However, we have no information to indicate that our approach is biased either negatively or positively. SWFSC used an effective strip width of 200 m to be consistent with the regional marine mammal viewing guidelines that NMFS has established for Alaska that restrict approaches to marine mammals to a distance of 100 m or greater in order to reduce the potential to cause inadvertent harm to marine mammals. (The Alaska region is believed to have the most similar environment to the Antarctic of all regions for which NMFS has established viewing guidelines.) We request the following annual incidental harassment takes associated with these activities for all age classes of the following pinniped species: Antarctic fur seal (417), southern elephant seal (2), Weddell seal (226), crabeater seal (2,705), and leopard seal (68).

Table 6.13. Estimated annual incidental harassment take of pinnipeds associated with AMLR vessel transects.

Species	Estimated density	Annual survey distance (km)	Effective strip width (km)	Estimated incidental harassment take
Antarctic fur seal[1]	0.0999/km	20,846	0.2	417
Southern elephant seal[1]	0.0003/km	20,846	0.2	2
Weddell seal[2]	0.0541/km^2	20,846	0.2	226
Crabeater seal[2]	0.6486/km^2	20,846	0.2	2,705
Leopard seal[1]	0.0162/km	20,846	0.2	68

[1] Densities were estimated using data from visual surveys conducted at sea during AMLR 2008/2009 season. These density estimates were made using strip transect methods rather than the line transect methods used in many marine mammal visual surveys.
[2] IUCN Red List Assessment (iucnredlist.org)

7. THE ANTICIPATED IMPACT OF THE ACTIVITY UPON THE SPECIES OR STOCK

We anticipate that the specified activities could impact the species or stocks of marine mammals by causing mortality, serious injury, and/or Level A (non-serious injury) harassment (through gear interaction) or by causing Level B (behavioral) harassment (through use of active acoustic sources and close vessel approaches to pinnipeds hauled out on ice when conducting Antarctic fisheries research activities). These could occur through the following:

- Entanglement in nets or longlines;
- Accidental hooking;
- Alterations in behavior caused by acoustics sources and by close vessel approaches to pinnipeds hauled out on ice during AMLR research activities

Other potential effects of the activity could include hearing impairment, masking, or non-auditory physiological effects, such as stress responses, resonance, and other types of organ or tissue damage related to the use of active acoustics. However, for reasons described below, we do not expect that these effects would occur. In addition, we do not expect that the anticipated impact of the activity upon the species or stocks would include the potential for effects on marine mammals from the following:

- Collision or vessel strike;

The SWFSC does not expect its survey operations or its cooperative surveys with other research entities would cause the marine mammal populations in the CCE, ETP, or Antarctic to experience reductions in reproduction, numbers, or distribution that might appreciably reduce their likelihood of surviving and recovering in the wild. Although these surveys have the potential to adversely impact the health and condition of an individual marine mammal, we anticipate no adverse effects on annual rates of recruitment or survival of the affected marine mammal species or stocks. The Center notes, however, that marine mammal distribution and abundance is not uniform in all parts of the study area, and varies substantially in different seasons. Most marine mammal surveys are conducted during the summer and fall; however, density information is not available for every season in all the study regions. The Center believes that the direct effects on species or stocks are minor because over the course of the operations during 2008-2012 only 63 marine mammals have been incidentally caught of which thirteen have been released alive. These animals caught include Pacific white-sided dolphins, northern right-whale dolphins, California sea lions, and northern fur seals (Table 6.1). From a population perspective, the impacts of these incidental captures are negligible.

While there are different approaches that could be taken to evaluating the significance of anticipated interactions with marine mammals during the course of fisheries research, the Potential Biological Removal (PBR) level used in classifying commercial fisheries is well established and applicable to removals of marine mammals in fisheries research activities, as well. PBR is defined by the MMPA as the maximum number of animals that may be removed from a marine mammal stock, not including natural mortalities, while allowing that stock to reach or maintain its optimum sustainable population. The PBR level is the product of the

minimum population estimate of the stock, one-half the maximum theoretical or estimated net productivity rate of the stock at a small population size, and a recovery factor of between 0.1 and 1.0.

In using PBR to evaluate the impact of SWFSC fisheries research activities on affected marine mammal stocks, two assumptions should be noted. First, as described in Section 6 of this application, SWFSC has requested a single number of takes in each gear for each stock in a combined category that includes Level A injury, serious injury and mortality. It is likely that some marine mammals that interact with SWFSC research gears will experience only non-serious injuries. However, for purposes of evaluating the significance of the SWFSC take request relative to PBR we assume the worst-case outcome that all animals in this combined category will be seriously injured or killed. The rationale for binning Level A injury, serious injury and mortality takes is described in greater detail in Section 6 of this application.

Second, SWFSC is assuming its anticipated take will equal its actual take of marine mammals in fisheries research activities. PBR was developed as a tool to evaluate actual human-caused removals from a population, not anticipated future removals. Nonetheless, the take request described in Section 6 is based on historical interactions, and as such SWFSC believes its request is a reasonable approximation of the number of takes that may occur in the future. Clearly, the actual number of serious injuries and mortalities that result from SWFSC research will need to be evaluated to understand the significance of these activities. As described in Section 14 of this application, SWFSC plans to implement an adaptive management approach to evaluating its actual takes and continuing to revisit its mitigation measures in light of take events to ensure they are appropriate.

7.1 Physical Interactions with Gear

The SWFSC incidentally caught 63 marine mammals during research activities within the California Current Ecosystem from 2008 to 2012 (Table 6.1). The mortalities occurred in the CCE during trawls conducted on sardine, juvenile salmon, and juvenile rockfish surveys. Additional non-lethal takes also occurred during trawl operations on sardine and juvenile rockfish surveys in the CCE, as well as on longlines set during highly migratory species (HMS) and thresher shark surveys in the CCE. The majority of incidental takes of marine mammals (over 92% from 2008 to 2012) were the result of surveys conducting trawls, with only five California sea lions caught and released alive during longline surveys. Rigorous mitigation measures have been employed since 2009 to minimize the incidental take of marine mammals (summarized at section 11). To reduce or eliminate incidental take the SWFSC has initiated use of a marine mammal excluder device on nets (MMED). This device was developed with the premise and supporting documentation of a similar device to minimize incidental take of turtles. The effectiveness of the MMED in tests during 2009 may be viewed in Appendix A and Dotson et al. (2010).

SWFSC is currently investigating whether data are sufficient to conduct a multivariate analysis of factors influencing research interactions with protected species, including whether environmental factors or mitigation measures implemented by SWFSC have an effect on interaction rates. This effort is still underway; however, initial efforts have uncovered that

important information on when and how mitigation measures are being used (e.g., sets in which operational pingers are used, number used, placement, etc.) has not been collected systematically for some surveys. Unfortunately, this lack of information may compromise SWFSC's ability to draw definitive conclusions at this time about the effectiveness of measures it has implemented to reduce protected species interactions. As described in later sections of this application, SWFSC is now seeking to make more systematic its training, operations, data collection, animal handling and sampling protocols, etc. in order to improve its ability to understand how mitigation measures influence interaction rates and ensure its research operations are conducted in an informed manner and consistent with lessons learned from those with experience operating these gears in close proximity to marine mammals.

Because of the low level of historical takes, as well as the low level of predicted future takes associated with the use of trawl gear and longline gear in research activities in the CCE, ETP, and AMLR, the SWFSC believes that the surveys described below: (1) will have a negligible impact on the affected species or stocks of marine mammals (based on the likelihood that the activities will not affect annual rates of recruitment or survival); and (2) will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses. The basis for this determination is that no historical takes or those requested for the future exceed a stock's PBR.

7.1.1 Anticipated impact of mid-water trawl and longline surveys conducted in the California Current Ecosystem (CCE) on marine mammal stocks

As described in Section 6, SWFSC relied heavily on its historic marine mammal interactions with its longline surveys that occur in the CCE and used other relevant information in developing its take request. Table 7.1 compares the SWFSC combined take request for mid-water trawl and longline gear in the CCE relative to each stock's PBR.

Included in Table 7.1 are takes requested for 1 unidentified delphinid species in trawl gear and 2 unidentified pinniped species, one each in longline and trawl gear. In other words, for every delphinid and pinniped stock for which SWFSC has requested take in trawl gear an additional take has been added in the "Total SWFSC Take Request" column to account for potential take of a delphinid and a pinniped that is not identified to species/stock. For the same reason, an additional take has also been added to each pinniped stock for which take is requested in longline gear. As a result, the SWFSC take request in this table differs in comparison to stock-specific takes requested in Table 6.3.

For each of the seventeen stocks for which take is requested, no take request exceeds its PBR. Because of the low level of predicted future takes associated with the use of mid-water trawl gear in research activities in the CCE relative to PBR, the SWFSC believes that the surveys for CPS, juvenile rockfish and juvenile salmon will neither affect annual recruitment or survival nor the health and condition of marine mammal species or stocks.

Table 7.1. Stocks for which SWFSC is requesting trawl and/or longline take in the CCE, cumulative numbers requested by stock, and evaluation of impact relative to PBR

	Total SWFSC Take Request[1,2] (2013-2018)	PBR (Annual Potential Biological Removal)	% PBR Requested Annually
Risso's Dolphin	13	39	6.67
Harbor Porpoise[3]	6	10	12.00
Dall's Porpoise	6	257	0.47
Pacific White-sided Dolphin	36	193	3.73
Bottlenose Dolphin (Coastal)	4	2.4	33.33
Bottlenose Dolphin (OR, WA Offshore)	10	5.5	32.73
Striped Dolphin	13	82	3.17
Short-Beaked Common Dolphin	13	3,440	0.08
Long-Beaked Common Dolphin	13	610	0.43
Northern Right Whale Dolphin	11	48	4.58
Short-finned Pilot Whale	1	4.6	4.35
Pygmy and Dwarf Sperm Whale	1	2.7	7.41
California Sea Lion	27	9,200	0.06
Steller Sea Lion	12	2,378	0.10
Northern Fur Seal	6	324	0.37
Harbor Seal (All Stocks)	10	1,600	0.13
Northern Elephant Seal	6	4,382	0.03

[1] Because SWFSC requested 1 unidentified delphinid species in trawl gear and 2 unidentified pinniped species, one each in longline and trawl gear, these additional takes have been included in this table for analytical purposes. In this table one take has been added to each delphinid for which take is requested in trawl gear, 1 take has been added to each pinniped for which take is requested in trawl gear, and 1 take has been added to each pinniped for which take is requested in longline gear (i.e., the impact of 2 additional takes of Steller and California sea lions was analyzed because it is anticipated these may be taken in longline and trawl gear), and these takes are incorporated in the % PBR Requested figures. As a result, the SWFSC take request in this table differs in comparison to stock-specific takes requested in Table 6.3.
[2] The SWFSC request is for Level A and serious injury and mortality takes. For purposes of evaluating impact of this request, all takes are assumed to result in serious injury / mortality.
[3] Harbor porpoise take request is across all stocks, and PBR used is the lowest calculated for any stock (Monterey Bay).

7.1.2 Anticipated impact of longline surveys conducted in the Eastern Tropical Pacific (ETP) Ecosystem on marine mammal stocks

The SWFSC has not historically conducted longline surveys in the ETP. However, as described in previous sections SWFSC believes it is likely it will conduct these surveys for sharks and HMS during 2013-2018, and in estimating its future take SWFSC used information from its CCE longline surveys and other relevant information. Table 7.2 shows a comparison of the SWFSC take request for longline gear in the ETP to a calculated PBR for each stock using accepted calculations for minimum population estimates (Nmin) and PBR (NMFS 2005).

Included in Table 7.2 are takes requested for 1 unidentified pinniped species in longline gear. In other words, for every pinniped stock for which SWFSC has requested take in longline gear an additional take has been added in the "Total SWFSC Take Request" column to account for

potential take of a pinniped that is not identified to species/stock. As a result, the SWFSC take request in this table differs in comparison to stock-specific takes requested in Table 6.3.

For each of the eleven stocks for which take is requested, no take request exceeds 2% of PBR. Because of the low level of predicted future takes associated with the use of longline gear in research activities in the ETP, the SWFSC believes that the HMS survey, habitat/swordfish survey and thresher shark pelagic survey will neither affect annual recruitment or survival nor the health and condition of marine mammal species or stocks.

Table 7.2. Stocks for which SWFSC is requesting longline take in the ETP and numbers requested relative to an approximation for PBR.

	SWFSC Longline Take Request (2013-2018)	**Population Estimate[3] (N)**	**Coefficient of Variation[3] (CV)**	**N_{min}[1]**	**PBR Calculation**	**% PBR Proxy Requested Annually**
Risso's Dolphin	1	110,457	0.348	83,092	831	0.12
Bottlenose Dolphin	1	335,834	0.197	284,952	2,850	0.04
Striped Dolphin	1	964,362	0.207	811,592	8,116	0.01
Short-Beaked Common Dolphin	1	3,127,203	0.264	2,513,269	25,133	0.004
Long-Beaked Common Dolphin	1	372,429	0.355	278,651	2,787	0.01
Coastal Spotted Dolphin	1 (take request is for Pantropical spotted dolphin)	161,596	0.308	125,414	1,254	0.08
Western/Southern Spotted Dolphin		758,985	0.265	609,493	6,095	
Northeastern Spotted Dolphin		822,157	0.157	720,929	7,209	
False Killer Whale	1	39,800	0.636	24,365	244	0.41
Short-finned Pilot Whale	1	589,315	0.26	475,141	4,751	0.02
Dwarf Sperm Whale	1	11,200	0.294	8,789	88	1.14
California Sea Lion[2]	6	105,000	0[4]	105,000	1,050	0.57
South American Sea Lion[2]	6	150,000	0[4]	150,000	1,500	0.40

[1] Nmin was calculated based on the Guidelines for Assessing Marine Mammal Stocks (GAMMS; NMFS 2005). Nmin is defined as the 20th percentile of a log-normal distribution based on an estimate of the number of animals in a stock (which is equivalent to the lower limit of a 60% 2-tailed confidence interval): $Nmin = N/\exp(0.842 * (\ln(1+CV(N)^2))^{½})$. PBR = Nmin*0.5Rmax*Fr; values for the recovery factor (Fr) and for Rmax were assumed to be 0.5 and 0.04, respectively.

[2] Because SWFSC requested 1 unidentified pinniped species in longline gear, these additional takes have been included in this table for analytical purposes (1 each for the sea lion species), and these takes are incorporated in the % PBR Requested figures to illustrate the impact if one unidentified take came from each of the pinniped stocks.

[3] Sources for population estimates (N) and associated CVs are as cited in footnote to Table 3.2. Surveys from which abundance estimates were made for long-beaked common dolphin, California sea lion and South American sea lion are over 8 years old. According to the GAMMS (NMFS 2005), the minimum population estimate of a stock should be considered unknown in these cases. However, because this is the best information available to evaluate the

potential impacts of the SWFSC take request on these stocks the most recent abundance information, even if older than 8 years, is being used in the calculation of Nmin and PBR.

[4] Population estimates for California and South American sea lions were made based on counts of animals in aerial photographs. Because photographic counts are usually considered as actual population size there is no error around the population estimates.

7.1.3 Survey gears for which no take of marine mammals by mortality or serious injury and by non-serious injury (Level A harassment) is being requested

As described in Section 6 of this application, the only SWFSC research gears that have taken marine mammals are mid-water trawls (NETS Nordic 264 and Modified Cobb) and longline gears used in surveys for sharks and HMS. The other net and hook gears used in SWFSC fisheries research – a variety of plankton nets, CTDs, ROVs, deep set buoy gear, AMLR snapper bottom trawl, and (deep set) longline gear for sablefish – have had no marine mammal interactions during the period 2008-2012. In addition, they are not considered to have the potential to take marine mammals given their physical characteristics, how they are fished, and the environments where they are used, and in the case of the bottom longline survey for sablefish the low level of effort virtually eliminates any potential to take marine mammals. Because of this, SWFSC is not requesting marine mammal take for these gears, and as such they are not expected to have an impact on marine mammal stocks in the SWFSC study areas.

7.2 Disturbance and Behavioral Changes

7.2.1 Due to close approach

As described previously, during AMLR surveys conducted during the southern hemisphere winter pinnipeds are expected to be hauled out on ice and at times experience close approaches by the survey vessel during the course of its fisheries research activities. SWFSC expects some of these animals will exhibit a behavioral response to the visual stimuli (e.g., including flushing, vocalizing and head alerts), and as a result estimates of Level B harassment have been calculated. These events are expected to be infrequent and cause only a very temporary disturbance (minutes). However, relevant studies of pinniped populations that experience more regular vessel disturbance indicate that population level impacts are unlikely to occur. Some key findings from these studies are summarized below.

In a popular tourism area of the Pacific Northwest where human disturbances were frequent to occur, past studies observed stable populations of seals over a 20-year period (Calambokidis et al. 1991). Despite high levels of seasonal disturbance by tourists using both motorized and non-motorized vessels, Calambokidis et al. (1991) observed an increase in site use (pup rearing) and classified this area as one of the most important pupping sites for seals in the Pacific Northwest. Another study observed an increase in seal vigilance only when vessels passed the haul out site, but then vigilance relaxed within 10 minutes of the vessels' passing (Fox 2008). If vessels were frequent to occur within a short time period (e.g., 24 hours), a reduction in the total number of seals present was also observed (Fox 2008).

Based on these studies, repeated disturbance can cause behavioral disturbance and alter normal activity patterns, and as such minimizing these types of disturbances, particularly those that are

frequent and prolonged, is important. However, if disturbances resulting from research activities are brief and infrequent (often the case during SWFSC surveys conducted in the ALMR), SWFSC does not expect the close approaches to result in prolonged or permanent separation of mothers and pups or to result in responses of the frequency or magnitude that would adversely affect annual recruitment or survival or the health and condition of pinniped species or stocks.

7.2.2 Due to noise

Characteristics of hearing and the effects of noise on marine life have been reviewed extensively (Richardson et al. 1995; Wartzok and Ketten 1998; Nowacek et al. 2007; Southall et al. 2007; Au and Hastings 2008). General characteristics of hearing in marine mammals is described briefly here primarily for the purposes of categorization with regard to the potential impacts of high frequency active acoustic sources, as well as current information regarding sound exposures that may be detectable, disturbing, or injurious to marine mammals.

7.2.2.1 Hearing in marine mammals

Within marine taxa, there is probably the most known about the hearing capabilities of marine mammals. However many species and in fact entire taxa (e.g., large whales) have not been measured directly in controlled/laboratory settings. Current knowledge is based on direct measurements (using behavioral testing methods with trained animals and electrophysiological measurements of neural responses to sound production), as well as various ways of predicting hearing sensitivity using ranges of vocalization, morphology, observed behavior, and/or taxonomic relatedness to known species (e.g., Ketten 1997; Houser et al. 2001). While less than a third of the >120 marine mammal species have been tested directly, sufficient data exist to indicate general similarities and differences within taxa (e.g., Richardson et al. 1995; Wartzok and Ketten 1999; Au and Hastings 2008) and reasonably assign marine mammal species into functional hearing groups (as in Southall et al. 2007). Based on the functional hearing groupings made in Southall et al. (2007) conclusions may be made about marine mammal hearing, as described below.

No direct measurements of hearing exist in large whales, primarily because of their sheer size and the resulting difficulties in housing and testing them in normal captive settings. Conclusions about their hearing capabilities must be considered somewhat speculative, but some general conclusions and predictions are possible (Richardson et al. 1995; Ketten 1997; Wartzok and Ketten 1999; Houser et al. 2001; Erbe 2002; Clark and Ellison 2004). The thirteen species of baleen whales have been determined to comprise a low frequency cetacean functional hearing group with estimated functional hearing between 7 Hz and 22 kHz (Southall et al. 2007; Figure 7.1). Humpback whales produce sounds with some energy above 24 kHz (Au et al. 2006), so it is possible that functional hearing could extend slightly higher in this group. Empirical measurements of Frankel (2005) in demonstrating minor avoidance behavior in gray whales to 21-25 kHz sounds and the anatomical predictions of Parks et al. (2007) are consistent with the interpretation of a slightly higher upper frequency hearing cut-off in mysticetes, perhaps extending close to 30 kHz in some species.

Odontocetes are segregated into two functional hearing groups based on their relative specialization (or lack thereof) to detect very high frequency sounds (Tables 4.1). Southall et al. (2007) distinguished these into the mid-frequency cetaceans including 32 species and subspecies of “dolphins”, 6 species of larger toothed whales, and 19 species of beaked and bottlenose

whales. These species are determined, based on direct behavioral and electrophysiological methods, to have functional hearing between approximately 150 Hz and 160 kHz (see references in Southall et al. 2007).

High frequency cetaceans include eight species and subspecies of true porpoises, six species and subspecies of river dolphins plus the Franciscana (*Pontoporia blainvillei*)), *Kogia*, and four species of cephalorhynchids and have functional hearing between 200 Hz and 180 kHz (Southall et al. 2007, and citations therein).

The pinnipeds (seals and sea lions) function in both air and water and have functional hearing in each media. Only underwater hearing is considered here, given that the active acoustic sources associated with SWFSC research vessels are operated in water. This group includes 16 species and subspecies of sea lions and fur seals (otariids), 23 species and subspecies of true seals (phocids), and two subspecies of walrus (odobenids). Based on the existing empirical data on hearing in laboratory individuals of nine pinniped species, Southall et al. (2007) estimated functional underwater hearing sensitivity in this group to be between 75 Hz and 75 kHz, but noted that there is considerable evidence that phocid seals have a broader range of hearing sensitivity than the otariids; the use of this bandwidth is thus a precautionary estimate in terms of how high frequency sounds might affect otariid pinnipeds.

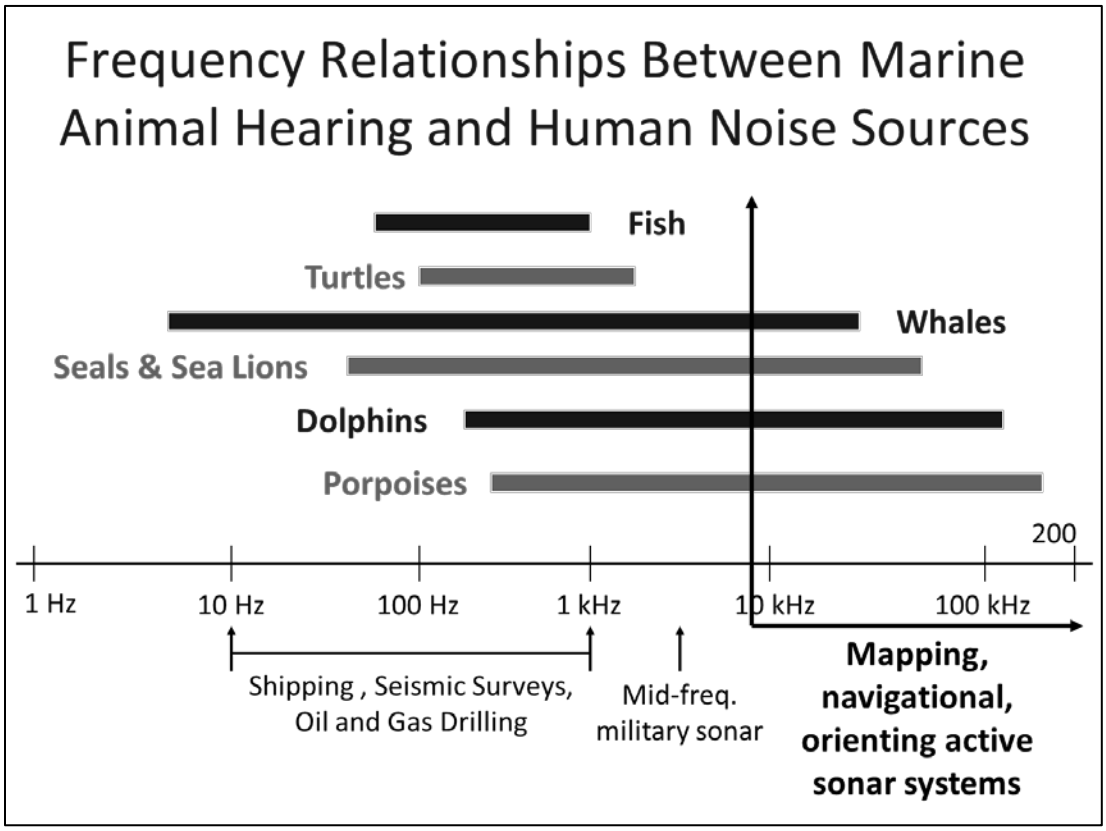

Figure 7.1. Typical frequency ranges of hearing in marine animals shown relative to various underwater sound sources, particularly high frequency active acoustic source.

7.2.2.2 Effects of anthropogenic noise on marine mammals

Anthropogenic sounds cover a broad range of frequencies and sound levels and can have a range of impacts on marine life, from no or minor responses to potentially severe, depending on received levels, behavioral context and various other factors. Many of the kinds of sources that have been investigated included sounds that are either much lower frequency and/or higher total energy (considering output sound levels and signal duration) than the high frequency mapping and fish-finding sonars used by the Center. These include low- and mid-frequency military sonars, seismic airguns used in geophysical research, pile-driving sounds associated with marine construction, and low- and mid- frequency sounds associated with vessel operations (NRC 1994, 2000, 2003, 2005; Nowacek et al. 2007; Southall et al. 2007; Popper and Hastings 2009). Other than the Navy's studies on the High-Frequency Marine Mammal Monitoring (HF/M3) active sonar system since 2001, there has been relatively little attention given to the potential impacts of high-frequency sonar systems on marine life, largely because their combination of high output frequency and relatively low output power is likely to render them less likely to impact many marine species than some of the other acoustic sources. However, it should be noted that some species of marine animals do hear and produce sounds at some of the frequencies used in these sources and ambient noise is much lower at high frequencies, increasing the relative probability of their detection relative to other sounds in the environment. Because, as seen in Figure 7.1, there is very little probability of fish even hearing active high frequency acoustic sources, the primary discussion here is related to marine mammals, with particular emphasis on the odontocete cetaceans.

Sounds must presumably be audible to be detected and the known or estimated functional hearing capabilities for different species are indicated in Figure 7.1. Additionally, Southall et al. (2007) provided a recent and extensive review on the effects of noise on marine mammal hearing and behavior.

The results of that review indicate that relatively high levels of sound are likely required to cause temporary hearing threshold shifts (TTS) in most pinnipeds and odontocete cetacean species (e.g., Schlundt et al. 2000; Finneran et al. 2000, 2002, 2005, 2007b, 2010a and b; Kastak et al. 1999, 2005, 2007). The exposures required are often measured with a variety of sound exposure metrics related to level (e.g., RMS, peak, or peak-peak sound pressure level) or sound energy (e.g., sound exposure level that considers level as well as exposure duration). While clearly dependent on sound exposure frequency, level, and duration, based on the results of these studies, for the kinds of relatively brief exposures associated with transient sounds such as the active acoustic sources usd by the Center, RMS sound pressure levels in the range of approximately 180-220 dB re: 1µPa are required to induce onset TTS levels for most species. Recently, Lucke et al. (2009) found a TTS onset in a harbor porpoise exposed to airgun noise at much lower (>20 dB) levels than reported by Finneran et al. (2002) for belugas using a similar impulse noise source; Kastelein (unpubl. data) has similarly observed increased sensitivity in this species. Additionally, Finneran and Schlundt (2010) indicate relatively lower TTS onset levels for higher sound exposure frequencies (20 kHz) than for lower frequencies (3 kHz) in some cetaceans. However, for these animals, which are better able to hear higher frequencies and may be more sensitive to higher frequencies, exposures on the order of ~170 dB RMS or higher for brief transient signals are likely required for even temporary (recoverable) changes in hearing sensitivity that would likely not be categorized as physiologically damaging. The corresponding

estimates for permanent threshold shift (PTS), which would be considered injurious, would still be at quite high received sound pressure levels that would rarely be experienced in practice.

Southall et al. (2007) provided a number of extrapolations to assess the potential for permanent hearing damage (permanent threshold shift or PTS) from discrete sound exposures and concluded that very high levels (exceeding 200 dB re: 1µPa received sound pressure levels) would be required; typically quite large TTS is required (~40 dB) to result in PTS from a single exposure. Southall et al. (2007) also provided some frequency weighting functions for different marine mammal groups, which essentially account for the fact that impacts of noise on hearing depends in large part on the frequency overlap between noise and hearing. Based on the Southall et al. (2007) results, Lurton and DeRuiter (2011) modeled the potential impacts (PTS and behavioral reaction) of conventional echosounders on marine mammals. They estimated PTS onset at typical distances of 10m to 100m for the kinds of sources in the fisheries surveys considered here. They also emphasized that these effects would very likely only occur in the cone ensonified below the ship and that animal responses to the vessel at these extremely close ranges would very likely influence their probability of being exposed to these levels. For certain species (e.g., odontocete cetaceans and especially harbor porpoises), these ranges may be somewhat greater based on more recent data (Lucke et al. 2009; Finneran and Schlundt 2010), although they are likely still on the order of hundreds of meters for most fisheries acoustic sources. In addition, the behavioral responses that typically occur (described below) further reduce this already low likelihood that an animal may approach close enough for any type of hearing loss to occur.

The overall conclusion here is that the available information on hearing and potential auditory effects in marine mammals would suggest that the high frequency cetacean species would be the most likely to have temporary (not permanent) hearing losses from a vessel operating high frequency sonar sources, but that even for these species, individuals would have to either be very close to and also remain very close to vessels operating these sources for multiple exposures at relatively high levels. Given the moving nature of vessels in fisheries research surveys, the likelihood that animals may avoid the vessel to some extent based on either its physical presence or active acoustic sources, and the intermittent nature of many of these sources, the potential for TTS is probably low for high frequency cetaceans and very low to zero for other species.

Behavioral responses of marine mammals are extremely variable depending on a host of exposure factors, including exposure level, behavioral context and other factors. The most common type of behavioral response seen across studies is behavioral avoidance of areas around sound sources. These are typically the types of responses seen in species that do clearly respond, such as harbor porpoises, around temporary/mobile higher frequency sound sources in both the field (e.g., Culik et al. 2001; Johnston et al. 2002) and in the laboratory settings (e.g., Kastelein et al. 2000, 2005, 2008a and b). However, what appears to be more sustained avoidance of areas where high frequency sound sources have been deployed for long durations has also been documented in some odontocete cetaceans, particularly those like porpoises and beaked whales that seem to be particularly behaviorally sensitive (e.g., Olesiuk et al. 2002; Carretta et al. 2008; Southall et al. 2007). While low frequency cetaceans and pinnipeds have been observed to respond behaviorally to low- and mid-frequency sounds, there is little evidence of behavioral

responses in these species to high frequency sound exposure (see e.g., Jacobs and Terhune 2002; Kastelein et al. 2006).

7.2.2.3 Active acoustic sources used by the SWFSC and their effect on marine mammals

A brief discussion of the general characteristics of high frequency acoustic sources associated with fisheries research activities is given below, followed by a qualitative assessment of how those sources may affect marine life. Marine mammals, as opposed to marine fish and sea turtles, are the focus of this assessment given their overlapping hearing capabilities (Figure 7.1) with the sounds produced by high frequency sound sources.

The high frequency transient sound sources operated by the Center are used for a wide variety of environmental and remote-object sensing in the marine environment. They include various echosounders (e.g., multibeam systems), scientific sonar systems, positional sonars (e.g., net sounders for determining trawl position), and environmental sensors (e.g., current profilers). The specific acoustic sources used in SWFSC active acoustic surveys, are described in Section 6.2. As a general categorization, however, the types of active sources employed in fisheries acoustic research and monitoring may be considered in two broad categories here, based largely on their respective operating frequency (e.g., within or outside the known audible range of marine species) and other output characteristics (e.g., signal duration, directivity). As described below, these operating characteristics result in differing potential for acoustic impacts on marine mammals and other protected species.

<u>Category 1 active acoustic sources</u>

Certain active fisheries acoustic sources (e.g., short range echosounders, acoustic Doppler current profilers) are distinguished by having very high output frequencies (>180 kHz) and generally short duration signals and highly directional beam patterns. Based on the frequency band of transmissions relative to the functional hearing capabilities of marine species, they are not expected to have any negative effect on marine life. They are thus not considered explicitly in the qualitative assessment below (or in the quantitative analysis conducted in Section 6.2). Additionally, passive listening sensors which are sometimes described as elements of fisheries acoustic systems that exist on many oceanographic research vessels have no potential impact on marine life because they are remotely and passively detecting sound rather than producing it.

These sources are determined to have essentially no probability of being detected by or resulting in any potential adverse impacts on marine species. This conclusion is based on the relative output frequencies (> 180 kHz) and the fact that this is above the known hearing capabilities of any marine species (as described above). Sounds that are above the functional hearing range of marine animals may be audible if sufficiently loud (e.g., see Møhl, 1968). However, the relative output levels of these sources and the levels that would likely be required for animals to detect them would be on the order of a few meters. The probability for injury or disturbance from these sources is essentially zero. In fact, NOAA does not regulate or require take assessments for acoustic sources with source frequencies at or above 180 kHz because they are above the functional hearing range of any known marine animal (including high frequency odontocete cetaceans, such as harbor porpoises).

<u>Category 2 active acoustic sources</u>

These acoustic sources, which are present on most SWFSC fishery research vessels, include a variety of single, dual, and multi-beam echosounders (many with a variety of modes), sources used to determine the orientation of trawl nets, and several current profilers with slightly lower output frequencies than Category 1 sources. Category 2 active acoustic sources have moderate to very high output frequencies (10 to 180 kHz), generally short ping durations, and are typically focused (highly directional) to serve their intended purpose of mapping specific objects, depths, or environmental features. A number of these sources, particularly those with relatively lower sound frequencies coupled with higher output levels can be operated in different output modes (e.g., energy can be distributed among multiple output beams) that may lessen the likelihood of perception by and potential impact on marine life.

Category 2 active acoustic sources are likely to be audible to some marine mammal species. Among the marine mammals, most of these sources are unlikely to be audible to whales and most pinnipeds, whereas they may be detected by odontocete cetaceans (and particularly high frequency specialists such as harbor porpoise). There is relatively little direct information about behavioral responses of marine mammals, including the odontocete cetaceans, but the responses that have been measured in a variety of species to audible sounds (see Nowacek et al. 2007; Southall et al. 2007 for reviews) suggest that the most likely behavioral responses (if any) would be short-term avoidance behavior of the active acoustic sources.

The potential for direct physical injury from these types of active sources is low, but there is a low probability of temporary changes in hearing (masking and even temporary threshold shift) from some of the more intense sources in this category. Recent measurements by Finneran and Schlundt (2010) of TTS in mid-frequency cetaceans from high frequency sound stimuli indicate a higher probability of TTS in marine mammals for sounds within their region of best sensitivity; the TTS onset values estimated by Southall et al. (2007) were calculated with values available at that time and were from lower frequency sources. Thus, there is a potential for TTS from some of the Category 2 active sources, particularly for mid- and high-frequency cetaceans. However, even given the more recent data, animals would have to be either very close (few hundreds of meters) and remain near sources for many repeated pings to receive overall exposures sufficient to cause TTS onset (Lucke et al. 2009; Finneran and Schlundt 2010). If behavioral responses typically include the temporary avoidance that might be expected (see above), the potential for auditory effects considered physiological damage (injury) is considered extremely low so as to be negligible in relation to realistic operations of these devices.

7.2.2.4 Acoustic summary

Based on current scientific understanding and knowledge of the kinds of sources used in field operations, many of the high frequency, directional, and transient active acoustic sources used in SWFSC fisheries research operations are unlikely to be audible to and thus have no adverse impacts on most marine mammals. Sources operating at lower output frequencies, higher output levels, more continuous types of operation and with less directed acoustic energy are more likely to be audible to and affect more marine species.

Among the marine mammals, the whales and pinnipeds are the least likely to detect and be affected by these sounds. The most likely taxa to hear and react would be the odontocete cetaceans (and especially the high frequency specialized and relatively behaviorally sensitive harbor porpoises), who have specialized echolocation systems and associated high frequency

hearing and excellent temporal processing of short-duration signals. The current NMFS acoustic step-function threshold of (160 dB RMS received level, irrespective of sound frequency,) is applied in the quantitative assessment in section 6.2 because this is the current requirement. However, for many marine mammal species with reduced functional hearing at the higher frequencies produced by category 2 active sources (e.g., 40-180 kHz), based purely on their auditory abilities, the potential impacts are likely much less (or non-existent) than might be calculated in the quantitative assessment since these relevant factors are not taken into account.

For species that can detect sounds associated with high frequency active sources, based on the limited observational and experimental data on these and similar sound sources, the most likely impacts would be localized and temporary behavioral avoidance. These kinds of reactions, depending on their relative duration and severity, have been considered relatively low to moderately significant behavioral responses in the severity scaling assessment for marine mammals by Southall et al. (2007).

There is a low probability of some temporary hearing impacts and an even lower probability of direct physical harm for odontocete cetaceans to the loudest kinds of these high frequency sources over very localized areas (tens of meters) around the source. There is no published evidence for marine mammal stranding events as a function of high frequency active acoustic sources.

As a general conclusion, while some of the active acoustic sources used in SWFSC active acoustics during fisheries research surveys are likely to be detected by some marine species (particularly phocid pinnipeds and odontocete cetaceans), the potential for direct injury or hearing impairment is extremely low and the most likely responses involve temporary avoidance behavior. Consequently, and in a manner consistent with the current NMFS acoustic guidelines for defining Level B harassment of marine mammals from impulse noise sources, a quantitative framework was developed (Section 6.2) for assessing the potential impacts of SWFSC active acoustic sources used in fisheries research.

7.3 Surveys That May Take Marine Mammals by Level B Harassment

Current NMFS practice regarding exposure of marine mammals to sound is that cetaceans and pinnipeds exposed to impulsive sounds of 180 and 190 dB RMS or above, respectively, are considered to have been taken by Level A (i.e., injurious) harassment. Behavioral harassment (Level B) is considered to have occurred when marine mammals are exposed to sounds at or above 160 dB RMS or impulse sounds (e.g., impact pile driving) and 120 dB RMS for continuous noise (e.g., vibratory pile driving), but below injurious thresholds. For airborne noise, pinniped disturbance from haul-outs has been documented at 100 dB for pinnipeds in general, and at 90 dB for harbor seals. NMFS uses these levels as guidelines to estimate when harassment may occur.

Gear interactions causing mortality/serious injury on non-serious Level A harassment may occur in Center fisheries surveys described at 7.2; Level B harassment associated with use of active acoustics equipment may also occur in SWFSC fisheries surveys. These surveys are described at 1.6 and 7.2 and include the following. The SWFSC believes that the activities listed below: (1)

will have a negligible impact on the affected species or stocks of marine mammals (based on the likelihood that the activities will not affect annual rates of recruitment or survival); and (2) will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses.

7.3.1 Surveys conducted in the CCE that may take marine mammals by Level B harassment using category 2 acoustic sources

Coastal Pelagic Species (CPS) Survey (aka. Sardine Survey). Level B harassment associated with use of active acoustics may occur.

Juvenile Salmon Surveys. Level B harassment associated with use of active acoustics may occur.

Juvenile Rockfish Surveys. Level B harassment associated with use of active acoustics may occur.

CalCOFI Survey - Winter. There have been no gear interactions associated with this survey; however, Level B harassment associated with use of active acoustics may occur.

CalCOFI Survey - Spring. There have been no gear interactions associated with this survey; however, Level B harassment associated with use of active acoustics may occur.

CalCOFI Survey - Summer. There have been no gear interactions associated with this survey; however, Level B harassment associated with use of active acoustics may occur.

CalCOFI Survey - Fall. There have been no gear interactions associated with this survey; however, Level B harassment associated with use of active acoustics may occur.

PaCOOS Central CA (MBARI). There have been no gear interactions associated with this survey; however, Level B harassment associated with use of active acoustics may occur.

PaCOOS Northern CA, Humboldt State University (HSU). There have been no gear interactions associated with this survey; however, Level B harassment associated with use of active acoustics may occur.

Highly Migratory Species (HMS) Surveys. Level B harassment associated with use of active acoustics may occur.

Thresher Shark Surveys. Level B harassment associated with use of active acoustics may occur.

Marine Mammal Ecosystem Surveys. There have been no gear interactions associated with this survey; however, Level B harassment associated with use of active acoustics may occur.

White Abalone Survey. There have been no gear interactions associated with this survey; however, Level B harassment associated with use of active acoustics may occur.

Collaborative Optical Acoustical Survey Technology (COAST) Survey. There have been no gear interactions associated with this survey; however, Level B harassment associated with use of active acoustics may occur.

Habitat Surveys. Level B harassment associated with use of active acoustics may occur.

Small boats. There have been no gear interactions associated with this survey; however, Level B harassment associated with use of active acoustics may occur.

7.3.2 Surveys conducted in the ETP that may take marine mammals by Level B harassment using category 2 acoustic sources

Marine Mammal Ecosystem Surveys. There have been no gear interactions associated with this survey; however, Level B harassment associated with use of active acoustics may occur.

Highly Migratory Species (HMS) Surveys. There have been no gear interactions associated with this survey; however, Level B harassment associated with use of active acoustics may occur.

7.3.3 Surveys conducted in the AMLR that may take marine mammals by Level B harassment using category 2 acoustic sources

Antarctic Survey. There have been no gear interactions associated with this survey; however, Level B harassment associated with use of active acoustics may occur.

7.4 Collision and Strike

Commercial and Navy ship strikes of cetaceans can cause major wounds, which may lead to the death of the animal. An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or an animal just below the surface could be cut by a vessel’s propeller. The severity of injuries typically depends on the size and speed of the vessel (Knowlton and Kraus 2001; Laist et al. 2001; Vanderlaan and Taggart 2007).

Injuries and death to marine mammals resulting from ship collisions caused by vessels during SWFSC research are not likely to occur. The probability of vessel and marine mammal interactions occurring during Center operations is negligible due to the vessel's slow operational speed, which is typically 4 kts or less. Outside of operations, each vessel's cruising speed would be approximately 10 kts, which is generally below the speed at which studies have noted reported increases of marine mammal injury or death (Laist et al., 2001).

Even though the likelihood of a ship strike is very small, we reviewed the available literature to assess the possible impact of ship strike as it applies to SWFSC survey vessels. Williams and O’Hara (2009) summarized their modeling efforts to characterize ship strikes of large cetaceans in British Columbia. Their information on ship strikes was based on ship activity provided to them by the Canadian Coast Guard. Spatially-explicit statistical modeling and Geographic Information System visualization techniques identified areas of overlap between shipping activity and waters used by humpback, fin and killer whales. Areas of highest risk were far removed from areas with high concentrations of people, suggesting that many beach-cast

carcasses could go undetected. With few exceptions, high-risk areas were found in geographic bottlenecks, such as narrow straits and passageways. Although not included in the geographic area of the Williams and O'Hara study, the SWFSC survey area is such an area where large numbers of cargo ships transit the area each year, yet evidence for ship collisions are rare. Williams and O'Hara (2009) state that their risk assessments illustrate where ship strikes are most likely to occur, but cannot estimate how many strikes might occur. Propeller wounds on live killer whales were common in their study region, and fatal collisions have been reported in B.C. for all three species.

In an analysis of the probability of lethal mortality of large whales at a given speed, results of a study using a logistic regression model showed that the greatest rate of change in the probability of a lethal injury to a large whale, as a function of vessel speed, occurs between vessel speeds of 8.6 and 15 knots (Vanderlaan and Taggart, 2007). Across this speed range, they found that the chances of a lethal injury decline from approximately 80% at 15 knots to approximately 20% at 8.6 knots. Notably, it is only at speeds below 11.8 knots that the chances of lethal injury drop below 50% and above 15 knots the chances asymptotically increase toward 100%. Vessels associated with the SWFSC survey project will not be traveling at speeds that could be lethal to large whales, including killer whales. Vessels associated with this project when conducting scientific research will be travelling <4 kts and at 10 kts during transit. Considering this slow speed and the continual bridge watches/observation for marine mammals during all ship operations, the SWFSC believes that the vessels will be able to change course if any marine mammal is sighted in the line of vessel movement and avoid a strike. Even under the remote chance that a strike occurs by a Center vessel it is unlikely to result in mortality.

Jensen and Silber (2003) summarized large whale ship strikes world-wide from 1975 to 2003 and found that most collisions occurred in the open ocean involving large vessels. Commercial fishing vessels were responsible for four of 134 records (3%), and one collision (0.75%) was reported for a research boat, pilot boat, whale catcher boat, and dredge boat.

There is a potential for vessels to strike cetaceans while traveling at slow speeds. For example, a NOAA contracted survey vessel traveling at low speed while conducting multi-beam mapping surveys off the central California coast struck and killed a female blue whale in October 2009. Pace and Silber (2005) found that the probability of death or serious injury increased rapidly with increasing vessel speed. Specifically, the predicted probability of serious injury or death increased from 45% to 75% as vessel speed increased from 10 to 14 kts, and exceeded 90 percent at 17 kts. Higher speeds during collisions result in greater force of impact, but higher speeds also appear to increase the chance of severe injuries or death by pulling whales toward the vessel. Computer simulation modeling showed that hydrodynamic forces pulling whales toward the vessel hull increase with increasing speed (Clyne 1999; Knowlton et al. 1995). In the case of the Center's vessels, we anticipate that vessel collisions with marine mammals are unlikely, unpredictable events for which there are no preventive measures. That said, although these surveys have the potential for vessel collision, we anticipate no adverse effects on annual rates of recruitment or survival of the affected marine mammal species or stocks because of the slow speed of the vessels, the move on rule, and visual monitoring.

7.5 Conclusions Regarding Impacts of SWFSC Fisheries Research Activities on Marine Mammal Species and Stocks

As outlined in this and previous sections, there are several SWFSC fisheries research activities that have the potential to cause Level B harassment, Level A harassment (injury), and serious injury or mortality of marine mammals in the CCE, ETP and AMLR study areas. However, because of the low level of historical interactions relative to the abundance of affected populations, as well as the low level of predicted future takes associated with SWFSC surveys, the SWFSC believes its activities will not affect annual rates of recruitment or survival or the health and condition of the species or stock of the requested species.

- As discussed earlier in this Section, the requested annual takes associated with entanglement or hooking in SWFSC fisheries research surveys over the period 2013-2018 do not exceed any stock's PBR, and for most affected stocks the SWFSC take request is only a small fraction of PBR.

- In the AMLR study area, SWFSC expects due to the density of pinnipeds hauled out on ice in the southern hemisphere winter some animals will experience Level B harassment when the survey vessel passes during the course of conducting research operations. However, these events are expected to be infrequent and ephemeral. Further, cited studies on pinniped disturbance do not indicate that impacts would be of the magnitude are likely to result in population-level impacts.

- In the CCE, ETP and AMLR, SWFSC surveys use a variety of active acoustic systems. These are expected to result in Level B harassment for marine mammals in close proximity to the survey vessel and its active acoustic systems. However, as noted previously in this section exposure to active acoustics used on SWFSC fisheries research surveys is not expected to result in injury to animals and behavioral disturbance is expected to be relatively short lived and not result in population level impacts.

Based on this information the SWFSC believes that its activities: (1) will have a negligible impact on the affected species or stocks of marine mammals (based on the likelihood that the activities will not affect annual rates of recruitment or survival); and (2) will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses.

8. THE ANTICIPATED IMPACT OF THE ACTIVITY ON THE AVAILABILITY OF THE SPECIES OR STOCKS OF MARINE MAMMALS FOR SUBSISTENCE USE.

The proposed activity will take place in the California Current Ecosystem, the Eastern Tropical Pacific, and the Antarctic. There are no relevant subsistence uses of marine mammals implicated by this action in these areas.

9. THE ANTICIPATED IMPACT OF THE ACTIVITY ON THE HABITAT OF THE MARINE MAMMAL POPULATIONS AND THE LIKELIHOOD OF RESTORATION OF THE AFFECTED HABITAT.

9.1 Changes in Food Availability

Prey of marine mammals varies by species, season, and location and, for some, is not well documented. SWFSC fisheries research removals of commonly utilized species are few in number and small in size and typically do not include the size and age of fish taken in commercial fisheries or consumed by marine mammals. Research takes are distributed over a wide area because of the random sampling design covering large sample areas. Fish removals by research are unlikely to affect the spatial concentrations and availability of prey for these species.

There is some overlap in prey of marine mammals in the CCE and the species sampled and removed during SWFSC research surveys. The removal by SWFSC fisheries research, regardless of season and location is, however, trivial relative to that taken through commercial and sport fisheries. Sardines are sampled during research surveys to determine fecundity and only a kilogram or less is needed on any one tow to determine female fecundity. The total annual removal of sardine in the CCE, whether targeted or caught incidentally in other research surveys, is approximately 1000 kg. Similarly SWFSC removal of anchovy, jack mackerel, and other fish that are consumed by marine mammals is a very small amount. Also, SWFSC fisheries research surveys catch very short (a few cm) juvenile rockfish that are not known to be prey of marine mammals in the CCE. Thus, SWFSC fish sampling during research surveys in the CCE is unlikely to effect changes in prey type, distribution, or quantity available to any marine mammals. The resulting impact of the catch level on prey resources would, therefore, be negligible.

Table 9.1 shows the average SWFSC research catch of target species in the CCE over the past five years compared to the allowable biological catch (ABC) or other metric for commercial harvests of these species. Only species that have been taken in quantities over 100 kg per year are shown. In all cases for which there are fishing metrics for comparison, the SWFSC research catch represents much less than 0.1% of the ABC or other metric for the target species. For all target species in the CCE, mortality from SWFSC research surveys is considered minor on the population level.

The lack of impact of fisheries research takes is especially true for pinnipeds in the CCE. With pinniped populations increasing and ranges expanding in the Pacific Northwest, food availability does not appear to be a limiting factor (Baraff and Loughlin 2000). All the pinnipeds that occur within the CCE are opportunistic predators that consume a wide assortment of fish and squid, including managed species such as rockfish, hake, anchovy, sardine, herring, and squid (summarized in Baraff and Loughlin 2000). Given the comparatively low catch rate by SWFSC and broad prey base of pinnipeds in the area, the potential for impacts on prey availability is negligible.

Finally, in the CCE SWFSC research activities overlap with areas that have been identified as Essential Fish Habitat (EFH) for several Fishery Management Plans, including the Coastal Pelagic Species, Highly Migratory Species and Groundfish Fishery Management Plans. However, the proposed research is expected to result in impacts that are no more than minimal and temporary in nature to EFH. Mortality from captures in surveys is a potential impact, but as noted previously past levels of catch in SWFSC research surveys are very small and considered

negligible to their respective populations. For species that are targeted by commercial fisheries, mortality due to research surveys is much less than one percent of commercial harvest and is considered to have negligible adverse effects for all species. Further, these gears are deployed in pelagic habitats, which due to their physical characteristics, are not affected in the same way benthic habitats are when they are contacted by fishing and research gears. For these reasons SWFSC research will have effects that are minimal and temporary in nature on any areas identified as EFH for federally managed species.

Table 9.1. Relative size of SWFSC research catch in California Current Ecosystem compared to commercial allowable biological catch (ABC). Only target species taken in excess of 100 kg per year are shown.

Species	**Stock Status**	**Average SWFSC Research Catch per year (kg) (2007-2011 data)**	**ABC Commercial Catch Reference Value (kg)**	**Average SWFSC Research Catch, Compared to ABC Reference Value (percentage)**
Blue shark	Not overfished	900	N/A	N/A
Common Mola	Monitored	1,135	N/A	N/A
Common thresher shark	Not overfished	2,200	N/A	N/A
Jack mackerel	Monitored	392	31,000,000	0.0003%
Jacksmelt	Monitored	330	N/A	N/A
North Pacific albacore tuna	Not overfished	1,589	405,000,000	0.0039%
Northern anchovy	Monitored	1,201	34,750,000	0.0003%
Pacific hake (whiting)	Not overfished	1,045	2 million metric tons (mt) (2011 spawning biomass)	<0.0001%
Pacific mackerel	Not overfished	7,534	42,375,000	0.0178%
Pacific sardine	Not overfished	1,564	84,681,000	0.0019%
Shortbelly rockfish	Not overfished	412	23,500,000	<0.0001%
Shortfin mako shark	Not overfished	2,500	N/A	N/A
Spiny dogfish	Not overfished	189	1,584,000	0.0001%
Yellowtail rockfish	Not overfished	117	4,320,000	<0.0001%

SWFSC research activities remove very small quantities of fish from the ETP, primarily larval and juvenile size classes caught in plankton nets. Overall catch of fish is only about 1 kg per year which is negligible for all species in the ETP.

SWFSC AMLR surveys in the Antarctic monitor Antarctic krill and remove a small amount of post-larval and adult krill during sampling with trawl nets in order to estimate krill biomass around the South Shetland Islands and South Orkney Islands. The amount of krill biomass removed is an insignificant amount compared to the amount of Antarctic krill available. Krill is

consumed by numerous marine mammals including southern fur seals, balaenopterid whales, and others. Therefore the small amount of krill removed by SWFSC will not cause changes in prey distribution or availability to marine mammals and the impact of the removal is negligible to none. The SWFSC also conducts periodic bottom trawl surveys in the South Orkney Islands area to monitor the recovery of several finfish that were overfished in the 1970s and 1980s. These surveys are only conducted every two or three years as funds and charter vessels become available. During the last research survey, conducted during the 2008-2009 season, only nine species were harvested in totals greater than 100 kg (Table 9.2). Although no commercial fisheries metrics have been determined for these species for many years, given the very small catches of all species and the periodic frequency of the finfish survey, the effects of SWFSC research mortality on fish species in the Antarctic can be considered negligible.

The overall effects of SWFSC research activities on fish populations found in the CCE, ETP, and AMLR are minor since they are of negligible magnitude and intensity, short-term in duration, of localized geographic extent, and are unlikely to result in measurable population change.

Table 9.2. SWFSC research catch in the Antarctic research area during bottom trawl surveys. No information is available on current stock size or status for any species. Data from Van Cise (2009).

Species	**SWFSC Research Catch per survey (kg) (2008-2009 data)**
Blackfin icefish	1,920
Mackerel icefish	575
Ocellated icefish	618
Humped rockcod	2,628
Grey rockcod	505
Black rockcod	110
South Georgia icefish	656

9.2 Changes in Physical Habitat

Physical impacts to seafloor habitat would be principally limited to the AMLR, which is the only SWFSC research area where bottom-contact trawl equipment is used during the course of research surveys (see Table 1.1). Such surveys would occur once every three years and have historically involved 75 bottom trawl hauls per survey.

Fishing gear that contacts the seafloor can physically damage seafloor habitat. Physical damage may include furrowing and smoothing of the seafloor as well as the displacement of rocks and

boulders, and such damage can increase with multiple contacts in the same area (Morgan and Chuenpagdee 2003; Stevenson et al. 2004). Other survey equipment that contacts the seafloor, such as sensors and samplers, could cause localized physical damage to benthic habitats; but the effects of such equipment on benthic habitat would be limited to a very small area because this equipment is not usually dragged along the seafloor.

In general, physical damage to the seafloor recovers within 18 months through the action of water currents and natural sedimentation, with the exception of rocks and boulders which may be permanently displaced (Stevenson et al. 2004). Silt, sand, clay, and gravel are abundant at particular sites within each research area. With the exception of rock and boulder displacement, any physical impacts to benthic habitat resulting from SWFSC survey activities would be expected to recover within 18 months.

Bottom-contact fishing gear can also increase turbidity and alter the chemical composition of water near the seafloor. However, these effects would be short-term, minor in magnitude, and limited in areal extent.

The area of benthic habitat affected by SWFSC research each year would be a very small fraction of the total of the research areas. Considering the small area affected and the limited magnitude of the physical effects, the overall effects of surveys on benthic habitat in each of the SWFSC research areas would be minor.

10. ANTICIPATED IMPACT OF LOSS OR MODIFICATION OF THE HABITAT ON MARINE MAMMAL POPULATIONS

As stated in response to Question 9 above, the proposed activities are not anticipated to result in impacts to marine mammal habitats or to the food resources on which they depend. Therefore, we do not expect any long-term adverse impacts to marine mammals resulting from loss of or modification to marine mammal habitats as a result of the proposed activities.

11. THE AVAILABILITY AND FEASIBILITY (ECONOMIC AND TECHNOLOGICAL) OF EQUIPMENT, METHODS, AND MANNER OF CONDUCTING SUCH ACTIVITY OR OTHER MEANS OF EFFECTING THE LEAST PRATICABLE ADVERSE IMPACT UPON THE AFFECTED SPECIES OR STOCKS, THEIR HABITAT, AND ON THEIR AVAILABILITY FOR SUBSISTENCE USES, PAYING PARTICULAR ATTENTION TO ROOKERIES, MATING GROUNDS, AND AREAS OF SIMILAR SIGNIFICANCE

Over the past five years, the SWFSC has invested significant time and effort in identifying technologies, practices and equipment to minimize the impact of the proposed activities on marine mammal species and stocks and their habitat. These efforts have resulted in the consideration of several mitigation measures, most of which SWFSC has determined to be feasible and has implemented during 2009 and 2010 as a standard part of sampling protocols (Hewitt 2009). These measures include the “move-on rule,” protected species visual watches and use of acoustic pingers on trawl gear, as well as current implementation of a marine mammal excluder device in Nordic 264 trawls and planned design and implementation of this device in modified Cobb trawls.

In addition, SWFSC is conducting an evaluation of oceanographic conditions and other factors that might contribute to interactions in order to avoid those conditions to minimize future takes. SWFSC staff have been using predictive machine-learning methods (classification trees) for various applications, including a recently published paper (Carretta and Barlow 2011) examining bycatch rates of cetaceans and pinnipeds in a commercial swordfish and thresher shark drift gillnet fishery in relation to the use of acoustic pingers. Using similar methods, the SWFSC plans to examine research trawl data for any link between trawl variables and observed marine mammal bycatch. SWFSC staff are currently reviewing historical fisheries research data to determine whether sufficient data exist for such an analysis. Some of the variables SWFSC is currently considering for this analysis are: moon phase, sky cover, pinger presence, trawl speed, vessel sonar use during trawl, use of deck lights, etc. SWFSC is exploring patterns in past marine mammal bycatch in its fisheries research surveys to better understand what factors might increase the likelihood of take. If take patterns emerge, the SWFSC will focus future research on reducing or eliminating high-risk factors in ways that enable scientifically important surveys to continue with minimized environmental impact.

11.1 Trawl Surveys

11.1.1 Monitoring methods

If marine mammal observers are not present and already conducting watches, marine mammal watches will be initiated 30 minutes prior to arrival on station to determine if these species are near the proposed trawl set location. When observers are not present the Officer on Deck (OOD), Chief Scientist (CS), and crew standing watch will visually scan for marine mammals during all daytime operations. Marine mammal watches will be conducted using any binocular or monocular sighting instrument, with a means to estimate distance to infringing protected species during daytime, and the best available means of observation during nighttime observations. This typically occurs during transit leading up to arrival at the sampling station because of another mitigation measure intended to reduce the risk of attracting curious marine mammals, immediate deployment of trawl gear upon arriving at station. However, in some cases it may be necessary to conduct a bongo plankton tow prior to deploying trawl gear. In these cases, the visual watch will continue until trawl gear is ready to be deployed.

11.1.2 Operational procedures

"Move-On" Rule. If marine mammals or other protected species are sighted within 1 nm of the planned set location in the 30 minutes before setting the gear, the vessel will transit to a different section of the sampling area to maintain a minimum set distance of 1 nm. If, after moving on, protected species remain within the 1 nm exclusion zone, the CS or watch leader may decide to move again or to skip the station. However, SWFSC acknowledges that the effectiveness of visual monitoring may be limited depending on weather and lighting conditions, and it may not always be possible to conduct visual observations out to 1nm. CS or watch leader will determine the best strategy to avoid potential takes of marine mammals based on the species encountered, their numbers and behavior, position and vector relative to the vessel, and other factors. For instance, a whale transiting through the area off in the distance might only require a short move from the designated station while a pod of dolphins gathered around the vessel may require a longer move from the station or possibly cancellation if they follow the vessel. In any case, no

gear will be deployed if marine mammals or other protected species have been sighted within 1 nm of the planned set location during the 30-minute watch period.

In many cases, trawl operations will be the first activity undertaken upon arrival at a new station, in order to reduce the opportunity to attract marine mammals to the vessel. However, in some cases it will be necessary to conduct plankton tows prior to deploying trawl gear in order to avoid trawling through extremely high densities of jellies and similar taxa that are numerous enough to severely damage trawl gear.

Once the trawl net is in the water, the OOD, CS, and/or crew standing watch will continue to monitor the waters around the vessel and maintain a lookout for marine mammal presence as far away as environmental conditions allow. If marine mammals are sighted before the gear is fully retrieved, the most appropriate response to avoid incidental take will be determined by the professional judgment of the CS, watch leader, OOD and other experienced crew as necessary. This judgment will be based on his/her past experience operating gears around marine mammals and SWFSC training sessions that will facilitate dissemination of Chief Scientist / Captain expertise operating in these situations (e.g., factors that contribute to marine mammal gear interactions and those that aid in successfully avoiding these events). These judgments take into consideration the species, numbers, and behavior of the animals, the status of the trawl net operation (net opening, depth, and distance from the stern), the time it would take to retrieve the net, and safety considerations for changing speed or course.

If trawling operations have been suspended because of the presence of protected species, the vessel will resume trawl operations (when practicable) only when these taxa have not been sighted within 1 nm of the planned set location. This decision is at the discretion of the officer on watch and is dependent on the situation.

Care will be taken when emptying the trawl to avoid damage to protected species that may be caught in the gear but are not visible upon retrieval. The gear will be emptied as quickly as possible after retrieval in order to determine whether or not protected species are present.

11.1.3 Tow duration

Standard tow durations of not more than 30 minutes at the target depth have been implemented, excluding deployment and retrieval time (which may require an additional 30 minutes depending on depth), to reduce the likelihood of attracting and incidentally taking marine mammals and other protected species. These short tow durations decrease the opportunity for curious marine mammals to find the vessel and investigate.

Trawl tow distances are less than 3nm, which should reduce the likelihood of attracting and incidentally taking marine mammals. Typical tow distances are 1-2 nm, depending on the survey and trawl speed.

11.1.4 Marine mammal excluder devices

Whenever possible, trawl nets will be fitted with marine mammal excluder devices (see Appendix A for detailed description) to allow marine mammals caught during trawling operations an opportunity to escape. These devices enable target species to pass through a grid or

mesh barrier and into the codend while preventing the passage of marine mammals, which are ejected out through an escape opening or swim back out of the mouth of the net.

Two types of trawls are used in SWFSC surveys: the Nordic 264 and the Modified Cobb trawl. Currently, all Nordic 264 nets are outfitted with excluder devices developed for the SWFSC (Appendix A). Most marine mammals caught during SWFSC operations have been caught in surveys using this type of net before the excluder devices were installed.

Modified Cobb trawls are considerably smaller than Nordic rope trawls, are fished at slower speeds, and have a different shape and functionality than the Nordic 264. Due to the smaller size of the modified Cobb, this gear does not yet have marine mammal excluder devices but research and design work are currently being performed to develop effective excluders that will not appreciably affect the catchability of the net and therefore maintain continuity of the fisheries research data set. Successful development and implementation of excluder devices for Modified Cobb trawls is expected to occur within the 5 year timeframe of this EA and is therefore included as part of the Preferred Alternative.

A reduction in target salmon catch rates is an issue that has arisen from preliminary analyses conducted by NWFSC when the MMED is used in Nordic 264 gear. Although NWFSC sample sizes are small, the preliminary results have cast some doubt as to whether the MMED would be suitable for surveys with a primary objective of estimating abundance (whether they use the Nordic 264 or the Modified Cobb gears). If data collected by NWFSC and SWFSC during testing of the MMED in Modified Cobb trawl gear continues to indicate reduce catch rates SWFSC would expect to continue testing to explore whether it is possible to calculate reliable conversion factors to equate catches when using the MMED to surveys when it was not. If this is not possible, then implementation of the MMED in these surveys may also not be possible without compromising one of their primary objectives.

11.1.5 Acoustic pinger devices

Pingers will be deployed during all trawl operations and all types of trawl nets. Two to four pingers will be placed along the footrope and/or headrope to discourage marine mammal interactions.

Acoustic pingers are underwater sound emitting devices that decrease the probability of entanglement or unintended capture of marine mammals (see Appendix A). Acoustic pingers have been shown to effectively deter several species of small cetaceans from becoming entangled in gillnets and driftnets (e.g., no observed catches of beaked whales after pingers implemented reported in Carretta and Barlow 2011; 50% reduction in common dolphin entanglement reported in Cameron and Barlow 2003; 60% reduction in harbor porpoise bycatch reported in Palka et al. 2008). While their effectiveness has not been tested on trawls, pingers are believed to represent a mitigation measure worth pursuing given their effectiveness in other gears.

Pingers are manufactured by STM Products, model DDD-03H. Pingers remain operational at depths between 10 meters (m) and 200 m. Tones range from 100 microseconds to seconds in duration, with variable frequency of 5-500 kilohertz (kHz). Maximum sound pressure level of 176 decibels (dB) root mean squared referenced to 1 micropascal at 1 m at 30-80 kHz.

11.1.6 Gear maintenance

The vessel's crew will clean trawl nets prior to deployment to remove prey items that might attract marine mammals. Catch volumes are typically small, with every attempt made to collect all organisms caught in the trawl.

11.1.7 Speed limits and course alterations

The vessel's speed during active sampling will rarely exceed 5 knots. Typical speeds during trawling are 2-4 knots. Transit speeds vary from 6-14 knots, but average 10 knots.

As noted above, if marine mammals are sighted within 30 minutes prior to deployment of the trawl net, the vessel will be moved away from the animals to a new station.

At any time during a survey or in transit, any crew member standing watch or dedicated marine mammal observer that sights marine mammals that may intersect with the vessel course will immediately communicate their presence to the bridge for appropriate course alteration or speed reduction as possible to avoid incidental collisions.

11.2 Longline Gear

11.2.1 Visual surveillance by OOD, CS, and crew

Longline surveys are conducted aboard smaller vessels and with fewer crew than trawl surveys but the pre-set monitoring procedures for longline gear are the same as described for trawling gear. No longline sets are made if marine mammals or other protected species have been seen within 1nm of the planned set location during the past 30 minutes, the move-on rule is implemented if these taxa are present, and the CS, watch leader, and OOD uses professional judgment to minimize the risk to protected species from potential gear interactions.

The only exception is when California sea lions are sighted during the watch period prior to setting longline gear. For this species only, longline gear may be set if a group of 5 or fewer animals is sighted within 1 nm of the planned set location; when groups of more than 5 sea lions are sighted within 1 nm deployment of gear would be suspended. This exception has been defined considering the rarity of past interactions between this gear and CA sea lions and in order to make this mitigation measure practicable to implement. Without it, given the density of CA sea lions in the areas where longline surveys are conducted, SWFSC believes implementing the move-on rule for a single animal would preclude sampling in some areas and introduce significant bias into survey results. Groups of 5 California sea lions or greater is believed to represent a trigger for the move-on rule that would allow sampling in areas where target species can be caught without increasing the number of interactions between marine mammals and research longline gear.

11.2.2 Operational procedures

SWFSC longline sets are conducted with drifting pelagic or anchored gear marked at both ends with buoys (Appendix A). Typical soak times are 2-4 hours, but may be as long as 8 hours when targeting swordfish (measured from the time the last hook is in the water to when the first hook is brought out of the water).

SWFSC longline protocols specifically prohibit chumming (releasing additional bait to attract target species to the gear). However, spent bait may be discarded during gear retrieval while gear is still in the water. In the experience of SWFSC, this practice increases survey efficiency and has not resulted in interactions with marine mammals. Scientist observations indicate pinnipeds do not gather immediately aft of the survey vessel as a result of discarding spent bait. However, if protected species interactions with longline gear increase or if SWFSC staff observe that this practices is contributing to protected species interactions it will revisit this practice and consider the need to retain spent bait until no gear remains in the water.

If protected species are detected while longline gear is in the water, the CS, watch leader and OOD exercise similar judgments and discretion to avoid incidental take of these taxa with longline gear as described for trawl gear. The species, number, and behavior of the marine mammals are considered along with the status of the ship and gear, weather and sea conditions, and crew safety factors. The CS, watch leader and OOD will use professional judgment and discretion to minimize risk of potentially adverse interactions with protected species during all aspects of longline survey activities.

If protected species are detected during setting operations and are considered to be at risk, immediate retrieval or halting the setting operations may be warranted. If setting operations have been halted due to the presence of protected species, resumption of setting will not begin until they have not been observed within 1 nm of the set location.

If marine mammals are detected during retrieval operations and are considered to be at risk, haul-back may be postponed until the CS, watch leader or OOD determines that it is safe to proceed. SWFSC anticipates that additional information on practices to avoid marine mammal – longline gear interactions can be gleaned from protected species training sessions and more systematic data collection standards being implemented by SWFSC.

11.3 AMLR Bottom Trawl Surveys

The SWFSC has no historical interactions with marine mammals in bottom trawl gear used in the Scotia Sea Antarctic ecosystem. Researchers conduct visual and acoustic surveys prior to deploying bottom trawl gear to assess the bathymetry and whether marine mammals are present in the area. These visual and acoustic surveys have resulted in very few detections of marine mammals during trawling operations, possibly because there is infrequent spatial-temporal overlap between bottom trawl surveys and significant densities of protected species. This may help to explain the absence of marine mammal interactions with this gear during past AMLR surveys. Visual and acoustic monitoring will continue as a regular part of future bottom trawl surveys in the AMLR study area, and if detections increase at some point in the future that may indicate a higher potential for marine mammal interactions.

11.4 Deep-set Buoy Gear Surveys

SWFSC does not anticipate deep-set buoy surveys to results in any marine mammal takes, and these surveys have resulted in no past takes. While no formal mitigation measures have been implemented, it should be noted the gear is specifically designed to minimize risk of protected

species interactions. For example, minimal visual and/or sensory attractants to the gear in the upper water column (e.g., no surface chumming or offal discharge, no visual cues from multiple hooks that are sinking to depth slowly) SWFSC believes minimizes hooking and entanglement risk. In addition, this gear features a single weighted monofilament line with virtually no slack or sag that is expected to minimize entanglement risk.

11.5 Sablefish Life History Surveys

These surveys have not historically taken marine mammals, and SWFSC does not anticipate that they will in the future. As such, no formal mitigation measures have been implemented for this survey/gear. However, factors that minimize future take likelihood include this survey's extremely small scale and low level of effort (approximately 200 hooks per month). In addition, because this gear fishes at the bottom it poses a significantly reduced risk of hooking and entanglement relative to surface gears.

11.6 Plankton Nets, Oceanographic Sampling Devices, Video Camera and ROV Deployments

The SWFSC deploys a wide variety of gear to sample the marine environment during all of their research cruises. These types of gear are not considered to pose any risk to protected species and are therefore not subject to specific mitigation measures. However, the OOD and crew monitor for any unusual circumstances that may arise at a sampling site and use their professional judgment and discretion to avoid any potential risks to protected species during deployment of all research equipment.

11.7 Handling Procedures for Incidentally Captured Individuals

The SWFSC is implementing a number of handling, data collection and reporting protocols to minimize potential harm to protected species that are incidentally taken during the course of fisheries research activities. In general, protocols have already been prepared for use on commercial fishing vessels. Because many parallels exist between commercial fishing operations and SWFSC fisheries research, SWFSC is adopting these protocols for use on its surveys on NOAA and charter vessels. In addition to the benefits implementing these protocols are believed to have on the animals through increased post-release survival, SWFSC believes adopting these protocols for data collection will also increase the information on which "serious injury" determinations are based and improve scientific knowledge about protected species that interact with fisheries research gears and the factors that contribute to these interactions.

Protected Species Handling
In general, following a "common sense" approach to handling protected species will present the best chance of minimizing injury to the animal and of decreasing risks to scientists, officers and crew. There are inherent safety concerns associated with handling/disentangling protected species, so using judgment and ensuring human safety is paramount.

SWFSC researchers will be provided with the PIFSC guide to "Identification, Handling and Release of Protected Species" (Appendix B.1) for more specific guidance on protected species

handling. In addition to including this guide, Appendix B.1 contains data forms SWFSC will use for protected species interactions. The guide demonstrates how to identify different species, bring an individual aboard a vessel, assess the level of consciousness, remove fishing gear, return an individual to water and log activities pertaining to the interaction. The handling guide for marine mammals demonstrates how to handle, disentangle, and also record interaction activities for small whales and dolphin encounters.

For longline surveys, SWFSC will record interaction information on either the Marine Mammal Biological Data Form prepared by the Pacific Islands Regional Office Longline Observer Program (Appendix B.2). To aid in serious injury determinations and comply with the current NMFS Serious Injury Guidelines, researchers will also answer a series of supplemental questions on the details of marine mammal interactions. Forms and supplemental questions are provided in (Appendix B.3). For trawl surveys, the SWFSC will follow the same protocol as mentioned above for longline surveys.

Finally, for any marine mammals that are killed during fisheries research activitites, scientists will collect data and samples pursuant to the SWFSC MMPA and ESA research and salvage permit and to the "Detailed Sampling Protocol for Marine Mammal and Sea Turtle Incidental Takes on SWFSC Research Cruises" (Appendix B.4). Although SWFSC is taking several significant measures to avoid incidentally killing marine mammals during the course of its fisheries research it also recognizes the scientific value of collecting samples from these animals to learn more about wild marine mammal populations.

12. WHERE THE PROPOSED ACTIVITY WOULD TAKE PLACE IN OR NEAR A TRADITIONAL ARCTIC SUBSISTENCE HUNTING AREA AND/OR MAY AFFECT THE AVAILABILITY OF A SPECIES OR STOCK OF MARINE MAMMAL FOR ARCTIC SUBSISTENCE USE, THE APPLICANT MUST SUBMIT EITHER A "PLAN OF COOPERATION (POC)" OR INFORMATION THAT IDENTIFIES WHAT MEASURES HAVE BEEN TAKEN AN/OR WILL BE TAKEN TO MINIMIZE ANY ADVERSE EFFECTS ON THE AVAILABILITY OF MARINE MAMMALS FOR SUBSISTENCE USE.

Not applicable. The proposed activity will take place in the California Current Ecosystem, the Eastern Tropical Pacific, and the Antarctic, and no activities will take place in or near a traditional Arctic subsistence hunting area. There are no relevant subsistence uses of marine mammals implicated by this action.

13. MONITORING AND REPORTING PLAN

13.1 Monitoring

Marine mammal watches are now a standard part of conducting fisheries research activities, particularly those that use gears (e.g., longlines and mid-water trawls) that are known to interact with marine mammals or that we believe have a reasonable likelihood of doing so in the future. Marine mammal watches are conducted in two ways. First, watches are conducted by watch-standers (those navigating the vessel and other crew) at all times when the vessel is being operated. The primary focus for this type of watch is to avoid striking marine mammals and to generally avoid navigational hazards. At present, these watch-standers do not record or report to

the scientific party data on marine mammal sightings except when gear is being deployed or retrieved. In most cases, watches in the first category are not done by dedicated staff; these personnel may have other duties associated with navigation and other vessel operations.

Second, marine mammal watches and monitoring occur for 30 minutes prior to deployment of gear, and they continue until gear is brought back on board, for longlines and mid-water trawl gear. Watches in this category are done by dedicated scientists with no other responsibilities during the watch period. If marine mammals are sighted within 1 nm of the planned set location then the sampling station is either moved or canceled. Watch-standers record the estimated species and number of animals present and their behaviors. This information can be valuable in understanding whether some species may be attracted to vessels or gears.

13.2 Reporting

As is normally the case, SWFSC will coordinate with the local Southwest Regional Stranding Coordinator and the NMFS Stranding Coordinator for any unusual marine mammal behavior and any stranding, beached live/dead, or floating marine mammals that are encountered during field research activities. In addition, Cruise Leaders provide reports to SWFSC leadership and to the Office of Protected Resources by event, survey leg and cruise. As a result, when marine mammals interact with the gear, whether killed or released alive, a report provided by the Cruise Leader will fully describe any observations of the animals, the context (vessel and conditions), decisions made and rationale for decisions made in vessel and gear handling. The circumstances of these events are critical in enabling SWFSC and the Office of Protected Resources to better evaluate the conditions under which takes are most likely occur. We believe in the long term this will allow us to avoid some of these situations in the future.

NOAA Fisheries has established a formal incidental take reporting system, the Protected Species Incidental Take (PSIT) database, requiring that incidental takes of protected species be reported within 48 hours of the occurrence. The PSIT generates automated messages to agency leadership and other relevant staff and alerts them to the event and that updated information describing the circumstances of the event have been inputted into the database. The PSIT and Chief Scientist reports represent not only a valuable real-time reporting and information dissemination tools, but also serve as an archive of information that could be mined at later points in time to study why takes occur, by species, gear, etc. Ultimately, SWFSC would hope that a single reporting tool capable of disseminating and archiving all relevant details of protected species interactions during fisheries research activities could be developed and implemented. Until that time, SWFSC will both input data into the PSIT database and submit detailed event reports.

A final and equally important component of reporting being implemented by SWFSC will facilitate serious injury (SI) determinations for marine mammals that are released alive. As discussed in Section 11, SWFSC is requiring that scientists complete data forms (already developed and used by commercial fisheries observer programs) and address supplemental questions, both of which have been developed to aid in SI determinations. SWFSC understands the critical need to provide scientists who make serious injury determinations with as much relevant information as possible about marine mammal interactions to inform their decisions.

14. COORDINATING RESEARCH TO REDUCE AND EVALUATE INCIDENTAL TAKE

NOAA Fisheries and the SWFSC provide a significant amount of funding and support to marine research. Specifically, NOAA Fisheries provides significant funding annually to universities, research institutions, Federal laboratories, private companies, and independent researchers around the world to study marine mammals. The SWFSC actively participates on Take Reduction Teams and in Take Reduction Planning, and it conducts a variety of studies, convenes workshops and engages in other activities aimed at developing effective bycatch reduction technologies, gears and practices. For example, the studies conducted by staff in the SWFSC Protected Resources Division have led to use of pingers in commercial fisheries to reduce beaked whale bycatch, development of alternative gears to reduce vaquita bycatch in Mexican shrimp fisheries, refinement of cetacean-habitat models to reduce ship strikes on the U.S. West Coast, and advances in circle hook technology to reduce protected species bycatch in South American longline fisheries. In addition, we have convened a number of expert workshops to address global bycatch issues, including in the purse-seine fishery for tuna in the eastern tropical Pacific and in West African nations to reduce bycatch.

Notably, in 2008, the SWFSC convened a workshop to evaluate and recommend mitigation measures in response to the sharp increase in marine mammal takes that it experienced in fisheries research activities earlier that year. In addition, oceanographic conditions of the time and location of interactions were evaluated to determine whether the events coincided with predictable oceanographic features. Workshop participants included SWFSC fisheries researchers and experts in bycatch reduction from the Protected Resources Division. As a result of this workshop, the SWFSC implemented a number of mitigation measures in 2009 and 2010 in fisheries research activities that use longline and trawl gears. Those include use of marine mammal watches, acoustic pingers, a marine mammal excluder device and others. The SWFSC will continue to foster this research to further reduce takes of protected species in both its operations and in commercial fisheries to the lowest practicable levels.

The SWFSC has a keen awareness that an increase in fisheries research effort is expected to result in more marine mammal takes over time. For this reason and because of resource limitations, the SWFSC maximizes efficient use of the charter and NOAA ship time it can attain. We also engage in operational plans with the Northwest and Pacific Islands Fisheries Science Centers in order to clearly delineate our respective research responsibilities and to ensure we avoid research gaps and duplication of effort between Centers. In short, the SWFSC is on the water conducting fisheries research activities no more often than is necessary to fulfill its responsibilities to provide scientific advice to the Southwest Regional Office, the Pacific Fisheries Management Council, and other relevant domestic and international management bodies.

Finally, as referenced in several earlier sections, SWFSC plans to implement an adaptive management approach to evaluating its actual takes on an annual basis and continuing to revisit its mitigation measures in light of take events to ensure they are appropriate. In consultation with Office of Protected Resources, if actual takes exceed those estimated in Section 6 of this

application SWFSC may deem it necessary to change its current mitigation strategy to improve efficacy or to implement additional measures to reduce take levels.

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APPENDIX A – SWFSC Research Gear and Vessel Descriptions

APPENDIX B – Data collection forms, protocols and supplemental questions to facilitate serious injury determination

Appendix D

Marine Mammal and Sea Turtle Handling and Data Collection for Southwest Fisheries Science Center Fisheries Research Vessels

Contents:

1. NOAA Fisheries Service Pacific Islands Region - Identification, Handling, and Release of Protected Species.
2. Marine Mammal and Sea Turtle Biological Data Forms from the PIRO Longline Observer Program.
3. Supplemental Questions for Marine Mammal Biological Data Form.
4. Detailed Sampling Protocol for Marine Mammal and Sea Turtle Incidental Takes on SWFSC Research Cruises

Science, Service, Stewardship

NOAA FISHERIES SERVICE

Pacific Islands Region

Identification, Handling, and Release of Protected Species

Sea Turtles

Marine Mammals

Seabirds

U.S. Department of Commerce | National Oceanic and Atmospheric Administration | National Marine Fisheries Service

Sea Turtle Handling Guidelines

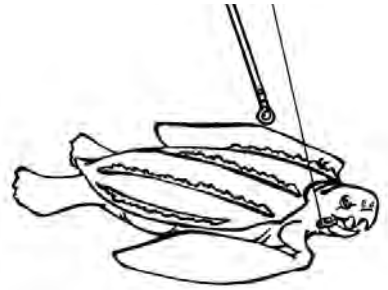
STEP 1:

Determine if the turtle is small enough to bring aboard.

Remember to use gaffs only on fishing gear, not on turtles

IF TURTLE IS TOO BIG TO BRING ABOARD:

- Bring turtle close to boat by pulling gently on the line.
- Determine if turtle is hooked or entangled, and choose the proper tools to remove as much fishing gear as possible from the turtle – including the hook.
- If turtle is hooked and the hook is visible just inside the mouth or on the body, use long handled dehooker to remove hook. See **Step 3** for instructions.
- If turtle is entangled or the hook is deep inside mouth or throat and cannot be removed, use a long-handled line cutter to cut all lines.
- Skip to **Step 5**.



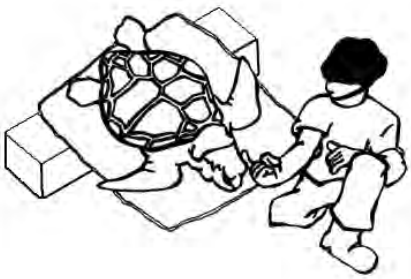
IF TURTLE IS SMALL ENOUGH TO BRING ABOARD:

- Use dip net to bring turtle aboard.
- Do not bring turtle aboard by pulling on fishing line or by grabbing the eye sockets.
- It may be helpful to grab the front flippers close to the turtle's body when using the net to help bring it aboard.
- Go to **Step 2**.

STEP 2:

After the turtle has been brought aboard, determine if it is alive or appears dead.

A turtle that looks dead may just be very tired, and can regain strength with your help.



UNCONSCIOUS TURTLE - inactive and appears dead

- Keep the turtle on a tire in a secure, shaded place away from activity.
- Remove fishing gear using instructions in **Step 3**.
- Place turtle on its belly and elevate back flippers at least 6 inches for at least 4 hours to help remove water from its lungs while recovering.
- Place a wet towel on turtle. Do not cover nostrils. Occasionally wet turtle with a deck hose. Avoid spraying turtle's head.
- Perform a reflex test every 3 hours, by gently touching corner of eye and lightly pulling on tail. Movement may indicate the turtle is recovering.
- If there is no movement from reflex tests after at least 4 hours, but no more than 24 hours, release the turtle to the ocean using methods in **Step 4**.

CONSCIOUS TURTLE - active or awake

- Keep the turtle on a tire in a secure, shaded place away from activity.
- Remove fishing gear using instructions in **Step 3**.
- Release the turtle using methods in **Step 4**. You do not have to wait 4 or more hours before release.

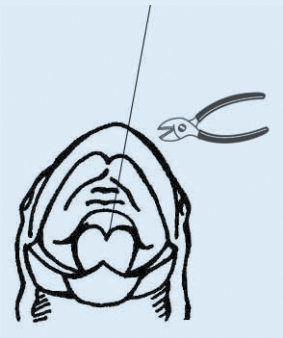
Questions? Call Pacific Islands Regional Office, Sustainable Fisheries Division at (808) 944-2200

When to Leave Hooks in Place.

It is normally best to remove all fishing gear from the turtle, but there are situations when the gear should not be removed. Leave hook in place and cut line as close as possible to hook if:

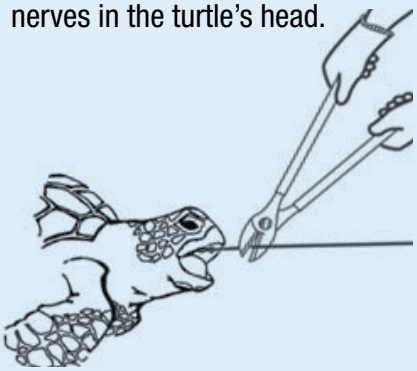
The hook has been swallowed.

Forcing a dehooking device down a turtle's throat may worsen its injuries or cause an infection.



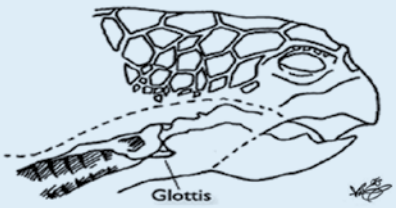
The hook has penetrated the roof of the mouth.

Trying to remove this hook may cause damage to the organs and nerves in the turtle's head.



The hook is in the glottis.

The glottis is located at the back of the mouth and covers the airway. Attempting to remove hooks from the glottis may cause further damage and prevent the turtle from covering its airway during dives.

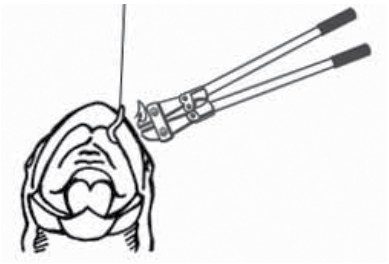


STEP 3:

Methods for removing fishing gear from a hooked turtle.

TURTLE HOOKED WITH BARB EXPOSED

1. Using bolt cutters, remove the barb of the hook.
2. Once barb has been clipped off, back the hook out to remove it.



TURTLE HOOKED WITH BARB EMBEDDED

1. Follow instructions on using a pig-tail dehooker.
2. If hook cannot be removed, cut line as close as possible to hook.

TURTLE IS HOOKED, BUT YOU CANNOT SEE HOOK

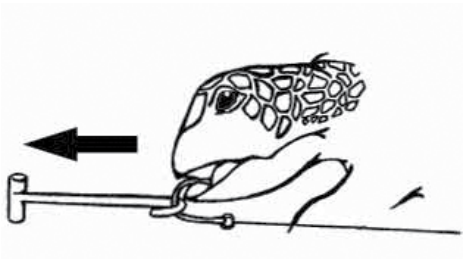
- Cut fishing line as close as possible to hook without pulling hard on line.

TURTLE ENTANGLED IN FISHING LINE

- Use monofilament or wire cutters to remove all fishing line from turtle.

IF BOLT CUTTERS ARE NOT AVAILABLE

1. Place a J-style dehooker or similar hand-held tool on the leader to cut hook. A short handled pig-tail dehooker can also be used. To get dehooker on the line, refer to pig-tail dehooker instructions.
2. Slide device down the leader to the bottom of the hook.
3. Pull the line so it is opposite from the handle of the dehooker.
4. Keep the line tight, then pull and twist dehooker to remove hook.



Dehooking a turtle using a pig-tail dehooker with your right hand:

Place the dehooker at 90^0 to the line with the end of the pig-tail facing up.

Draw the dehooker back towards you like a bow and arrow until loop pulls on line, maintaining contact between the dehooker and the line.

Rotate the dehooker 1/4 turn clockwise. (The line should be inside the curl of dehooker)

Run the dehooker down the line until it engages the bottom bend of the hook.

Pull the line tight and parallel to the dehooker. Give quick thrusts to remove the hook.

Keep line tight, so the hook remains inside the curl of dehooker, until hook is clear of the turtle.

Circle Hooks

When using the long-handled pig-tail dehooker on a turtle in the water, it may be easier to remove circle hooks if the line is not parallel to the dehooker's handle once the dehooker is on the line.

- While keeping the line tight, separate the line and dehooker, then try to push and twist the dehooker to dislodge the hook. This may work better than quick thrusts.
- If you cannot remove the hook, cut line as close as possible to the hook.
- If turtle is aboard, try to rotate the hook back out by using the line or pliers before using the dehooker. This may help remove the hook.

STEP 4:

Carefully return turtle to water.

1. Stop vessel, and take engine out of gear.
2. Release the turtle away from any fishing gear in the water.
3. Gently put turtle in the water, head-first.
4. Make sure turtle is clear of vessel before motoring away.

STEP 5:

Record the interaction in your logbook.

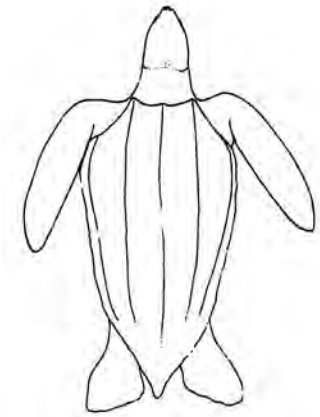
1. Record the identified species.
2. Write down how much fishing gear remained on turtle after release.
3. Record any tag numbers observed on turtle.

Photo courtesy of Steve Beverly

Questions? Call Pacific Islands Regional Office, Sustainable Fisheries Division at (808) 944-2200

LEATHERBACK

- Dark, leathery skin covers body and shell
- No scutes or scales like other turtles
- 5-7 head to tail ridges on back
- Adults are much larger than other turtles



Hard Shell Turtles

GREEN

- 1 pair of prefrontal scales
- 5 central scutes
- 4 pairs of lateral scutes
- 4 inframarginal scutes on each side

TOP VIEW OF HEAD

TOP VIEW

BOTTOM VIEW OF TURTLE

Prefrontal Scales
Central Scutes
Lateral Scutes
Inframarginal Scutes

LOGGERHEAD

- 2 pairs of prefrontal scales
- 5 central scutes
- 5 pairs of lateral scutes
- 3 inframarginal scutes on each side

HAWKSBILL

- 2 pairs of prefrontal scales
- 5 central scutes
- 4 pairs of overlapping lateral scutes
- 4 inframarginal scutes on each side

OLIVE RIDLEY

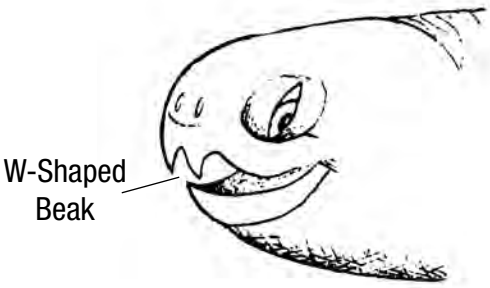
- 2 pairs of prefrontal scales
- 5 central scutes
- 5-9 pairs of lateral scutes
- 4 inframarginal scutes on each side with pores

Leatherback Sea Turtle

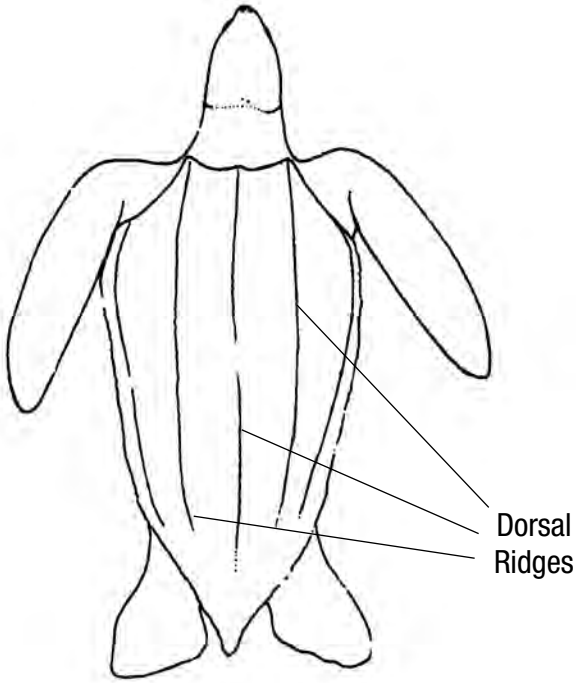
(Dermochelys coriacea)

- Only soft-shelled species
- Dark gray or black with variable white spotting
- 5-7 head-to-tail ridges on back
- Leathery shell
- No scales
- W-shaped upper jaw or beak
- May attain great size

Approximate range



SIDE VIEW
OF HEAD



TOP VIEW

TURTLE FACTS:

Leatherback turtles interact with both the Hawaii swordfish (shallow-set) and tuna (deep-set) longline fisheries. They are usually hooked or entangled externally, rather than in the mouth. This turtle has a firm, leathery skin covering the shell and body, instead of a hard shell and scales like other turtles. They are highly migratory, swimming long distances across the Pacific from nesting to foraging areas. Leatherbacks are the largest of all sea turtles with adults reaching 6½ feet (2 meters) in length and over 1,500 pounds (681 kg).

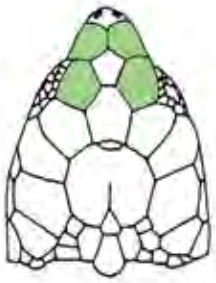
Questions? Call Pacific Islands Regional Office,
Sustainable Fisheries Division at (808) 944-2200

Loggerhead Sea Turtle

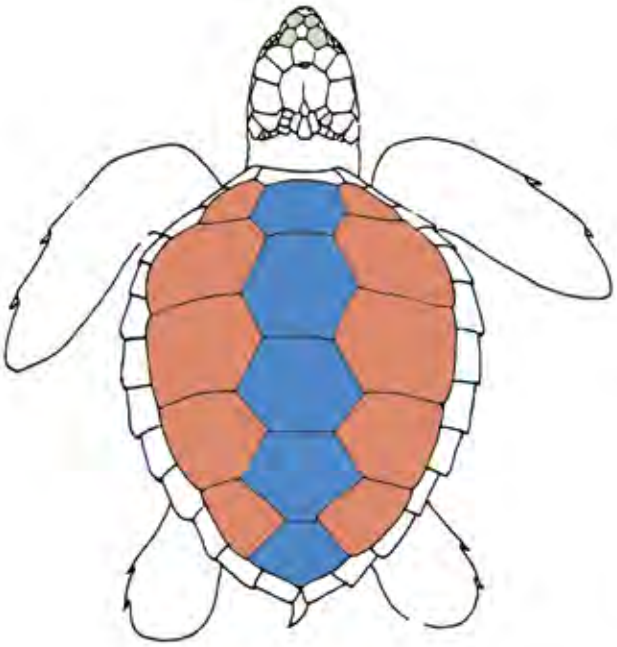
(Caretta caretta)

- 2 pairs of prefrontal scales
- 5 central scutes
- 5 pairs of lateral scutes
- 3 pairs of inframarginal scutes

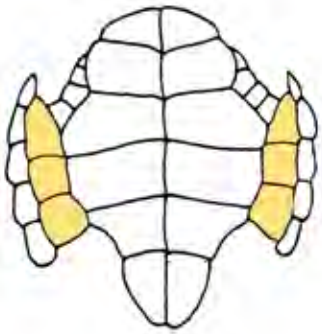
Approximate range



TOP VIEW OF HEAD



TOP VIEW



BOTTOM VIEW OF TURTLE

TURTLE FACTS:

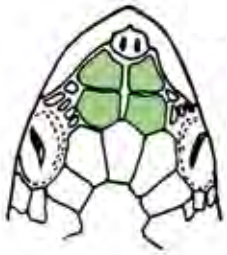
Loggerhead turtles interact with both the Hawaii swordfish (shallow-set) and tuna (deep-set) longline fisheries. In the North Pacific, juveniles hatched from nests in Japan swim across the ocean to feed and grow near the Mexican coast. They can spend decades in migratory and developmental habitats in Mexico and the central Pacific until maturity, when they return to Japan. Loggerheads can grow to over 36 inches (92 cm) in shell length and 250 pounds (113 kg). They have large heads, strong jaws, and typically have shells that are reddish-brown with a yellow underside.

Olive Ridley Sea Turtle

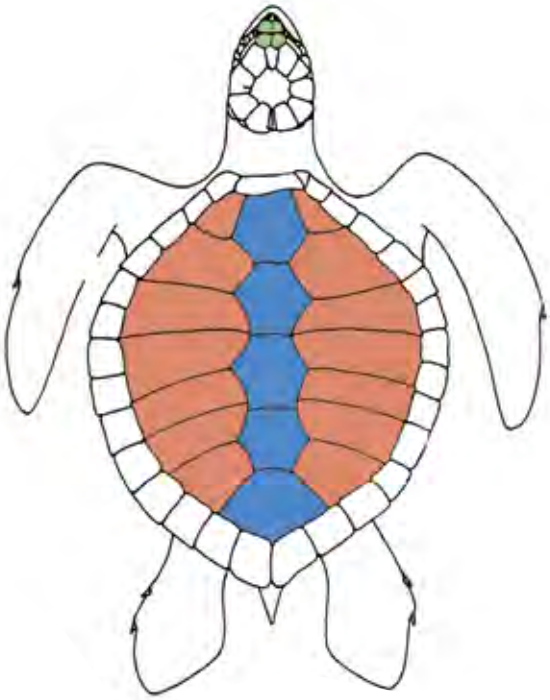
(Lepidochelys olivacea)

- 2 pairs of prefrontal scales
- 5 central scutes
- 5-9 pairs of lateral scutes
- 4 pairs of inframarginal scutes with one pore on each scute

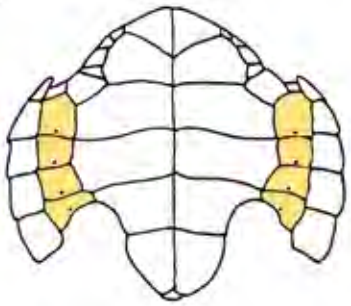
Approximate range



TOP VIEW OF HEAD



TOP VIEW



BOTTOM VIEW OF TURTLE

TURTLE FACTS:

Olive ridley turtles interact primarily with the Hawaii tuna (deep-set) longline fishery, and occasionally with the swordfish (shallow-set) fishery. These turtles are highly migratory and usually live in warm, tropical waters, but may also occur in cooler waters north of Hawaii. Olive ridley turtles are the smallest sea turtles, averaging 25 inches (61 cm) in shell length and 100 pounds (45 kg). Their shell is generally olive green with a light yellow underside. They sometimes have more lateral scutes on one side of their shell than the other. They are the only turtles in the Pacific with a pore on each inframarginal scute.

Questions? Call Pacific Islands Regional Office, Sustainable Fisheries Division at (808) 944-2200

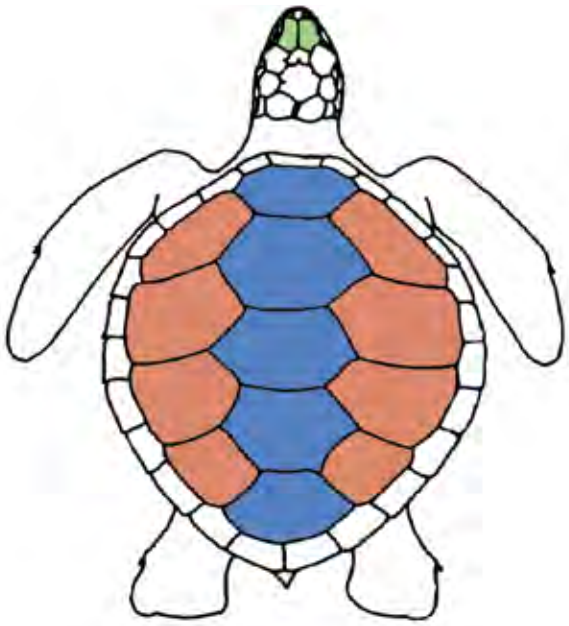
Green Sea Turtle

(Chelonia mydas)

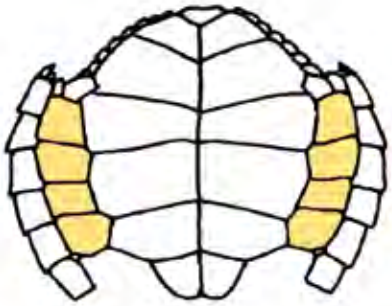
- 1 pair of prefrontal scales
- 5 central scutes
- 4 pairs of lateral scutes
- 4 pairs of inframarginal scutes

Approximate range

TOP VIEW
OF HEAD



TOP VIEW



BOTTOM VIEW
OF TURTLE

TURTLE FACTS:

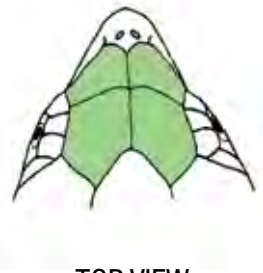
The green turtle is the most widespread and commonly-known sea turtle in tropical and sub tropical waters. Green turtles are not usually caught in longline fisheries, but interactions can occur in the Hawaii and American Samoa fisheries. Green turtles are the largest of the hard-shell turtle species and can grow up to 47 inches (120 cm) in shell length and weigh over 300 pounds (136 kg). They get their name from the color of their fat. The shell color can range from yellow-green to reddish-brown to almost black. Loggerheads and olive ridley turtles can be easily mistaken for a green turtle. When in doubt, look at the head and check the number of prefrontal scales.

Hawksbill Sea Turtle

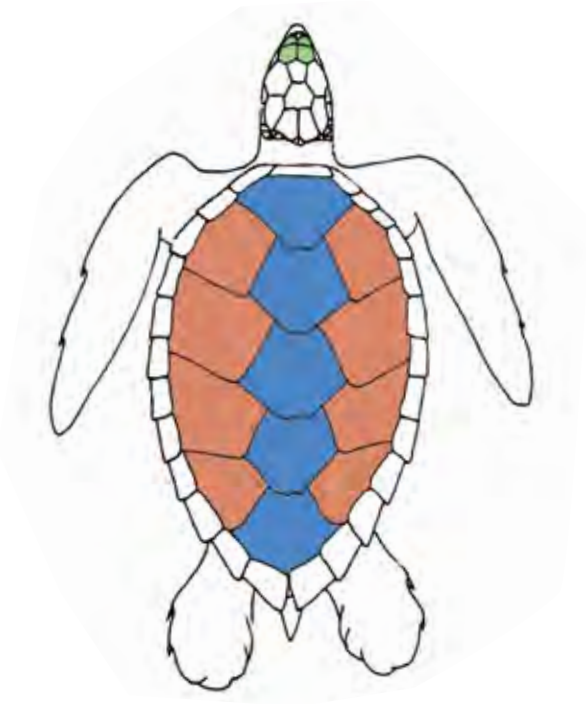
(Eretmochelys imbricata)

- 2 pairs of prefrontal scales
- 5 central overlapping scutes
- 4 pairs of overlapping lateral scutes
- 4 pairs of inframarginal scutes

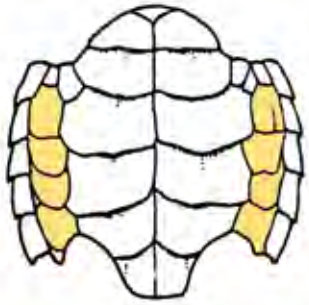
Approximate range



TOP VIEW
OF HEAD



TOP VIEW



BOTTOM VIEW
OF TURTLE

TURTLE FACTS:

There has been no reported interaction between a hawksbill turtle and the Hawaii longline fisheries. Hawksbills can be found in tropical and sub-tropical regions across the Pacific. They nest in low numbers throughout the Pacific, including Hawaii. Adult hawksbills can grow to almost 3 feet (90 cm) in shell length and weigh up to 200 pounds (91 kg). The hawksbill is named for its sharp, pointed, bird-like beak. The shell has "tortoise shell" coloring, ranging from dark to golden brown, with streaks of orange, yellow, brown and black. These are the only sea turtles that have overlapping scutes on the top shell, like roof shingles.

Questions? Call Pacific Islands Regional Office,
Sustainable Fisheries Division at (808) 944-2200

Have an identification guide and paper available in case of a marine mammal interaction.

Small Whales and Dolphins

1. Make sure the crew is ready to help.
2. Move the boat carefully, stop the boat, and put the transmission in neutral when the animal is close.
3. If the far side of the mainline is within reach, use gaffs to grab only the line. This will keep any remaining gear in the water from pulling on the line and the animal. Do NOT use gaffs or sharp objects to grab an animal.
4. Slowly bring the animal next to the boat.
5. Avoid sudden actions that may scare the animal.

If the animal is tangled in line:

1. Grab the far side of the mainline and tie the mainline to the boat.
2. Use a long-handled line cutter to cut as much line off the animal as you can.

If the animal is hooked:

1. Use a dehooker to remove the hook.
2. If the hook cannot be removed, use a long-handled line cutter to cut the line as close as you can to the hook.
3. Remove as much line as possible from the animal. Do not use ropes or other lines to tie the animal to the boat.

Large Whales

If a large whale is alive and hooked or entangled in fishing gear, immediately call the Disentanglement Hotline at **1-888-256-9840** or the U.S. Coast Guard on VHF Ch. 16 for instructions.

If a large whale is dead and hooked or entangled in fishing gear, immediately call the U.S. Coast Guard on VHF Ch. 16 for instructions.

For All Interactions

Write down as much information as possible to describe the animal, and its injuries.

- How long was the animal?
- What did the animal look like (did it have stripes, spots, or different colors)?
- Was there any fishing gear still on the animal when it was released? If so, where, what kind, how much?
- Did you see any tags on the animal? If yes, can you see any letters or numbers on the tag?

After an interaction with a marine mammal, get the rest of your fishing gear out of the water. Then record all the information about the interaction on your Marine Mammal Injury / Mortality Reporting Form, even if you had an observer aboard. Mail the form when you get to port.

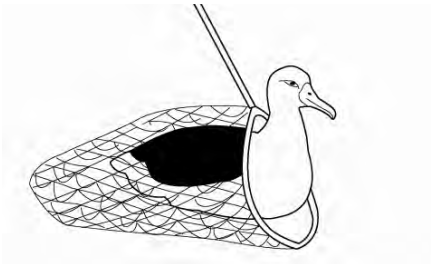
If you have a marine mammal interaction, you could have another if you keep fishing in the same area. Move away from the area, and call other fishermen to warn them. If you stay in the same area, wait 2 days before setting your gear to avoid more interactions.

Questions? Call Pacific Islands Regional Office, Sustainable Fisheries Division at (808) 944-2200

Seabird Handling Guidelines

PLEASE NOTE: If bird is a short-tailed albatross, follow special guidelines for handling short-tailed albatross. For all other seabirds, see below.

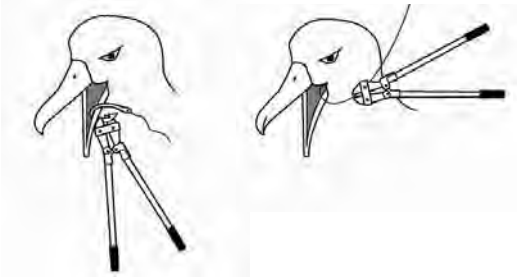
1. Stop vessel to reduce tension on the line and bring bird aboard using a dip net.



2. Working with another person, hold the back of the bird's head and isolate the hooked or entangled area while the other person takes the bird from the net. Fold the bird's wings to their natural resting position against the body.

3. Wrap the bird's wings and feet with a clean towel or blanket. Do not wrap the bird's body too tightly or block the nostrils, as these will prevent the bird from breathing.

4. Cut and remove all fishing line from bird. If bird is lightly hooked in the bill, leg, or wing, and the barbed end of the hook is visible, use bolt cutters to cut the barb and then back the hook out. If bird has been deeply hooked, cut the line as close as possible to hook and leave hook in place.



Never attempt to remove a hook from anywhere on a bird by pulling on line.

5. Allow bird to dry for 1/2 hour to 4 hours in a safe, enclosed place. Refer to **Release Guidelines.**

6. Record any leg band numbers observed on the bird in logbook.

Wear gloves, long sleeves and protective eyewear when handling seabirds. They have sharp beaks and give painful bites.

Release Guidelines

A bird is ready for release when its feathers are dry.

Albatross NOT ready to be released

Albatross ready to be released

If bird is ready for release:
Stop the vessel. Gently place bird onto the surface of the water. Do not throw bird in air or motor away if bird is not clear of vessel.

Questions? Call Pacific Islands Regional Office, Sustainable Fisheries Division at (808) 944-2200

Short-Tailed Albatross Handling Guidelines

Short-tailed albatross are an endangered species and have special handling requirements.

If you catch a short-tailed albatross:

Immediately try to contact National Marine Fisheries Service, U.S. Coast Guard, or U.S. Fish and Wildlife Service. They will contact an expert to give you advice in the handling and release of short-tailed albatross.

National Marine Fisheries Service (NMFS)
(808) 944-2200

U.S. Coast Guard (USCG)
08240.0 KHz (Daytime ITU Channel 816)
12242.0 KHz (Daytime ITU Channel 1205)
04134.0 KHz (Nightime ITU Channel 424)
06200.0 KHz (Nightime ITU Channel 601)

U.S. Fish and Wildlife Service at French Frigate Shoals (USFWS)
Contact frequency: 10.0054

If a short-tailed albatross is hooked or entangled:

1. Stop vessel to reduce tension on the line and bring bird aboard using a dip net.
2. Wrap the bird's wings and feet with a clean towel to protect its feathers from oils or damage.
3. Remove any entangled lines from the bird and determine if the bird is dead or alive.

   If dead, notifiy NMFS. Label the bird, put it in a plastic bag and store in freezer. Give bird to NMFS when you return to port.

   If alive, place bird in a safe, enclosed place and immediately contact NMFS, USCG and USFWS.

   If unable to make contact for 24-48 hours, determine if the bird is lightly, moderately, or deeply hooked. See description.
4. If bird is deeply hooked, keep bird in a safe, enclosed place until further instructed. Do NOT release the bird.
5. If bird is lightly or moderately hooked, remove hook by cutting the barb and backing hook out.
6. Allow bird to dry for 1/2 hour to 4 hours in a safe, enclosed place. Refer to **Release Guidelines.**
7. Record information in the short-tailed albatross recovery data form.

Short-tailed albatross fly across the entire North Pacific. Around Hawaii, only young short-tailed albatross (shown above) have been seen. The number of birds is increasing, but fewer than 3,000 birds remain in the wild.

Is the bird lightly, moderately, or deeply hooked?

Lightly Hooked: Hook is clearly visible on bill, leg or wing.

Moderately Hooked: Hooked in the mouth or throat with hook visible.

Deeply Hooked: Hook has been swallowed and is located inside the bird's body below the neck.

Release Guidelines

The bird is ready for release if it meets ALL of the following criteria:

- Stands on both feet with toes pointed forward
- Holds its head erect and responds to sound and motion
- Breathes without making noise
- Flaps and retracts wings to normal folding position
- Feathers are dry

If any of these conditions are not met, the bird cannot be released.

If bird is ready for release:
Stop the vessel. Gently place bird onto the surface of the water. Do not throw bird in air or motor away if bird is not clear of vessel.

Laysan Albatross *(Phoebastria immutabilis)*

Feathers:
- White head, neck, and belly
- Dark brown upper wings and back
- Brown and white under wings
- Dark area around each eye

Legs/Feet Color: Pink to gray

Bill Color: Yellow-pink with gray tip

Black-footed Albatross *(Phoebastria nigripes)*

Feathers:
- Dark brown head, body, and wings
- Small white patch behind the eyes
- White ring around base of bill
- Adults - small white patch at base of tail

Legs/Feet Color: Black-brown

Bill Color: Black-brown

Short-tailed Albatross *(Phoebastria albatrus)*

ENDANGERED SPECIES

JUVENILE

Feathers: Dark brown head, body, and wings

Legs/Feet Color: Brown-gray

Bill Color: Bright pink with a thin black line around base

SUB ADULT

Feathers:
- White neck, belly, and back
- Dark brown cap and back of neck
- Black and white wings

Legs/Feet Color: Pink to gray

Bill Color: Bright pink with a thin black line around base

ADULT

Feathers:
- Golden-yellow head and neck
- White back, base of tail, and belly
- Black and white wings

Legs/Feet Color: Pink to gray

Bill Color: Bright pink with a thin black line around base

Questions? Call Pacific Islands Regional Office,
Sustainable Fisheries Division at (808) 944-2200

Observer ID

DOC/NOAA Fisheries
Pacific Islands Region
Longline Observer Program

Trip No.

Set No.

Marine Mammal Biological Data Form

Capture

Date/Time — Day | Month | Year (20 __) | Hour | Minute

Latitude — Deg. | Decimal Min. (.) | N/S

Longitude — Deg. | Decimal Min. (.) | E/W

Species Code

742	False Killer Whale
746	Risso's Dolphin
743	Short-Finned Pilot Whale
731	Bottlenose Dolphin
700	Unidentified Cetacean

Associated Form Code

Associated Form Page No.

Associated Form Line No.

Landed? ☐ ✓

Tags Present? ☐

Y= Yes
N= No
U= Unknown

Release Condition

03 Injured
04 Dead

Photo? ☐ ✓

Specimen? ☐ ✓

Sketch? ☐ ✓

Hooking/Entanglement

Hook Type

01 Tuna
02 J-Hook
03 Offset Tuna
04 Offset J-hook
05 Circle
06 Other
07 Offset Circle

Hook Size

Hooked? ☐ Y N

Entangled? ☐ Y N

Location (check all that apply)		Code	Location (check all that apply)	
Mouth	☐	MO	Mouth	☐
Lip	☐	LP	Lip	☐
Head	☐	HD	Head	☐
Body	☐	BO	Body	☐
Pectoral Fin	☐	PF	Pectoral Fin	☐
Dorsal Fin	☐	DF	Dorsal Fin	☐
Fluke	☐	FK	Fluke	☐
Internal/Ingested	☐	IN	Internal/Ingested	☐
Unknown	☐	UK	Unknown	☐
Other (describe on back)	☐	OT	Other (describe on back)	☐

Gear

Gear Attached After Release

Code			
NO	None	☐	
HK	Hook	☐	
WL	Wire leader	☐	If ✓'d, provide length.
MN	Mono leader	☐	If ✓'d, provide length.
WT	Weight	☐	If ✓'d, provide size & numbers.
BL	Branch line	☐	If ✓'d, provide numbers & lengths.
FO	Float line	☐	If ✓'d, provide numbers & lengths.
FT	Floats	☐	If ✓'d, provide numbers.
ML	Main line	☐	If ✓'d, provide length.
OT	Other	☐	If ✓'d, provide description.

Provide requested details about anything ✓'d above on reverse side under Gear Comments.

Measurements

Total Length ___ **cm**

OR

Approximate Length ___

F= feet
M= meters

Capture Behavior

	Code
☐ **Struggling?**	SR
☐ **Calm?**	CA
☐ **Vocalizing?**	VO

Observer ID

DOC/NOAA Fisheries
Pacific Islands Region
Longline Observer Program

Trip No.

Set No.

Marine Mammal Biological Data Form Comments

Comments:

Gear Comments: (Please describe in detail anything ✓ 'd on front, & how/where remaining gear was attached upon release)

Injuries Description: (Where exactly is hook? Where/how are lines constricting? Additional injuries sustained during handling/release? Bleeding?

Identifying Characteristics:

Observer ID

DOC/NOAA Fisheries
Pacific Islands Region
Longline Observer Program

Trip No.

Set No.

Sea Turtle Biological Data Form

Species Code

504 Loggerhead Sea Turtle
502 Green Sea Turtle
506 Leatherback Sea Turtle
503 Hawksbill Sea Turtle
505 Olive Ridley Sea Turtle
500 Unid. Hard Shell Sea Turtle
501 Unidentified Sea Turtle

Photo? ☐ ✓
Specimen? ☐ ✓
Sketch? ☐ ✓
Tag? ☐ ✓
Comment? ☐ ✓ (Enter comments on back of this form.)

Associated Form Code
Associated Form Page No.
Associated Form Line No.

Capture

Date/Time — Day | Month | Year (2 0) | Hour | Minute

Latitude — Deg. | Decimal Min. | N/S

Longitude — Deg. | Decimal Min. | E/W

Boarded (0)

01 Boarded w/ Dipnet
02 Boarded w/o Dipnet
03 Not Boarded

Tags Present?

Y Yes
N No
U Unk.

Release

Date/Time — Day | Month | Year (2 0) | Hour | Minute

Disposition Code (0)

01 Previously dead
02 Relsd. unharmed
03 Relsd. injured
04 Died
05 Escaped
06 Treated as catch
07 Other/Unknown

Latitude — Deg. | Decimal Min. | N/S

Longitude — Deg. | Decimal Min. | E/W

Tags Removed? ☐ ✓

Tags Applied? ☐ ✓

Hooking/Entanglement

Hooked ?

Y Yes
N No
U Unknown

Entangled ?

Hook Location

Entangle Location

01 Ingested (in esophagus)
03 Front Flipper
04 Body/Shell
05 Unknown
06 Tail
07 Rear Flipper
20 Other
10 Upper beak
11 Lower beak
12 Side of mouth
13 Tongue/Glottis
14 Head/Neck
15 Roof of mouth
16 Mouth unknown

Gear Removal

00 Unknown
02 Fell from gear while in water.
03 Fell from gear once out of water.
04 Fell from gear by force of roller.
05 Removal req. cutting gear/animal
06 Removal with no cutting.
12 Dehooker
99 Other

Remaining Gear

X None
H Hook
L Line
B Both Hook and Line

Describe hook or line and length left on animal:

Morphology

Skin Covered Carapace?
(N implies carapace is covered w/ scutes.)

Overlapping Scutes?

Inframarginal scutes with pores?

One pair of prefrontal scales?
(N implies more than one pair.)

Y Yes
N No
U Unknown

Carapace Scute Counts

(Enter the no. of scutes in the boxes.)

No. of Left Lateral Scutes

No. of Right Lateral Scutes

No. of Vertebral Scutes

No. of Inframarginal Scutes

Dorsal Coloration (0)

01 Orange/Red
02 Grayish
03 Other, give color below

Other dorsal color:

Measurements

Round to the nearest half cm.

Carapace Length (curved) . cm

Carapace Width (curved) . cm

Plastron Length (straight) . cm

Tail Length . cm

Carapace Length (straight) . cm

Carapace Width (straight) . cm

Light Device

Complete only if light devices were used and the light device type has been indicated on the gear configuration form.

Color Code

01 Blue
02 Green
03 Black
04 Pink
05 White
06 Yellow
07 Magenta
08 Mixed
09 Other
10 Clear
11 Red
12 Orange
13 Silver/Metal

Proximity Code (0)

00 On this branch line
01 Light is 1 branch line away
02 Light is 2 branch lines away
03 Light is 3 branch lines away
04 None in vicinity

form v. TR.11.07

Observer ID

DOC/NOAA Fisheries
Pacific Islands Region
Longline Observer Program

Trip No.

Set No.

Sea Turtle Biological Data Form Comments

Comments:

Injuries Description:

Identifying Characteristics:

Supplemental Questions for Marine Mammal Biological Data Form – Longline gear

Please attempt to provide answers to the following questions, as they related to the interaction, when completing the comment section of your MMBD form.

1. How long was the observed/documented part of the interaction? Did you observe the entire interaction? Was the animal primarily at the surface? If not, approximately how many times did you see the animal surface during the interaction?
2. How far was the animal from the vessel when it was initially sighted? How long did it take to pull the animal in to the vessel and how long was it handled along-side the vessel?
3. *If applicable* – If hooking location is not clearly specified, what can you tell us about likely locations? What prevented you from seeing the hooking location?
4. *If applicable* – How did the interaction end? Did the line break? Was it cut? Where was it cut?
5. Did you attempt to get a sample from the animal?
6. Were there any other animals in the area during the interaction? If so, please describe number, appearance, and behavior.

Please attempt to provide answers to the following questions, as they related to the interaction, when completing the gear section of your MMBD form.

1. *If applicable* – Did you measure the remaining branchline after it snapped/ was cut to determine the amount remaining on the animal, or did you estimate?
2. *If applicable* – Could you verify the hook type/ size associated with the interaction? Did the hook straighten or break during the interaction?

Please attempt to provide answers to the following questions, as they related to the interaction, when completing the injury section of your MMBD form.

1. *If applicable* – If entangled- Could you see line wrapped around or restricting movement in the entanglement location? How many times was the entangled line wrapped around the animal? Were there multiple wraps remaining after its release? Was the line wrapped tightly or loosely?
2. Did the animal incur any injuries during the course of this interaction.

Please attempt to provide answers to the following questions, as they related to the interaction, when completing the identifying characteristics section of your MMBD form.

1. Describe the color of the animal(s)?
2. Describe capes? patterns? scars? masks? etc?
3. Describe head shape? color? Was a beak present? If so, describe its size?
4. Did the animal have a dorsal fin? What size? shape? Describe relative location on the body?
5. When species is unidentified what species might it have been?

Detailed Sampling Protocol for Marine Mammal and Sea Turtle Incidental Takes on SWFSC Research Cruises

When marine mammals or sea turtles are incidentally killed during research activities cannot be retained (i.e., frozen or transferred to shore) as much data as possible is to be collected at sea.

Each animal needs to have a unique identifying field number assigned to it and a data sheet created (Figure 1). A procedural outline for processing follows.

1) **Assign a Field ID**: The identification number consists of three parts: 1) letters identifying the platform on which the animal was collected: Bell M Shimada is BMS; Ocean Starr is OS; 2) the date in the format of year, month, day: yymmdd, and 3) a sequential number assigned to each animal as it is processed. For example, the third animal collected by scientists aboard the Bell M Shimada on June 4, 2012 would be BMS120604.03. Attach two tags with cable or zip ties to the animal. Put one around the flukes and flipper of cetaceans, and the hind and fore flippers (of pinnipeds and sea turtles).
2) **Record collection details**: Record the year, month and day of collection along with the lat/long and time of day. Record the name(s) of data recorders as "Collector."
3) **Other data to record**:
    a. **Photos:** Photograph both sides of the animal, the head and genital region. Include a label or tag with the animal's unique Field ID and an object such as a ruler or pen for scale.
    b. **Species Id:** ***Record the species or common name.***
    c. **Total Standard Length**
        i. **Marine mammals:** Measure from tip of upper jaw to fluke notch (cetaceans – Figure 2) or tip of nose to tip of tail (pinnipeds – Figure 3), see diagram on following page. Straight length is preferable to curvilinear. It is assumed length is straight. Please note if it is curvilinear.
        ii. **Sea turtles:**
            1. **Curved carapace length (CCL):** Measure from the nuchal notch of the carapace (where the skin of the neck meets the carapace) to the caudal tip making sure to measure to the longest point. For leatherbacks, pull the tape tight between the middle of the nuchal notch and the tip of the caudal peduncle (pygal), without forcing the tape along the top of the ridge. Record measurement in centimeters (cm).
            2. **Curved carapace width (CCW):** Measure across the widest point of the carapace from one edge to the other for both hard-shelled species and leatherbacks. The exact location will vary amongst species and individuals so be sure to move the tape up and down to find the widest point. Record measurement in centimeters (cm).
            3. **Straight carapace length (SCL):** Use same landmarks as for CCL, but use calipers if available. If unable to use calipers, please estimate straight length as accurately as possible with a measuring tape, either by laying it out next to the turtle or stretching it out above the turtle. Please check the appropriate box for tape or calipers. Record measurement in centimeters (cm).

4. **Straight carapace width (SCW):** Use same landmarks as for CCW, but use calipers if available. If unable to use calipers, please estimate straight width as accurately as possible with a measuring tape by stretching it out above the turtle. Please check the appropriate box for tape or calipers. Record measurement in centimeters (cm).
5. **Total tail length:** On the ventral side, measure the length of the tail from the caudal end of the plastron to the tip of the tail, following the curve of the tail. Record measurement in centimeters (cm).
6. **Cloaca to tail tip:** On the ventral side, measure from the cloacal opening to the tip of the tail. Record measurement in centimeters (cm).

d. **Girth.** Maximum girth is collected for cetaceans (Figure 2) and axillary girth is collected for pinnipeds (Figure 3). If there is no dorsal fin on a cetacean (e.g. northern right whale dolphins) take axillary girth.
e. **Sex**. Photograph genital region. In cetaceans – Figure 2, anus and genital slit are almost continuous in females, but are clearly separate in males. In pinnipeds – Figure 3, two openings between the rear flippers indicates female, one between rear flippers and one on belly indicates male.
f. **Skin** (3 x 0.5 cm is sufficient), frozen in whirlpack or vial. In pinnipeds, skin (not fur) is available at the end of the flippers. For sea turtles, collect 2-6 mm of soft skin tissue from either the neck or hip area.
g. **Blubber** with thin layer of muscle attached, 4 x 4 in, wrapped in foil, frozen. For cetaceans, this is collected from left lateral side just anterior of dorsal fin (where max. girth is taken).
h. **Head** - the head should simply disarticulate once you cut through the blubber, muscle and esophagus. Start cutting one fist length posterior to the blowhole. You do not need to cut through any bone to get the head off.
i. **Flippers** – Collect one front flipper with humerus bone intact and one rear flipper with femur bone intact.

Figure 1. Data sheet for recording information about each animal.

MARINE MAMMAL and SEA TURTLE SPECIMEN DATA
INCIDENTAL RESEARCH TAKES ONLY

Collection Date: **Collector**:

Field ID (ship initials-yymmdd.xx): **Species**:

Locality: **Lat/Long**:

Sex: Male/Female/Unknown

Marine Mammals:

Length (cm): Girth (cm):

Sea Turtles:

Straight carapace length (cm): Straight carapace width (cm):

Curved carapace length (cm): Curved carapace width (cm):

Brief History: Date of Death: Time of Death:

ADDITIONAL DATA COLLECTED:	**Yes**	**No**
Photographs:		
Carcass:		
Head:		
Skin:		
Blubber:		

EXTERNAL EXAMINATION: Provide as much detail as possible

General condition (lesions, deformities, appearance, color):

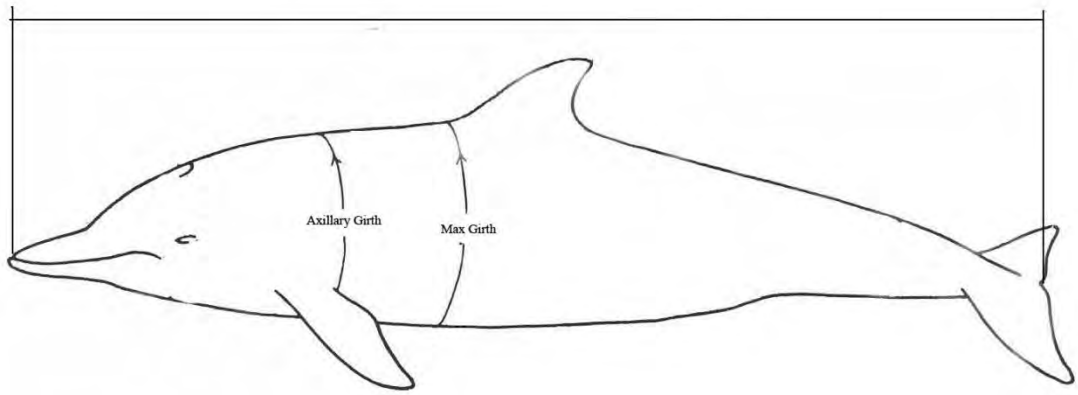
Parasites:
Mouth / Teeth:
Eyes:
Blowhole / Nostrils:
Anus and Urogenital openings:
Mammary slits / glands:
Fins / Flukes / Flippers:

Supplies provided: sampling instructions, data sheets including a fillable pdf, tags, cable ties, body bags.

Questions? For mammals contact Kerri Danil: kerri.danil@noaa.gov, (858) 366-2667, or Susan Chivers: susan.chivers@noaa.gov, (858) 945-0759, and for sea turtles contact Robin LeRoux: robin.leroux@noaa.gov, (619) 840-0693 or Erin LaCasella: erin.lacasella@noaa.gov, (858) 337-9065.

Figure 2: Cetacean data collection:

a. Standard total length = tip of upper jaw to fluke notch; Locations for axillary and maximum girth measurements are also shown.



b. Genital slit and anus for females (top) and males (bottom).

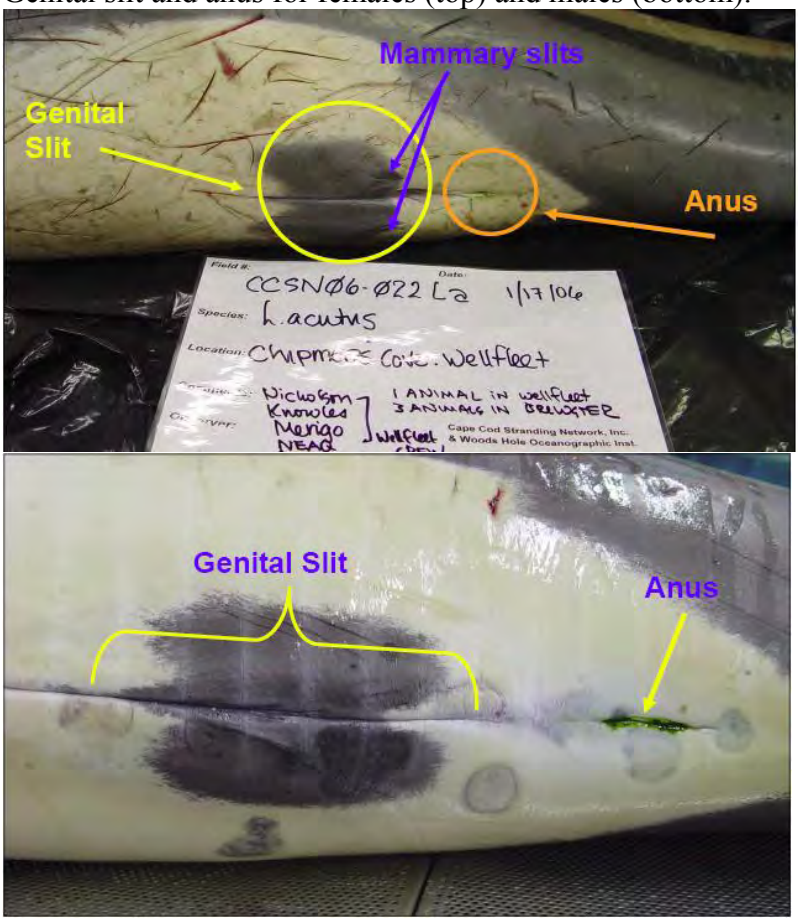
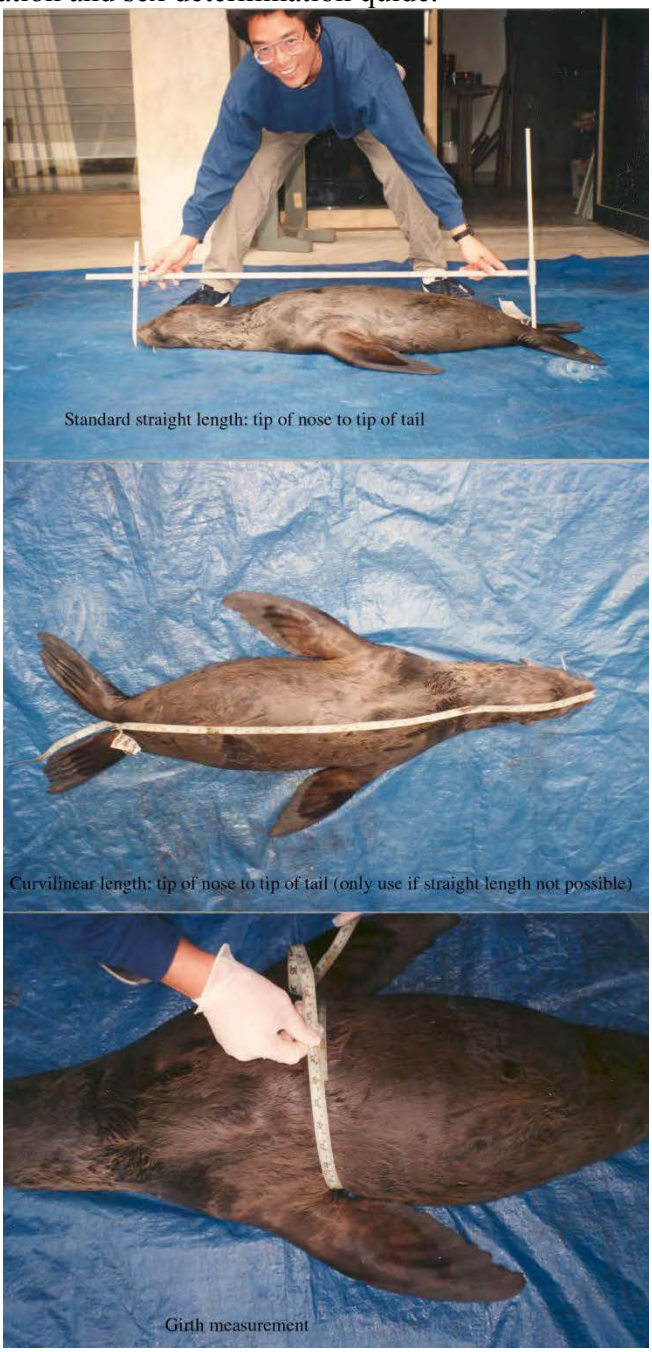


Figure 3: Pinniped data collection: total body length measurement endpoints, girth measurement location and sex determination quide.



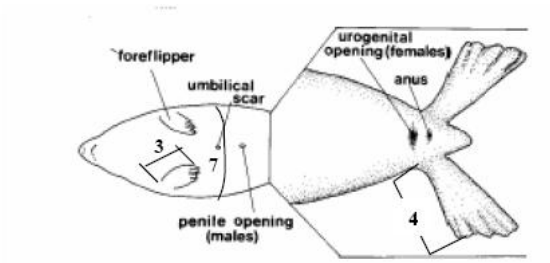


Figure 4. Sea turtle data collection: curved carapace length (CCL) and curved carapace width (CCW) measurements for hard-shelled and leatherback species, and straight carapace length (SCL) measurement.

Curved Carapace Width - leatherback

Straight Carapace Length