UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE
Office of Protected Resources

PETITION FOR PROMULGATION OF REGULATIONS AND REQUEST FOR LETTER OF AUTHORIZATION PURSUANT TO SECTION 101 (a) (5) (A) OF THE MARINE MAMMAL PROTECTION ACT

for the

Taking of Marine Mammals Incidental to Fisheries and Ecosystem Research

Conducted and Funded by the Southwest Fisheries Science Center

50 C.F.R. Part 216, Subpart R

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Submitted by:

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ACRONYMS AND ABBREVIATIONS

Acronym/ Abbreviation	Definition
ACDP	Acoustic Doppler Profiler
AMLR	Arctic Marine Living Resources
ASL	above sea level
AUV	Autonomous Underwater Vehicles
AZFP	Acoustic Zooplankton Fish Profiler
BMP	Best Management Practice
CalCOFI	California Cooperative Oceanic Fisheries Operations
CCE	California Current Ecosystem
CFR	Code of Federal Regulations
cm	centimeter
COAST	Collaborative Optical Acoustical Survey Technology
CPS	Coastal Pelagic Species
CS	Chief Scientist
CTD	Conductivity, Temperature, and Depth
CUFES	Continuous Underway Fish Egg Sampler
CV	Coefficient of Variation
D	Depleted under the MMPA
DAS	days at sea
dB	decibels
DON	Department of the Navy
DPS	Distinct Population Segment
E	Endangered under the ESA
EEZ	Exclusive Economic Zone
ENP	Eastern North Pacific
EO	Executive Order
ESA	Endangered Species Act
ETP	Eastern Tropical Pacific
FAA	Federal Aviation Administration
fm	fathom
FONSI	Finding of No Significant Impact
FR	Federal Register
FREEBYRD	AMLR glider program
ft	feet
GPS	Global Positioning System
HMS	Highly Migratory Species
Hz	hertz
ICUN	International Union for Conservation of Nature
IHA	Incidental Harassment Authorization
in.	inch
ITA	Incidental Take Authorization
ITR	Incidental Take Regulation
kg	kilograms

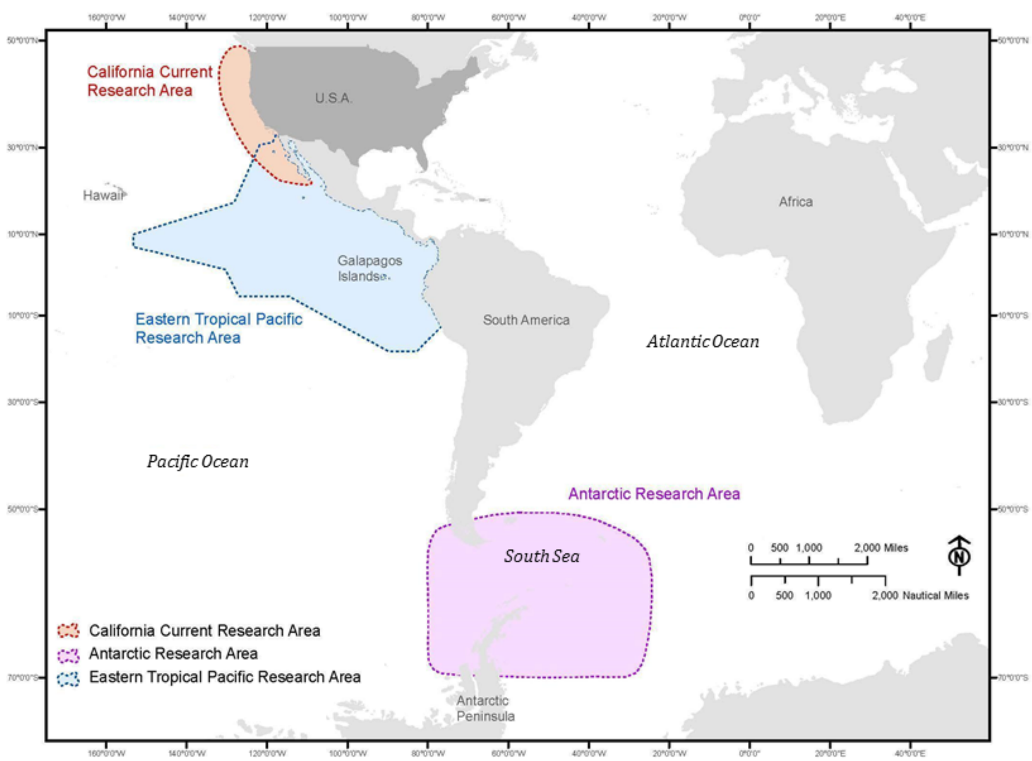
kHz	kilohertz
km	kilometers
km^2	square kilometers
LME	Large Marine Ecosystem
LOA	Letter of Authorization
m	meters
mi	miles
MLLW	Mean low lower water
mi^2	square miles
MMED	Marine Mammal Exclusion Device
MMPA	Marine Mammal Protection Act
M/SI	Mortality/Serious Injury
NEPA	National Environmental Policy Act
NL	not listed under the ESA
NS	Not strategic under the MMPA
nm	nautical mile
NMFS	National Marine Fisheries Service
MML	National Marine Mammal Laboratory
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
OMAO	Office of Marine Aviation and Operations
OOD	Officer on Deck
OPR	Office of Protected Resources
PBR	Potential Biological Removal
PEA	Programmatic Environmental Impact Statement
ppt	parts per thousand
PSIT	Protected Species Incidental Take
PTS	Permanent Threshold Shift
rms	root mean square
ROV	Remotely Operated Vehicle
RPAS	Remotely Piloted Aircraft Systems
S	Strategic under the MMPA
Secretary	U.S. Secretary of Commerce
SI	serious injury
SWFSC	Southwest Fisheries Science Center
TTS	Temporary Threshold Shift
UAS	Unmanned Aerial Systems
UME	Unusual Mortality Event
U.S.	United States
μPa	microPascal
VTOL	vertical take-off and landing
XBT	eXpendable BathyThermograph

1. DESCRIPTION OF ACTIVITIES

1.1. Nature of Request

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) Southwest Fisheries Science Center (SWFSC) based in La Jolla, California and within NMFS' Southwest Region, is responsible for conducting science-based management, conservation, and protection of living marine resources within the U.S. EEZ. 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 (ETP) Ocean, and in the Southern Ocean off Antarctica (Figure 1-1).

The SWFSC previously analyzed the potential environmental effects of fisheries and ecosystem research and on September 30, 2015, NMFS Office of Protected Resources (OPR) promulgated regulations and subsequently issued a 5-year Letter of Authorization (LOA) (80 FR 58981) for the incidental taking of marine mammals pursuant to Section 101(a)(5)(A) of the MMPA. In compliance with the National Environmental Policy Act (NEPA) and to support the MMPA authorization as well as other applicable laws, in June of 2015 the SWFSC published a Final Programmatic Environmental Assessment (PEA) for Fisheries Research Conducted and Funded by the Southwest Fisheries Science Center (NMFS 2015a). The 2015 PEA (NMFS 2015a) was determined to be sufficient and a Finding of No Significant Impact (FONSI) was signed on August 31, 2015.



Source: NMFS 2015a

FIGURE 1-1. SOUTHWEST FISHERY SCIENCE CENTER RESEARCH AREAS

The SWFSC plans to continue fisheries and ecosystem research in the California Current Ecosystem (CCE) and the Antarctic Living Marine Resources (AMLR) ecosystem for the period 2020–2025, and is in the process of preparing a Supplemental PEA to evaluate new research activities and issues that were not previously analyzed in the 2015 PEA. Therefore, the purpose of this request by SWFSC is for NMFS OPR to develop regulations and issue a 5-year LOA, effective October 31, 2020 through October 2025, allowing for the potential incidental taking of small numbers of marine mammals during fisheries and ecosystem research in the CCE and AMLR as described in the Supplemental PEA, and to be conducted and funded by the SWFSC over the period 2020–2025. No surveys of any kind were conducted in the ETP during the period 2015–2019, and research surveys are not planned for the ETP over the period 2020–2025. Therefore, this LOA application does not request takes for species in that area.

1.2. Regulatory Context

The MMPA, Section 101(a)(5) directs 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), if certain findings are made.

There are two types of Incidental Take Authorizations (ITAs) that can be issued by NMFS: an LOA under Section 101(a)(5)(A) and an Incidental Harassment Authorization (IHA) under Section 101(a)(5)(D) of the MMPA. Under Section 101(a)(5)(A), for multi-year activities NMFS must issue regulations through an LOA. The activities must be well planned with enough detailed information provided to allow for an analysis of potential takes over the duration of the activity. Incidental Take Regulations (ITRs) can be valid for up to five consecutive years and an LOA can be issued each of those years; NMFS recommends following the rulemaking/LOA process for multiple-year projects (such as annual ice roads, trails and pads) even when serious injury or mortality is not anticipated. IHAs are generally only requested when the project is short-term in nature (12 months or less) and expected to result in harassment, not serious injury or mortality. Table 1-1 provides guidelines used to determine which ITA is appropriate.

TABLE 1-1. GUIDELINES FOR DETERMINING APPROPRIATE ITA PROCESS

If the proposed action has potential to:	Then:
Result in **"harassment"** only (i.e., injury or disturbance)	Apply for an IHA (effective up to 1 year)
Result in harassment only (i.e., injury or disturbance) AND is planned for multiple years	Request rulemaking and apply for multiple LOAs (effective up to 5 years)
Result in **"serious injury"** or mortality	Request rulemaking and apply for multiple LOAs (effective up to 5 years)

Fisheries and ecosystem research could result in taking of small numbers of marine mammals by harassment. Serious injury or mortality of marine mammals could occur due to entanglement. Therefore, the SWFSC is submitting this application for promulgation of an ITR and LOA effective October 31, 2020, that would allow the potential taking of small numbers of marine mammals by serious injury or mortality as well as harassment incidental to the proposed research activities (see Section 1.3).

1.3. Description of the Activity

1.3.1. Definition of Action Area

NMFS defines the outer boundary of an Action Area for a project as the point where no detectable or measurable effect from the project would occur. Therefore, for purposes of this request for rulemaking, the Action Area is defined consistent with ESA regulations as the area within which all relevant direct and indirect effects of fisheries and ecosystem research would occur. Over the five year period that is the subject of this request, SWFSC will conduct research in two areas: the CCE along the U.S. West Coast and in the Southern Ocean off Antarctica (AMLR) (Figure 1-1). The ETP is not considered part of the Action Area because no research surveys are planned for the region over the period 2020–2025.

1.3.2. Proposed Action

The proposed action is the continuation of SWFSC fisheries research activities conducted throughout the CCE and AMLR to produce scientific information necessary for the management and conservation of living marine resources in those areas. The SWFSC deploys a wide variety of gear to sample the marine environment during these research cruises. While these types of gear are not considered to pose a risk to marine mammals that may occur throughout the Action Area, the SWFSC implements a series of mitigation and monitoring measures to reduce the risk of encounters with marine mammals. Table 1-2 summarizes the types of SWFSC research activities to be covered under the ITR and LOA effective October 31, 2020. The activities shown in Table 1-2 are anticipated survey efforts and examples of the types of surveys that would occur over the 5 year period of the LOA. The need for additional surveys could arise, or some of the identified surveys could be eliminated or reduced in effort. Therefore, research activities associated with the requested LOA are not necessarily limited to the surveys shown in Table 1-2. For a complete list of proposed mitigation and monitoring measures, please see Sections 11 and 13.

International research conducted in the AMLR is directed toward gathering ecological and biological information to: quantify the functional relationships between finfish and krill, their environment and their predators; develop an ecosystem approach to ensure sustained harvesting of krill, fish and crabs; and protect predator populations of seals, penguins, and pelagic seabirds resident in the Southern Ocean surrounding Antarctica. While work in territorial waters does not require authorization under the MMPA or ESA, NMFS must follow the applicable laws of the lead country (for example, studies led by New Zealand). Additionally, Executive Order (EO) 12114 (January 1979) *Environmental Effects Abroad of Major Federal Actions* requires that federal agencies taking major federal actions outside of the geographical boundaries of the U.S. and its territories and possessions shall exchange information concerning the environment on a continuing basis. To provide a comprehensive evaluation of proposed research activities, this application includes proposed surveys planned for the AMLR for the period 2020-2025.

TABLE 1-2. FUTURE SWFSC RESEARCH ACTIVITIES (BEGINNING 2020) BY GEAR TYPE

	Proposed Action	Area of Operation	Seasonal Frequency	Gear Used[1]	Effort[1] (No. of Tows or Casts)
Surveys Using Trawl Gear	Coastal Pelagic Species (CPS) Survey (Sardine Survey) including nearshore (depths between 20-50m)	Nearshore waters out to 120 miles from San Diego, CA to the northern extent of Vancouver Island, Canada	Annually or biennially. April-May or July-August. 70 Days at Sea (DAS) (~35 DAS per vessel); and June-September; DAS: 80 (nearshore study using an industry fishing vessel)	NETS Nordic 264; Various plankton nets; Conductivity Temperature Depth (CTD) and rosette water sampler; Continuous Underway Fish Egg Sampler (CUFES); Hook and Line/Handline; Multi-frequency single beam active acoustics (EK80, ME70, SX90)	50 tows, of which 3-4 tows occur at night; 75 tows 75 casts; Continuous Continuous
	Rockfish Recruitment and Ecosystem Assessment Survey - midwater trawls	CCE/ West Coast EEZ	Annually, May-mid June, 45 DAS	Modified Cobb; Isaacs Kidd CTD profiler and rosette water sampler; Bongo and tucker plankton nets; Multifrequency single beam active acoustics	150 tows 150 casts; 50 tows; Continuous
Purse Seine Surveys	Purse Seine Survey including nearshore areas	CCE	Summer- in order to shadow the Reuben Lasker during the CSP Survey; DAS: 30–35	Purse seine Simrad Echosounder EK60	10-25 schools sampled after targeting with acoustics; 100 sardine samples will be retained per set; 3-7 transects/day, for total ~100 transects Day-night comparison surveys propose 4 sets/day (i.e., 2 daytime and 2 nighttime) over 5 days

	Proposed Action	Area of Operation	Seasonal Frequency	Gear Used[1]	Effort[1] (No. of Tows or Casts)
Longline Surveys	Highly Migratory Species Surveys including new gear (deep set buoy gear, troll and hook and line) for any HMS species	Southern California Bight to Central CA	Annually, June to July, 30 DAS	Deep set buoy gear; pelagic longline: troll hook and line CTD profiler and rosette water sampler bongo plankton tows; Multi-frequency single-beam active acoustics	varying sets and numbers of hooks depending on species targeted; daytime sampling; up to 30days of effort; 60 casts; 60 tows; Continuous
Hook and Line and/or Rod and Reel Surveys	Genetics Physiology and Aquaculture	CCE	2 years; November-June; 4 DAS	Hook and line (recreational)	12 live fish/year/species
	Life History and Reproductive Ecology Investigations of Rockfish including new target species, Sebastes species, using hook and line or other gear. (Current research on sablefish may also be conducted)	CCE	Annually; Season is dependent on species targeted- therefore, monthly collection is possible; DAS: 10-15 over multiple 1-day trips; no current efforts are scheduled; potential projects could include sail drone and surveys in April-May-June-July, and micro-trolling[2] surveys in May-October	Hook and line	Several hundred

	Proposed Action	Area of Operation	Seasonal Frequency	Gear Used[1]	Effort[1] (No. of Tows or Casts)
Unmanned Systems including ROVs	CA Current Ecosystem spring and summer surveys conducted with available ship time	CCE	Spring/summer; Frequency: with available ship time; ~120 DAS	Unmanned Systems	~46-50 transects
	White Abalone Study using Remotely Operated Vehicles (ROV)	CCE; Southern California Bight	Opportunistically as funds and ship time are available; ~25 DAS	ROV; still and video imaging cameras taken from the ROV	Continuous
	California Current Deep Sea Coral and Sponge Assessment	CCE	Summer/1 survey per year/ 14-21 DAS	ROV with attached underwater camera, UAS and towed camera systems	1 dive/day for each DAS
	Antarctic Living Marine Resources Program (FREEBYRD) using various types of autonomous underwater vehicles, such as gliders, deployed for longer periods and greater depths	Scotia Sea/AMLR; CCE (testing)	Annually 3-5 months; deployed in December and collected in March	Gliders	Data collected at predetermined intervals; Distance 1500-6000 km
	Antarctic Living Marine Resources Program (Seabirds) - Land-based surveys using Unmanned Systems and telemetry	Scotia Sea/AMLR	Cape Shirreff field camp from December - March each year, and occupy Copacabana field camp in January into early February each year	UAS, telemetry	
	Collaborative Optical Acoustical Survey Technology (COAST) Survey using unmanned systems	Southern and Central California	Opportunistically as funds and ship time are available (~40 DAS)	Mid-frequency single beam active acoustics; Still and video camera images taken from an ROV	Continuous; Continuous
	Ecosystem Based Fisheries Management and Stock Assessment including Monterey Bay or other regions within the California Current	CCE; possibly focus on Monterey Bay Area	Monthly for 2+ years; 12 DAS annually	UAS	

	Proposed Action	Area of Operation	Seasonal Frequency	Gear Used[1]	Effort[1] (No. of Tows or Casts)
Multi-gear Surveys	California Cooperative Oceanic Fisheries Operations (CalCOFI) Winter, Spring, Summer and Fall Survey	CCE; San Diego to San Francisco	Four surveys annually. January to February, April, July, October. 90 DAS total for 4 surveys	Various plankton nets; CTD profiler and rosette water sampler; Small fine mesh nets; CUFES; Multi-frequency single-beam active acoustics; Hook and Line/Handline; Multi-beam echosounder	75-113 stations per survey; 340 samples total 340 casts total; 35-85 tows total; Continuous Continuous Continuous
	Juvenile Salmon Survey including trawl, micro-trolling[2] (hook and line) and unmanned systems	CCE	Annually, June and September, 30 DAS total for two surveys; Saildrone, surveys in April-May-June-July, and micro-trolling[2] surveys in May-October	Nordic 264 trawl; CTD profiler and rosette water sampler; Hook and line (Micro-troll[2]); Multi-frequency single beam active acoustics; Unmanned systems	50 tows; 50 casts; 50 tows (of trolling lines); Continuous; Continuous
	Humboldt State University Cooperative Fisheries Oceanography Research Team: Trinidad Headlines	CCE	Monthly; 12 hour cruise duration	Plankton nets; CTD	11 plankton tows/cruise (6 vertical; 5 oblique)
	Pacific Coast Ocean Observing Program (Central California)	Central California including Monterey and San Francisco Bays	Annually, July and October; 6 DAS total for two surveys	CTD profiler and rosette water sampler	40 casts
	Pacific Coast Ocean Observing Program (Northern California)	Northern California including areas such as Eureka	Monthly; 12 DAS for a total of 12 surveys	Various plankton nets; CTD profiler and rosette water sampler	100 tows; 100 casts

[1]Additional information on gear and effort is provided in Table 1-3.

[2]Micro-trolling uses a smaller vessel, slower tow rates, and modified recreational gear to capture fish. The slower speed and smaller hoods incur low hooking mortalities and allow for the return of fish after tagging or measuring and obtaining samples.

TABLE 1-3. DETAILED DESCRIPTION OF SWFSC RESEARCH WITH *NEW ACTIVITIES (BEGINNING 2020) IN BOLD ITALICS*

Survey Name	Survey Description	Area of Operation	Season/ Frequency/ Days at Sea (DAS)	Gear Used	Effort
Fisheries Resources Division					
CPS Survey	1- to 2-ship surveys each in the northern and southern portions of the study area to inform the annual assessment of sardines and the corresponding harvest guidelines. 2-ship surveys preferred when possible. Southern portion is in conjunction with spring or summer CalCOFI survey. Protocols similar to CalCOFI plus midwater trawls conducted near the surface at night to sample sardines. The FSV Reuben Lasker will survey distributions and abundances of coastal pelagic fish species (CPS), their prey, and their biotic and abiotic environments in the California Current between San Diego, CA and the northern extent of Vancouver Island, Canada. ***Proposed 2020-2025: Historically, the survey has only surveyed in water depths >50m and consequently does not sample the nearshore area, potentially under-sampling any nearshore CPS aggregations. The aim of this collaborative research is to quantify this potential sampling bias by using an industry fishing vessel to extend the sampling closer to shore.***	Nearshore waters out to 120 miles from San Diego, CA to the northern extent of Vancouver Island, Canada	Annually or biennially. April-May or July-August. 70 DAS (~35 DAS per vessel) Nearshore June-September; DAS: 80	NETS Nordic 264 Trawl two-warp rope trawl	50 tows 3-4 tows at night
				Various plankton nets (Bongo, Pairovet, Manta)	75 tows
				Conductivity Temperature Depth (CTD) and rosette water sampler	75 casts
				Continuous Underway Fish Egg Sampler (CUFES)	Continuous
				Hook and Line/Handline: angler hook and line gear and hand lines with tuna troll lures.	100 to 500 casts per cruise
				Multi-frequency single beam active acoustics (EK80, SX90)	Continuous
				Multi-beam echosounder (Simrad ME70) and sonar (Simrad MS70)	Continuous

Survey Name	Survey Description	Area of Operation	Season/ Frequency/ Days at Sea (DAS)	Gear Used	Effort
CalCOFI Winter, Spring, Summer and Fall Surveys	University of California (UC) at San Diego Scripps Institution of Oceanography, California Department of Fish and Wildlife. Since 1949, this survey aims to describe pelagic ecology of the California Current and its influence on the population dynamics of West Coast sardine stocks. Monitors several hundred taxa of marine fishes and zooplankton along with aspects of their physical and biological environment. Sampling protocols include transects to assess the distribution and abundance of marine mammals and seabirds.	California Current Ecosystem; San Diego to San Francisco	Four surveys annually. January to February, April, July, October. 90 DAS total for 4 surveys	Various plankton nets (Bongo, Pairovet, Manta, PRPOOS)	75-113 stations per survey; 340 samples total
				CTD profiler and rosette water sampler	340 casts total
				Various small, towed, fine mesh nets designed to sample larval and juvenile fish and small pelagic invertebrates. (Matsuta-Oozeki-Hu Trawl net, Isaac-Kidd-Midwater Trawl, MOCNESS, and Tucker)	35-85 tows total
				CUFES	Continuous
				Multi-frequency single-beam active acoustics	Continuous
				Hook and Line/Handline: angler hook and line gear and hand lines with tuna troll lures.	100 to 500 casts per cruise
				Multi-beam echosounder (Simrad ME70) and sonar (Simrad MS70)	Continuous
Collaborative Optical Acoustical Survey Technology (COAST)	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)	mid-frequency single beam active acoustics	Continuous
				still and video camera images taken from an ROV	Continuous

Survey Name	Survey Description	Area of Operation	Season/ Frequency/ Days at Sea (DAS)	Gear Used	Effort
Pacific Coast Ocean Observing Program (Central California)	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 California including Monterey and San Francisco Bays	Annually, July and October; 6 DAS total for two surveys	Various plankton nets (bongo, California Vertical Egg Tow CalVET), pairovet, manta)	40 tows
				CTD profiler and rosette water sampler	40 casts
Pacific Coast Ocean Observing Program (Northern California)	Extension of CalCOFI observation protocols to a sampling line off Eureka, CA. Surveys are conducted in conjunction with Humboldt State University.	Northern California including areas such as Eureka	Monthly; 12 DAS for a total of 12 surveys	Various plankton nets (bongo, CalVET, pairovet, manta)	100 tows
				CTD profiler and rosette water sampler	100 casts
Unmanned Systems (in water)	The use of Unmanned Surface Vehicles (USVs), gliders and other unmanned systems will augment ship surveys and monitor nearshore waters for CPS where a ship cannot safely navigate. The projects will study migrating fish stocks, vertical migration and schooling behaviors.	California Current Ecosystem	Spring/ summer; Frequency: with available ship time; ~120 DAS	Unmanned Systems	~46-50 transects
Purse Seine Survey	A commercial PSV will perform acoustic and biological surveys in conjunction with the NOAA ship Reuben Lasker along inshore portions of established transect lines to contribute additional information on the biomass of CPS ***species in waters previously un-surveyed such as nearshore;*** validation of acoustic data and additional biological samples will enhance SWFSC's ability to improve its stock assessment for Pacific Sardine and other CPS. ***This survey would be conducted in conjunction with the CPS survey.*** ***Proposed research 2020-2025 as indicated in bold italics.***	California Current Ecosystem	Summer- in order to shadow the Reuben Lasker during the California Current Ecosystem Survey; DAS: 10	Purse seine	10-25 schools sampled after targeting with acoustics; 100 sardine samples will be retained per set
				Simrad Echosounder EK60/80	200-320 tows max; 3-5 acoustic transects/day, not to exceed 35 transects

Survey Name	Survey Description	Area of Operation	Season/ Frequency/ Days at Sea (DAS)	Gear Used	Effort
White Abalone Survey	ROV surveys of endangered white abalone to monitor population recovery. Surveys confined to offshore banks, island and continental margins.	California Current Ecosystem; Southern California Bight	Opportunistically as funds and ship time are available; ~25 DAS	ROV; still and video imaging cameras taken from the ROV	
Highly Migratory Species Surveys	Cooperative survey with Pfleger Institute of Environmental Research, CDF11W, Monterey Bay Aquarium Research Institute (MBARI), Stanford University, Scripps, Texas A and M, University of Delaware, Far Seas Laboratory/Japan, CICESE Mexico to capture, ***tag and monitor highly migratory species.*** The sample collection and tagging program targets blue sharks, shortfin mako sharks, and other HMS to support stock assessments and HMS Fishery Management Plans. Information collected includes biology, distributions, movements, stock structure and status, and potential vulnerability to fishing pressure. Surveys involve catching sharks on longline ***or other gear***, measuring, attaching various tags and releasing them alive. ***Proposed research 2020-2025 as indicated in bold italics.***	Southern California Bight to Central CA	Annually, June to July, 30 DAS ***10-14 DAS for deepset buoy gear***	***Deep Set Buoy Gear: Includes two strike-indicator floats and one large non-compressible longline float affixed to a high-flyer flag and at least one locating device.*** ***Gear is designed to fish between 250 and 350 m deep 8 m-long Gangions are made of 1.8 to 2.0 mm monofilament leader with a crimped 18/0 circle hook.***	***Up to three hooks per gear with a max of 10 individual pieces deployed at one time.***
				<u>Pelagic Longline General</u>: 2-4 mile mainline with 10-15 foot gangions (consisting of leader, monofilament line, and baited hook), 50-100 feet apart using 200-400 9/0 J-type or 16/0 circle-type hooks.	

Survey Name	Survey Description	Area of Operation	Season/ Frequency/ Days at Sea (DAS)	Gear Used	Effort
Highly Migratory Species Surveys-*continued*	Cooperative survey with Pfleger Institute of Environmental Research – *continued*	Southern California Bight to Central CA - *continued*	Annually, June to July, 30 DAS - *continued*	Specific: Blue and mako sharks - Drift longline with vessel attached to one end of mainline or mainline suspended free between two radio buoys. Highly Migratory Species: - 100 hooks baited with mackerel. Swordfish and Opah: - 250 hooks baited with mackerel spread over 2-10 miles.	Blue and mako sharks - 2 sets/ day; 200 hooks; soak time: 2-4 hrs; < 30 sets. HMS - 2 sets/day; soak time: 2-4 hrs; <30 sets; Swordfish and Opah - <100m and >100m depth sets will be conducted during the night and day, respectively; Soak time: 4-6 hrs; <20 sets
				Troll/ hook and line artificial lures used to target Pacific Bluefin tuna; Live bait used in large school if located	Daytime sampling; up to 30 days of effort
				CTD profiler and rosette water sampler	60 casts
				Bongo plankton tows	60 tows
				Multi-frequency single-beam active acoustics	Continuous
Genetics Physiology and Aquaculture	Combined effort to study barotrauma and other aspects of rockfish biology in cowcod, bocaccio, and other Sebastes species through genetics, tagging, and fish collection for physiology experiments in captivity.	California Current Research Area	2 years; November-March; 4 DAS	Hook and line (recreational)	12 live fish/year

Survey Name	Survey Description	Area of Operation	Season/ Frequency/ Days at Sea (DAS)	Gear Used	Effort
Fisheries Ecology Division					
Rockfish Recruitment and Ecosystem Assessment Survey	Is a NOAA led survey that partners with UC Santa Cruz, Farallon Institute, NWFSC, MBARI, CDFW, Hopkins Marine Station Stanford University, Humboldt State University, Moss Landing Marine Laboratory, California State University Monterey Bay, California State Maritime Academy, Bodega Marine Laboratory UC Davis. The survey targets pelagic phase of juvenile rockfish and other groundfish with nighttime tows. Results of survey inform stock assessments of several rockfish populations, provides information on ecosystem and species assemblages, and may soon be used in assessments of Central California Salmon productivity.	California Current Ecosystem/ West Coast EEZ	Annually, May-mid June, 45 DAS	Modified Cobb; Isaacs Kidd	150 tows
				CTD profiler and rosette water sampler	250 casts
				Bongo and tucker plankton nets	50 tows
				Multifrequency single beam active acoustics	Continuous

Survey Name	Survey Description	Area of Operation	Season/ Frequency/ Days at Sea (DAS)	Gear Used	Effort
Juvenile Salmon Survey	Cooperative with Oregon State University, UC Santa Cruz, MBARI (Autonomous Underwater Vehicles [AUV] deployment), Moss Landing Marine Laboratory, UC Davis. 1) Use of unmanned systems and passive receivers to monitor acoustics and environmental data; 2) Gliders to receive acoustic fish tags, environmental data, eDNA, and acoustics (EK); 3) Hook-and-line trolling to capture juvenile and subadult salmon to tag with visible tags, archival tags (temp, time, depth), and acoustic tags (for distribution studies); Nordic 264 rope trawl used to collect juvenile and subadult salmonids and other epipelagic fish and invertebrates that share the coastal surface zone above the shelf. Aims to collect spatially matched biological samples (e.g. zooplankton, chlorophyll) and physical oceanographic data (e.g. temperature, salinity, turbidity) to describe the range of conditions encountered. ***Proposed 2020-2025: this project may use micro-trolling (hook and line) sampling, and unmanned aircraft for collecting hydro-acoustic and physical oceanographic data.***	California Current Ecosystem	Annually, June and September, 30 DAS total for two surveys (no current efforts are scheduled; potential projects could include sail drone and surveys in April-May-June-July, and micro-trolling surveys in May-October)	Nordic 264 trawl	50 tows
				CTD profiler and rosette water sampler	50 casts
				Hook and line (Micro-troll)	50 tows (of micro-trolling gear)
				Multi-frequency single beam active acoustics	Continuous
				Unmanned system	Continuous
				Acoustic Tags	

Survey Name	Survey Description	Area of Operation	Season/ Frequency/ Days at Sea (DAS)	Gear Used	Effort
Life History and Reproductive Ecology Investigations of Rockfish	Cooperative study with partners including industry (commercial or recreational fishing operation) charters, Moss Landing Marine Laboratories, Cal Poly researchers, Humboldt State University Researchers, University of California Davis- Bodega Marine Laboratory Researchers. ***Proposed future research (2020-2025) will focus on rockfish species (Sebastes species) while current research focuses on sablefish.*** Season is dependent on species targeted- therefore, monthly collection is possible;	California Current Ecosystem	Annually; DAS: 10-15 over multiple 1 day trips; no current efforts are scheduled; potential projects could include unmanned surveys in April-May-June-July, and micro-trolling surveys in May-October	Hook and line	Several hundred
California Current Deep Sea Coral and Sponge Assessment	Survey of fishes and deepsea corals and sponges in situ using mobile camera gear (either ROV, AUV, submersible, unmanned surface vehicle or towed camera). Cameras can be single or in stereo pairs. Resultant videos are analyzed for species densities and habitat associations. Cooperative project with NWFSC, USGS, BOEM, UCSB, CSUMB, MBARI.	California Current Research Area	Fall (Sept-Nov.)/ 1 survey per year/ 14-21 DAS	ROV with attached underwater camera, AUVs and towed camera systems	1 dive/day for each DAS
Humboldt State University Cooperative Fisheries Oceanography Research Team: Trinidad Headlines	Monthly cross-shelf ocean observing transect: hydrography, chemistry, plankton	California Current Research Area	Monthly; 12 hour cruise duration	Glider	Continuous
				Plankton nets (bongo, vertical ring)	11 plankton tows/cruise (6 vertical; 5 oblique)
				CTD	

Survey Name	Survey Description	Area of Operation	Season/ Frequency/ Days at Sea (DAS)	Gear Used	Effort
Antarctic Ecosystem Research Division					
Antarctic Living Marine Resources Program (FREEBYRD)	***Proposed research 2020-2025: The U.S. AMLR Program has developed a new oceanographic program that relies on autonomous underwater vehicles (i.e., long-range hybrid gliders) to measure the hydrography and productivity in the western Antarctic Peninsula and to obtain acoustic estimates of krill biomass/trends in lieu of chartering research vessels. Gliders would be deployed for three to four months at a time and will sample depths from the surface to 1000 m, allowing for broader temporal and spatial coverage than has been previously possible using at-sea surveys. Gliders will "fly" a programmed trajectory along the west shelf of the Antarctic Peninsula region and in the Bransfield Strait, critical areas for the krill fishery and for krill-dependent predators, and will collect data using various glider-mounted sensors. Testing would be conducted in CCRA 1 month per year.***	Scotia Sea/ AMLR; CCRA (testing)	Annually 3-5 months; deployed in December and collected in March	Gliders	Data collected at predetermined intervals; Distance 1500-6000 km
				Acoustic Zooplankton Fish Profiler (AZFP) mounted on the glider; 8 fixed moorings	Moorings equipped with single beam broadband scientific echosounders and Acoustic Doppler Current Profilers (ADCP) operating at a nominal 100khz, and sampling the upper 350m of the water column.
Antarctic Living Marine Resources Program (Seabirds)	Annual survey using UAS for seabird census and breeding colony mapping. All activities are land-based, observational, and may include use of telemetry instruments and UAS for census work of seabirds. This research is also covered under Permit No. ACA 2017-012 effective through July 30, 2021.	Scotia Sea/AMLR	Cape Shirreff field camp from December–March each year, and we occupy our Copacabana field camp in January into early February each year	UAS, telemetry	

Survey Name	Survey Description	Area of Operation	Season/ Frequency/ Days at Sea (DAS)	Gear Used	Effort
International Collaborative Research	International collaborative research cruises on commercial longline vessels fishing for toothfish (2 species) including Antarctic toothfish. Tag and release using conventional dart tags and pop-off sat tags (PSATs) as well as lethal sampling (gonads, etc.).	New Zealand Cruise			
Environmental Research Division					
Ecosystem Based Fisheries Management and Stock Assessment	Use both a fixed-wing and rotorcraft UAS for regular monthly surveys of Monterey Bay (using established track lines) to provide data on forage fisheries that are missed by the ship-borne surveys. Cooperative with NWFSC, MBARI and Monterey Bay Aquarium	California Current Ecosystem; possibly focus on Monterey Bay Area	Monthly for 2+ years; 12 DAS annually	UAS	

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2. DATES, DURATION, AND REGION OF ACTIVITY

2.1. Dates and Durations of Activities

Fisheries and ecosystem research conducted and funded by SWFSC is summarized in Table 1-2. While these surveys are planned over the next 5-year period, not every survey may occur each year. The number and extent of surveys depends on available funding, which is subject to change from year to year. However, for the purposes of this LOA application, information on the types of surveys (i.e., description), area of operation, season/frequency, gear used, and level of effort such as number of tows or casts is provided in Table 1-2 for the full suite of activities, including international work in the Antarctic, that may occur during the 5-year period 2020–2025. This precautionary approach allows SWFSC to estimate the potential for interacting with marine mammals during this period and to calculate potential takes as described in Section 6 of this application.

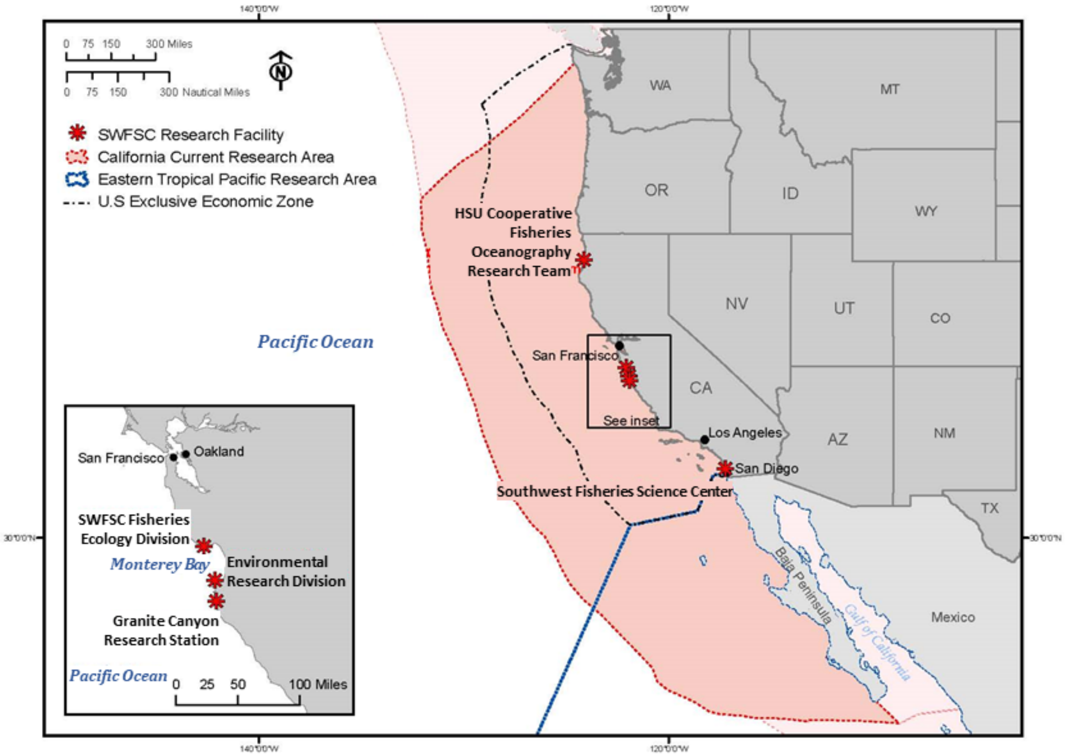
2.2. Region of Activity

SWFSC research is conducted in two geographic areas that correspond to the CCE and AMLR ecosystems (see Figure 1-1).

2.2.1. California Current Ecosystem

The California Current Large Marine Ecosystem (LME) covers a surface area of about 2.2 million square kilometers (km^2) and is bordered by the U.S. and Mexico. The California Current defines the LME and is part of the North Pacific Gyre and brings cool waters southward. The current originates off the coast of southern British Columbia and flows south along the western coast of North America, past Washington, Oregon and California, and terminates off of southern Baja California (Bograd *et al.* 2010). The California Current LME includes coastal areas where SWFSC conducts research surveys for rockfish, coastal pelagics and numerous other species (Figure 2-1). However, the SWFSC also conducts research that extends into deeper waters beyond the California Current LME boundary.

FIGURE 2-1. CALIFORNIA CURRENT ECOSYSTEM (CCE) AND FACILITIES



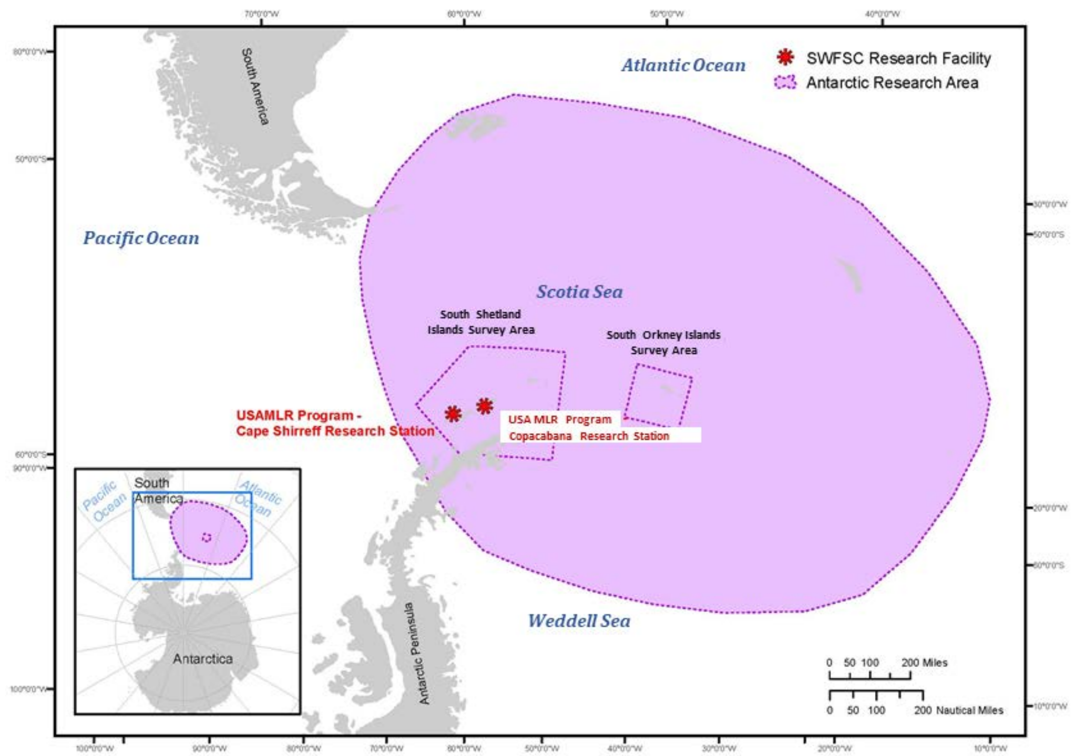
Source: NMFS 2015a

2.2.2. Antarctica

The AMLR ecosystem 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 is the world's longest ocean current and moves clockwise. There are only limited areas of shallow waters in the Southern Ocean, where the average depth is between 4,000 and 5,000 m. 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).

Survey activities conducted by the SWFSC generally occur within the Antarctic LME (Figure 2-3). The northern boundary of the Antarctic LME is defined by the Antarctic Convergence, which oscillates between 48 and 60°S. This is the boundary between cold Antarctic surface water and warmer sub-Antarctic waters (Sherman and Hempel 2009).

FIGURE 2-2. ANTARCTIC MARINE LIVING RESOURCES (AMLR) ECOSYSTEM AND FACILITIES



Source: NMFS 2015a

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3. SPECIES AND NUMBERS OF MARINE MAMMALS IN THE ACTION AREAS

Twenty-seven cetacean species (*Mesoplodon* spp. includes six beaked whale species) and six pinniped species occur in the waters of the CCE (Table 3-1). Six of the cetacean species are listed as endangered under the ESA (southern resident killer, sperm, blue, fin, sei, and humpback whales of the central America Distinct Population Segment [DPS]), and one is threatened (humpback whales of the Mexico DPS). No pinnipeds within the action areas are listed as endangered under the ESA; however, the Guadalupe fur seal is listed as a threatened species in the CCE. As seen in Table 1-2, 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 coastal bottlenose dolphins, harbor porpoise or gray whales migrating north.

Table 3-2 lists the twelve cetacean species and five pinniped species that occur in the waters of the AMLR. Four of the cetacean species are listed as endangered under the ESA (blue, fin, sperm, and southern right whales). The AMLR surveys occur annually during January-March or August-October (Table 1-2) and may interact with marine mammals that occur in the survey area. Details on species status and distribution are provided in Section 4.

Abundance estimates are based on the best available information including the most recent SARs (i.e., Carretta *et al*. 2019). To calculate CCE densities for all cetaceans except gray whales CETSound density data were used. Density maps from the CETSound website were reviewed and an appropriate density was chosen from the map based on overlap with SWFSC activities. For CCE Gray whales and pinnipeds the most recent abundance estimates were used to calculate densities. The most recently available abundance estimates were divided by the area used to determine densities in the 2015 rule (80 FR 58981). Appendix A provides detail on how each density was determined.

Data on marine mammal abundance or density the AMLR are more difficult to obtain given the remote location. For this reason, no new information is available for species that occur in this research area. Therefore, density estimates of marine mammal species provided in Table 3-2 for ARA are the same as reported in the 2015 PEA.

TABLE 3-1. ABUNDANCE, STATUS AND DENSITY OF CCE MARINE MAMMALS

Common Name	Scientific Name	Stock Abundance Estimate[1]	ESA Status[2]	MMPA Status[3]	Density (per km^2)[4]
Cetaceans					
Harbor Porpoise[5]	*Phocoena phocoena*	35,769	NL	NS	0.03411
Dall's Porpoise	*Phocoenoides dalli*	25,750	NL	NS	0.04631
Pacific White-sided Dolphin	*Lagenorhynchus obliquidens*	26,814	NL	NS	0.02084
Risso's Dolphin	*Grampus griseus*	6,336	NL	NS	0.01057
Bottlenose Dolphin[6]	*Tursiops truncatus*	2,377	NL	NS	0.00313
Striped Dolphin	*Stenella coeruleoalba*	29,211	NL	NS	0.04464
Short-beaked Common Dolphin	*Delphinus delphis*	969,861	NL	NS	0.72962
Long-beaked Common Dolphin	*Delphinus capensis*	101,305	NL	NS	0.07207
Northern Right Whale Dolphin	*Lissodelphis borealis*	26,556	NL	NS	0.03107
Killer Whale[7]	*Orcinus orca*	77	E	D	0.00064
Short-finned Pilot Whale	*Globicephala macrorhynchus*	836	NL	NS	0.00034
Baird's Beaked Whale	*Berardius bairdii*	2,697	NL	NS	0.00262
Mesoplodont Beaked Whales	*Mesoplodon spp.*[8]	3,044	NL	NS	0.00306
Cuvier's Beaked Whale	*Ziphius cavirostris*	3,274	NL	NS	0.00584
Pygmy Sperm Whale	*Kogia breviceps*	4,111	NL	NS	0.00774
Sperm Whale	*Physeter macrocephalus*	1,997	E	S, D	0.00350
Humpback Whale CA/OR/WA stock[9]	*Megaptera novaeangliae*	2,900	E, T	S, D[10]	0.00117
Blue Whale	*Balaenoptera musculus*	1,647	E	S, D	0.00090
Fin Whale	*Balaenoptera physalus*	9,029	E	S, D	0.00629
Sei Whale	*Balaenoptera borealis*	519	E	S, D	0.00037
Minke Whale	*Balaenoptera acutorostrata scammoni*	636	NL	NS	0.00096
Gray Whale[11]	*Eschrichtius robustus*	26,960	NL	NS	0.02697

Common Name	Scientific Name	Stock Abundance Estimate[1]	ESA Status[2]	MMPA Status[3]	Density (per km^2)[4]
Pinnipeds					
California Sea Lion	*Zalophus californianus*	257,606	NL	NS	0.25761
Steller Sea Lion, Eastern DPS[12]	*Eumetopias jubatus monteriensis*	71,562	NL	NS	0.06261
Guadalupe Fur Seal	*Arctocephalus townsendi*	15,830	T	D	0.01583
Northern Fur Seal[13]	*Callorhinus ursinus*	637,561	NL	D	0.63680
Harbor Seal[14]	*Phoca vitulina richardsi*	30,968	NL	NS	0.05633
Northern Elephant Seal	*Mirounga angustirostris*	179,000	NL	NS	0.17900

[1]Carretta *et al*. (2019).
[2]NL – not listed, E – Endangered, T – Threatened
[3]NS – not strategic, S – strategic, D – Depleted
[4]Densities based on area used in the 2015 rule 80 FR 58982.
[5]N. CA/ S. OR stock only; no other harbor porpoise stocks are known to have interacted with fishery research surveys
[6]Coastal plus offshore stocks used for abundance
[7]SRKW stock used to calculate density. This is the stock with the lowest abundance
[8]Includes six mesoplodont beaked whale species
[9]Change in ESA-listing status (81 FR 62259, September 8, 2016). The Central America (endangered) and Mexico (threatened) DPSs occur in the CCE. However, for MMPA purposes the operable unit is the CA/OR/WA stock. Therefore the abundance estimate from Carretta *et al*. (2019) for this stock is shown here.
[10]Central America and Mexico DPS
[11]Eastern Pacific stock. Western Pacific stock is not expected to be impacted.
[12]De-listed since the 2015 PEA (81 FR 62259, September 8, 2016).
[13]Pribilof Island/Eastern pacific stock; declining trend continues; Muto *et al.* 2018
[14]California stock.

TABLE 3-2. STATUS AND DENSITY OF AMLR MARINE MAMMALS

Common Name	Scientific Name	Estimated Number in AMLR[1]	ESA Status[2]	MMPA Status[3]	Density (animals/km^2) [4]
Cetaceans					
Spectacled Porpoise	*Phocoena dioptrica*	-	NL	NS	0.00150
Hourglass Dolphin	*Lagenorhynchus cruciger*	-	NL	NS	0.00150
Killer Whale	*Orcinus orca*	25,000	NL	NS	0.00150
Sperm Whale	*Physeter macrocephalus*	-	E	D	0.00065
Arnoux's Beaked Whale	*Berardius arnuxii*	-	NL	NS	0.00060
Southern Bottlenose Whale	*Hyperoodon planifrons*	-	NL	NS	0.00060
Long-finned Pilot whale	*Globicephala melas*	-	NL	NS	0.00760
Antarctic Minke Whale	*Balaenoptera bonaerensis*	1,544	NL	NS	0.00180
Southern Right Whale[5]	*Eubalaena australis*	1,755	E	D	0.00041
Fin Whale[6]	*Balaenoptera physalus*	n/a	E	D	0.08390
Blue Whale[7]	*Balaenoptera musculus*	4,487	E	D	0.00012
Humpback Whale[8]	*Megaptera novaeangliae*	1,829	NL	NS	0.03610
Pinnipeds					
Antarctic Fur Seal	*Arctocephalus gazella*	n/a	NL	NS	0.09990
Southern Elephant Seal	*Mirounga leonina*	640,000	NL	NS	0.00300
Crabeater Seal	*Lobodon carcinophaga*	5-10,000,000	NL	NS	0.64865
Weddell Seal[9]	*Leptonychotes weddelli*	500-100,000	NL	NS	0.05405
Leopard Seal	*Arctocephalus gazella*	220,000	NL	NS	0.01622

[1]Except where noted, data is from the 2015 PEA because more recent abundance data is not available
[2]NL – not listed, E – Endangered, T – Threatened
[3]NS – not strategic, S – strategic, D – Depleted
[4]Estimated densities are not changed from those reported in the 2015 PEA and used in the 2015 rule.
[5]Williams *et al*. (2006)
[6]Santora *et al.* (2009)
[7]Williams *et al*. (2006)
[8]Humpback whale DPSs that forage in Southern Hemisphere were delisted (81 *FR* 62259, September 8, 2016). Density from Williams *et al.* (2006)
[9]SWFSC research would take Weddell seals on pack ice, so the density provided estimates the number of seals in pack ice areas, not at-sea.

4. AFFECTED SPECIES STATUS AND DISTRIBUTION

4.1. California Current Ecosystem (CCE)

Extralimital species are not included. For the CCE, extralimital species include Bryde's whale (*Balaenoptera edeni*) and the North Pacific right whale (*Eubalaena japonica*).

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 short and stocky and are one of the smaller porpoises. On average females average 1.6 m and 60 kg, while males average 1.4 m and 50 kg (Bjørge and Tolley 2009). They are dark gray dorsally and the chin and ventral surfaces are white. Harbor porpoise have a small triangular dorsal fin that is easily recognized when swimming.

Status and Trends: Four stocks are recognized within the CCE geographic area: Morro Bay, Monterey Bay, San Francisco-Russian River, and Northern California-Southern Oregon. Harbor porpoise in California are not listed as threatened or endangered under the ESA nor as depleted under the MMPA.

Previous estimates of abundance for California harbor porpoise were based on aerial surveys conducted between the coast and the 50-fathom (fm) isobath during 1988-95 (Forney 1999). These 'early' estimates did not include the abundance of individuals found in deeper waters. Starting in 1999, aerial surveys extended farther offshore (to the 200m depth contour or a minimum of 27.8 km from shore) in the region of Monterey Bay and Morro Bay to provide a more complete abundance estimate.

Generally, the range of the following three stocks are very nearshore and the range does not overlap with the distribution of the SWFSC fisheries research surveys. The only stock potentially impacted by the surveys as indicated by the range overlap between the distribution of the porpoise and the surveys is the Northern California/Southern Oregon stock.

Morro Bay Stock: The most recent estimate of abundance for the Morro Bay stock, based on 2012 aerial surveys is 2,917 (Coefficient of Variation [CV]=0.41) harbor porpoises (Forney *et al.* 2013; as referenced in Carretta *et al.* 2019). The minimum population estimate is 2,120 animals with a Potential Biological Removal (PBR)[1] of 21 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: The most recent estimate of abundance for the Monterey Bay stock, based on 2011 aerial surveys is 3,715 (CV=0.51) harbor porpoises (Forney *et al.* 2013; as referenced in Carretta *et al.* 2019). The minimum population estimate is 2,480 animals with a PBR of 25 animals. These numbers are increased from those reported in the 2015 PEA (NMFS 2015a). The Monterey Bay harbor porpoise stock is not considered "strategic" under the MMPA. There are no known habitat issues of particular concern for this stock.

[1]Potential Biological Removal (PBR) 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.

San Francisco-Russian River: The most recent estimate of abundance for the San Francisco-Russian River stock, based on 2007-2011 aerial surveys is 9,886 (CV=0.51) harbor porpoises (Forney *et al.* 2013; as referenced in Carretta *et al.* 2019). The minimum population estimate is 6,625 animals with a PBR of 66 animals (Carretta *et al.* 2019). The latest abundance estimate is very similar to the previous 2002-2007 estimate of 9,189 harbor porpoises (Carretta *et al.* 2012), and no recent trend is apparent.

Northern California-Southern Oregon Stock: The most recent estimate of abundance for the northern California/southern Oregon stock, based on 2007-2011 aerial surveys is 35,769 (CV=0.52) harbor porpoises (Forney *et al.* 2013; as referenced in Carretta *et al.* 2019). The minimum population estimate for harbor porpoise in northern California-southern Oregon is 23,749 animals with a PBR of 475 animals. The latest abundance estimate is similar to the previous 2002-2007 estimate of 39,581 harbor porpoises (Carretta *et al.* 2012), and no recent trend is apparent.

Distribution and Habitat Preferences*:* Harbor porpoises are found throughout the coastal waters of the North Pacific, North Atlantic, and Black Sea. In the eastern North Pacific they are distributed from Point Conception, California to Alaska and across to Russia (Carretta *et al.* 2019). Along the west coast of North America, harbor porpoise are not panmictic or migratory, and their movements are sufficiently restricted such that genetic differences have evolved. They are typically found in groups of 1-3 individuals often consisting of a female-calf pair, but larger groups are not uncommon (Bjørge and Tolley 2009). Harbor porpoise frequent 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). Harbor porpoise in the CCE are not migratory and their movement is sufficiently restricted such that genetic differences have evolved (Carretta *et al*. 2019) with small-scale subdivision within the U.S. portion of this range (Chivers *et al*. 2007 as reported in Carretta *et al.* 2019).

Behavior and Life History*:* Harbor porpoises calve and breed throughout their range, generally giving birth 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). Harbor porpoise tend to avoid ships and rarely bow ride.

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 kilohertz (kHz), with a reduced sensitivity around 64 kHz. Maximum sensitivity (about 33 decibels [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 very high-frequency functional hearing group (Southall *et al.* 2019). Their vocalizations range from 110 to 150 kHz (Department of the Navy [DON] 2008a).

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 white along the dorsal edge. The tail stock is deepened and there is a noticeable beak; the flippers and fluke are small (Jefferson 2009). Males are somewhat larger than females but both may reach a length of about

2.2 m and weigh about 150 kilograms (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: There are two recognized stocks found in the North Pacific: the Alaska stock and the California/Oregon/Washington stock. Only the latter stock is expected to be potentially affected by SWFSC research activities. The most recent abundance estimate of Dall’s porpoise is from the 2008 and 2014 summer/autumn vessel-based line-transect surveys of California, Oregon, and Washington waters which estimated 25,750 (CV=0.45) animals (Barlow 2016; as cited in Carretta *et al.* 2019). The minimum population estimate is 17,954 Dall’s porpoise with a PBR of 172 animals (Carretta *et al.* 2019). The distribution and abundance of Dall’s porpoise off California, Oregon and Washington varies considerably at both seasonal and interannual time scales (Forney and Barlow 1998 as reported in Carretta *et al.* 2019, Barlow 2016; as cited in Carretta *et al.* 2019), but long term trends have not been identified. Dall’s porpoise are not listed under the ESA, nor are they considered strategic or depleted under the MMPA.

Distribution and Habitat Preferences: The species is found only in temperate waters of the North Pacific and adjacent seas (Jefferson 2009). Dall’s porpoises are commonly seen in shelf, slope and offshore waters off California, Oregon and Washington (Barlow 2016; as cited in Carretta *et al.* 2019). The sighting data suggest that north-south movements occur between these states as oceanographic conditions change, both on seasonal and inter-annual time scales.

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 2009). 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 2009).

Behavior and Life History: Calves are born in summer, and gestation is thought to be about one year (Osborne *et al.* 1988; Jefferson 2009). 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 and North Pacific 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).

Status and Trends: Although there is clear evidence that two forms of Pacific white-sided dolphins occur in the North Pacific, 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 (Carretta *et al*. 2019). Although the genetic data are unclear, management issues support the designation of two management stocks: the California/Oregon/Washington stock and the North Pacific stock" (Muto et al. 2019). Only the California/Oregon/Washington stock occurs in the CCRA.

The most recent estimate of Pacific white-sided dolphin abundance is the geometric mean of estimates from 2008 and 2014 summer/autumn vessel-based line-transect surveys of California, Oregon, and Washington waters, 26,814 (CV=0.28) animals (Barlow 2016; as cited in Carretta *et al.* 2019). The minimum population estimate is 21,195 animals and the PBR is 191 (Carretta *et al*. 2019). The distribution and abundance of Pacific white-sided dolphins off California, Oregon and Washington varies considerably at both seasonal and interannual time scales (Forney and Barlow 1998, Becker *et al*. 2012, Barlow 2016; as cited in Carretta *et al.* 2019), but no long-term trends have been identified. Pacific white sided dolphins are not considered listed under the ESA, nor are they strategic or depleted under the MMPA.

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^{o}N, just south of Baja California (Black 2009). They do not migrate but exhibit seasonal shifts in distribution related to oceanographic variability. 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 (Carretta *et al.* 2019). 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.

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). The estimate of mortality and serious injury for Pacific white-sided dolphin in the California drift gillnet fishery for the five most recent years of monitoring, 2010-2014, is 1.1 animals (CV=0.97) per year (Carretta *et al.* 2017; as reported in Carretta *et al.* 2019).

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: 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 most recent estimate of Risso's dolphin abundance is the geometric mean of estimates from 2008 and 2014 summer/autumn vessel-based line-transect surveys of California, Oregon, and Washington waters, 6,336 (CV=0.32) animals (Barlow 2016 as referenced in Carretta *et al.* 2019), The minimum population estimate is 4,817, and the PBR for Risso's dolphins is 46 animals (Carretta *et al.* 2019). No long term trends in abundance have been identified (Carretta *et al.* 2019).

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. Historically, Risso's dolphin mortality has been documented as a result of interactions with the squid purse seine fishery off Southern California (Heyning *et al.* 1994). The cause of mortality is likely from animals killed intentionally to protect catch or gear, rather than incidental mortality. Intentional takes by fisheries are now illegal under the 1994 Amendment to the MMPA. This fishery has expanded markedly since 1992 (California Department of Fish and Game, unpubl. data). An observer program in the squid purse seine fishery from 2004-2008 observed 377 sets (<10%) without an observed Risso's dolphin interaction (Carretta *et al.* 2019).

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).

<u>Behavior and Life History</u>: As summarized in Baird (2009, and citations therein), Risso's dolphins are relatively gregarious, and typically travel 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).

<u>Acoustics and Hearing</u>: 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).

4.1.5. Bottlenose Dolphin (Tursiops truncatus) California Coastal and Offshore Stocks

<u>Description</u>: 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).

<u>Status and Trends</u>: Two forms of common bottlenose dolphins are recognized in the western North Pacific Ocean: California coastal stock and California/Oregon/Washington offshore stock. The California coastal stock of bottlenose dolphins is distinct from the California/Oregon/Washington offshore stock based on significant differences in genetics and cranial morphology (Lowther-Thielking *et al.* 2015; as cited in Carretta *et al.* 2019).

California coastal bottlenose dolphins are generally found within about one kilometer of shore (Carretta *et al*. 1998; as reported in Carretta *et al.* 2019) from central California south into Mexican waters. As a result it is highly unlikely that this stock would interact with SWFSC research surveys which occur further offshore. Estimates of the California coastal stock population date back to the 1980s (Dudzik *et al.* 2006 as cited in Carretta *et al.* 2019), with the more recent estimates being larger. Previously, the closed population estimate for this stock was 453 (CV=0.06) animals (Carretta *et al.* 2019).

Bottlenose dolphins from the California/Oregon/Washington offshore stock have been found at distances greater than a few kilometers from the mainland and throughout the Southern California Bight. A recent estimate of California/Oregon/Washington offshore stock abundance is calculated as the geometric mean of estimates from 2008 and 2014 summer/autumn vessel-based line-transect surveys of California, Oregon, and Washington waters, which estimated 1,924 (CV=0.54) animals (Barlow 2016, as reported in Carretta *et al.* 2019). This estimate includes new correction factors for animals missed during the surveys. The minimum population size is based on the minimum number of individually identifiable animals documented during surveys in 2009-2011, or 346 animals (Weller *et al.* 2016; as reported in Carretta *et al.* 2019). This number of individually recognizable dolphins exceeds the number recorded in previous survey periods: 1984-1986 (160 dolphins); 1987-1989 (284); 1996-1998 (260); and 2004-2005 (164) (Weller *et al*. 2016; as reported in Carretta *et al.* 2019).

Bottlenose dolphins are not listed under the ESA nor are they considered a strategic stock or depleted under the MMPA.

<u>Distribution and habitat Preferences</u>: 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^{o} 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^{o} 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).

<u>Behavior and Life History</u>: 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 minutes are recorded for trained individuals but typical dives are shallower 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.

<u>Acoustics and Hearing</u>: 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).

4.1.6 Striped Dolphin (Stenella coeruleoalba) California, Oregon, Washington Stock

<u>Description</u>: 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: 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 most recent estimate of striped dolphin abundance is the geometric mean of estimates from 2008 and 2014 summer/autumn vessel-based line-transect surveys of California, Oregon, and Washington waters, 29,211 (CV=0.20) animals (Barlow 2016, reported in Carretta *et al.* 2019). This estimate includes new correction factors for animals missed during the surveys. The minimum population estimate is 24,782 striped dolphins with a PBR of 238 striped dolphins per year (Carretta *et al.* 2019).

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. No long term trends have been identified (Carretta *et al.* 2019).

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).

4.1.6. 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 are the most abundant cetacean off California and are widely distributed between the coast and at least 556 km distance from shore. As oceanographic conditions vary, short-beaked common dolphins may spend time outside the U.S. EEZ. Therefore, a multi-year average abundance estimate is considered the most appropriate for management within U.S. waters. The abundance estimate reported in the 2015 PEA was based on two summer/fall shipboard surveys conducted in 2005 (Forney 2007; as cited in Carretta *et al.* 2019) and 2008 (Barlow 2010). The most recent estimate of short-beaked common dolphin abundance (969,861 [CV = 0.17]) is the geometric mean of estimates from 2008 and 2014 summer/autumn vessel-based line-transect surveys of California, Oregon, and Washington waters (Barlow 2016 as cited in Carretta *et al.* 2019). The minimum population estimate is 839,325 short-beaked common dolphins with a PBR of 8,393 short-beaked common dolphins per year (Carretta *et al.* 2019).

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 considered strategic or depleted under the MMPA.

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 556 km 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 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 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.

4.1.7. 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*:* 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 distribution and abundance of long-beaked common dolphins off California varies inter-annually and seasonally. As oceanographic conditions change, long-beaked common dolphins may move between Mexican and U.S. waters, and therefore a multi-year average abundance estimate is considered the most appropriate for management within the U.S. waters. The most recent geometric mean abundance estimate (101,305 [CV=0.49]) for California, Oregon and Washington waters is based on two ship surveys conducted in 2008 and 2014, with additional correction factors (Barlow 2016; as cited in Carretta *et al.* 2019). The minimum population estimate is 68,432, and the PBR is 657 long-beaked common dolphins for the California stock (Carretta *et al.* 2019).

There appears to be an increasing trend of long-beaked common dolphins in California waters over the last 30 years, but a trend analysis for this stock has not been performed to date (Carretta *et al.* 2019). 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 strategic or depleted under the MMPA.

Distribution and Habitat Preferences*:* Long-beaked common dolphins are commonly found within about 93 km of the coast, from Baja California (including the Gulf of California) northward to about central California (Carretta *et al.* 2019). 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.

4.1.8. 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*:* As northern right-whale dolphins may spend time outside the U.S. EEZ, NMFS considers a multi-year average abundance estimate the most appropriate for management within U.S. waters. The most recent estimate of northern right whale dolphin abundance (26,556 with correction factors [CV=0.44]) is the geometric mean of estimates from 2008 and 2014 summer/autumn vessel-based line-transect surveys (Barlow 2016 as cited in Carretta *et al*. 2019). The minimum population estimate for 2008-2014 is 18,608 dolphins and the PBR is 179 dolphins per year (Carretta *et al*. 2019). Long term trends have not been identified.

No habitat issues are known to be of concern for this species. They are not listed as threatened or endangered under the ESA nor are they considered strategic or depleted under the MMPA.

Distribution and Habitat Preferences*:* This species is endemic to the North Pacific Ocean, and is found primarily in cool-temperate (8–19^{o} C) continental shelf and slope waters. 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). Off the U.S. west coast, they have been seen primarily in shelf and slope waters with seasonal movements into the Southern California Bight (Carretta *et al*. 2019). Northern right-whale dolphins occur in the survey area year-round, but their abundance and distribution vary seasonally. Based on sighting patterns, Barlow (2016; as cited in Carretta *et al.* 2019) suggested seasonal north-south movements, with animals found primarily off California during the colder water months and shift northward into Oregon and Washington as water temperatures increase in late spring and summer.

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.

4.1.9. Killer Whale (Orcinus orca)

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*:* There are three recognized stocks of killer whale that may occur in the SWFSC research area: southern resident, transient, and offshore. 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).

Eastern North Pacific Southern Resident. On September 19, 2019, NMFS proposed to expand critical habitat for the southern resident stock of killer whales based on information about their coastal range and habitat use (84 FR 49214) The proposal would extend critical habitat for the whales along approximately 160 km of West Coast waters between the depths of 6.1 m and 200 m. Designated critical habitat would stretch from Cape Flattery, Washington, south to Point Sur, California, just south of Santa Cruz and Monterey Bay. The additional area covers roughly 40,471 km^2 or more than 10 million acres.

The southern resident population increased to 99 whales in 1995, then declined to 79 whales in 2001, and most recently numbered 77 whales in 2017 (Carretta *et al*. 2019). The most recent census spanning 1 July 2016 through 1 July 2017 includes no new calves and the deaths of three post-reproductive age females, a young adult male, and a young reproductive age female and her dependent calf. The PBR level for this stock is calculated as the minimum as of 0.13 whales per year, or one whale every 7 years.

__Transient__. 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.

__Eastern North Pacific Offshore__. Population size of the eastern North Pacific stock of offshore killer whales is estimated with photo-ID mark-recapture methods at 300 whales (95% Highest Posterior Density Interval (HPDI) = 257–373, CV=0.10), including marked and unmarked individuals encountered from 1988-2012 (Ford *et al.* 2014; as reported in Carretta *et al*. 2019). This study included 157 encounters of 355 distinct whales from the Aleutian Islands to southern California. The minimum population estimate is 276 animals and the PBR for this species is 2.8.

__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. 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*. 2003). 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.

4.1.10. 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**:* 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 most recent estimate of short-finned pilot whale abundance is the geometric mean of estimates from 2008 and 2014 summer/autumn vessel-based line-transect surveys of California, Oregon, and Washington waters, or 836 (CV=0.79) animals (Barlow 2016 as cited in Carretta *et al*. 2019). This estimate includes new correction factors for animals missed during the surveys. The minimum population estimate is 466 and the PBR is calculated as 4.5 whales per year (Carretta *et al*. 2019)

Following the virtual disappearance of short-finned pilot whales from California after the 1982-83 El Niño, they have been encountered infrequently and primarily during warm-water years, such as 1991, 1993, 1997, 2014, and 2015 (e.g., Barlow 2016; as cited in Carretta *et al.* 2019). These patterns likely reflect large-scale, long-term movements of this species in response to changing oceanographic conditions. It is not known whether the animals sighted more recently are part of the same population that was documented off Southern California before the mid-1980s or a different wide-ranging pelagic population. Therefore, no inferences can be drawn regarding trends in abundance of short-finned pilot whales off California, Oregon and Washington.

Short-finned pilot whales are not listed as threatened or endangered under the ESA or considered as strategic or depleted under the MMPA.

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).

4.1.11. 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. Mean body length of whales 15 years or older are 10.5 m in females and 10.1 m in males.

Status and Trends*:* The abundance of Baird's beaked whales in the California Current is estimated at 5,394 (CV=0.83) and 7,960 (CV=0.93) for surveys conducted in 2008 and 2014, respectively (Carretta *et al*. 2019). A trend-based analysis of line-transect data from all surveys conducted between 1991 and 2014 yielded an estimate of abundance of 2,697 (CV=0.60) whales (Moore and Barlow 2017; as cited in Carretta *et al.* 2019). These numbers were based on newer (lower) g(0) estimates from earlier analyses but were not as low as those used by Barlow (2016; as cited in Carretta *et al.* 2019), thus the abundance estimates are not as high (Moore and Barlow 2017; as cited in Carretta *et al.* 2019). Based on this analysis, the recent 2014 estimate of 2,697 (CV=0.60) Baird's beaked whales is considered the most appropriate estimate for this stock. Their minimum population estimate is 1,633, and the PBR is 16 Baird's beaked whales per year (Carretta *et al*. 2019).

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 strategic or depleted under the MMPA.

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^{o} 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 minutes to a maximum of 68 minutes (Baird *et al*. 2006).

Acoustics and Hearing*:* DON (2008b) reviewed the literature on beaked whale acoustics and reported that beaked whales use frequencies 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.

4.1.12. Mesoplodont Beaked Whales (Mesoplodon spp.) California, Oregon, Washington Stocks

Description*:* 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*) (Carretta *et al*. 2019). 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.

<u>Status and Trends</u>*:* A trend-based analysis of line-transect data from surveys conducted between 1991 and 2014 provides new estimates of Mesoplodon species abundance (Moore and Barlow 2017; as cited in Carretta *et al.* 2019). The new estimate accounts for the proportion of unidentified beaked whale sightings likely to be Mesoplodon beaked whales and uses a correction factor for missed animals adjusted to account for the fact that the proportion of animals on the trackline missed by observers increases in rough seas.

The best estimate of Mesoplodon abundance is represented by the model-averaged estimate for 2014 (Moore and Barlow 2017, as cited in Carretta *et al*. 2019). Based on this analysis, the best (50th percentile) estimate of abundance for all species of Mesoplodon species combined in 2014 in waters off California, Oregon and Washington is 3,044 (CV=0.54). The trend-model analysis incorporates information from the entire 1991- 2014 time series for each annual estimate of abundance, and suggests evidence of an increasing abundance trend over that time (Moore and Barlow 2017, as cited in Carretta *et al*. 2019), which is a reversal of the population decline reported by Moore and Barlow (2013; as cited in Carretta *et al.* 2019). The minimum population estimate for mesoplodont beaked whales in California, Oregon, and Washington is 1,967 animals and the PBR is 20.

None of the six mesoplodont species are listed as threatened or endangered under the ESA nor are they considered strategic or depleted under the MMPA.

<u>Distribution and Habitat Preferences</u>*: 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).

<u>Behavior and Life History</u>*:* 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 minutes to a maximum of 68 minutes (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).

4.1.13. 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*:* A line-transect survey of U.S. west coast waters in 2014 yielded an abundance estimate of 3,775 (CV=0.68) Cuvier's beaked whales (Barlow 2016 as cited in Carretta *et al.* 2019). A trend-based analysis of line-transect data from surveys conducted between 1991 and 2014 incorporated information from the entire time series for each annual estimate of abundance. Given the strong evidence of a decreasing trend in abundance over that time (Moore and Barlow 2013 and 2017; as cited in Carretta *et al*. 2019), the best estimate of abundance for Cuvier's beaked whales in 2014 in waters off California, Oregon and Washington is 3,274 (CV= 0.67) whales (Carretta *et al*. 2019). The minimum population estimate is 2,509 animals and PBR for the species is 21 per year (Carretta *et al*. 2019). There is substantial evidence, based on line-transect survey data and the historical stranding record off the U.S. west coast, that the abundance of Cuvier's beaked whales in waters off California, Oregon and Washington is lower than in the early 1990s (Moore and Barlow 2013 and 2017, as cited in Carretta *et al*. 2019).

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 strategic or depleted under the MMPA.

Distribution and Habitat Preferences*:* Cuvier's beaked whales are 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 minutes) 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).

4.1.14. Pygmy Sperm Whale (Kogia breviceps)

***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 (McAlpine 2009). Adults are bluish-gray to blackish-brown dorsally and light below. 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."

***Status and Trends**:* Most sightings of *Kogia* in the CCE are only identified to genus due to their cryptic nature. Based on previous sighting surveys and historical stranding data, it is likely that recent ship survey sightings were of pygmy sperm whales; *K. breviceps* rather than dwarf sperm whales (*K. sima*) (Carretta et al. 2019). The rarity of 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 (Carretta et al. 2019).

No information is available to estimate the population size of dwarf sperm whales off the U.S. west coast, as no sightings of this species have been documented despite numerous vessel surveys of this region (Barlow 1995; Barlow and Gerrodette 1996; Barlow and Forney 2007; Forney 2007; Barlow 2010, Barlow 2016). Therefore all *Kogia* sightings are considered *K. breviceps* for purposes of this LOA application.

The best estimate of abundance for this stock is 4,111 (CV=1.12) animals based on the geometric mean of 2008 and 2014 shipboard line-transect surveys. This estimate is considerably higher than previous abundance estimates for the genus Kogia and results from a new and lower estimate of g(0), the trackline detection probability (Barlow 2015 as cited in Carretta *et al*. 2019). Only 3% of Kogia groups were estimated to have been detected on the trackline during 1991-2014 surveys (Barlow 2016 as cited in Carretta *et al*. 2019). The minimum population estimate is 1,924 animals and the PBR is 19 pygmy sperm whales per year.

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 strategic or deplete under the MMPA.

Distribution and Habitat Preferences*:* Pygmy 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 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 this species. *Kogia* feed on cephalopods and, less often, on deep-sea fishes and shrimps, and 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. Recordings of stranded pygmy sperm whales were in the 60 to 200 kHz range (DON 2008a).

4.1.15. 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: Previous estimates of sperm whale abundance from 2005 (3,140, CV=0.40, Forney 2007) and 2008 (300, CV=0.51, Barlow 2010 as cited in Carretta *et al*. 2019) show a ten-fold difference that cannot be attributed to human-caused or natural population declines and likely reflect sampling variance or inter-annual variability in movement of animals into and out of the study area. New estimates of sperm whale abundance in California, Oregon, and Washington waters out to 300 nmi are available from a trend-model analysis of line-transect data collected from seven surveys conducted from 1991 to 2014 (Moore and Barlow 2017; as cited in Carretta *et al.* 2019), using the same methods and in a previous abundance trend analysis (Moore and Barlow 2014; as cited in Carretta *et al.* 2019). Abundance trend models incorporate information from the entire 1991-2014 time series to obtain each annual abundance estimate, yielding estimates with less inter-annual variability. The trend model also uses improved estimates of group size and trackline detection probability (Moore and Barlow 2014; as cited in Carretta *et al*. 2019, Barlow 2015, as cited in Carretta *et al*. 2019). Sperm whale abundance estimates based on the trend-model ranged between 2,000 and 3,000 animals for the 1991-2014 time series (Moore and Barlow 2014; as cited in Carretta *et al.* 2019). The best estimate of sperm whale abundance in the California Current is the trend-based estimate corresponding to the most recent survey (2014), or 1,997 (CV= 0.57) animals. This estimate is corrected for diving animals not seen during surveys. The minimum population estimate is 1270 whales (Moore and Barlow 2017; as cited in Carretta *et al.* 2019) and the PBR is 2.5 whales per year.

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. Moore and Barlow (2014; as cited in Carretta *et al.* 2019) reported that sperm whale abundance appeared stable from 1991 to 2008 and additional data from a 2014 survey does not change that conclusion (Moore and Barlow 2017; as reported in Carretta *et al*. 2019).

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.

<u>Distribution and Habitat Preferences</u>*:* 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^{o} 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^{o} W) and tapers off northward towards the tip of Baja California.

<u>Behavior and Life History</u>*:* 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. 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 minutes (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 minute dive with a 9 minute 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 milliseconds), low frequency (dominant frequencies around 0.5 kHz) with estimated source levels between 140 and 162 dB re 1 micro Pascal (μPa-m) root means square (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).

4.1.16. Humpback Whale (Megaptera novaeangliae) Central America and Mexico DPSs

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: For the MMPA stock assessment reports, the California/Oregon/Washington Stock is defined to include humpback whales that feed off the west coast of the U.S., including animals from both the California-Oregon and Washington-southern British Columbia feeding groups (Calambokidis *et al.* 2008, Barlow *et al.* 2011). The relationship of MMPA stocks to ESA DPSs is complex. Whales from three different DPSs (Central America, Mexico, and Hawaii) are included in the MMPA stock identified in this report as the "California/Oregon/Washington Stock" (Muto et al. 2019). Most humpbacks that feed in California and Oregon waters in summer originate from the threatened Mexico DPS, while a much smaller fraction originate from the endangered Central American DPS (Wade *et al.* 2016, Wade 2017)[2]. In Washington and southern British Columbia waters, all three DPSs (Hawaii, Mexico, and Central America) occur.

Distribution and Habitat Preferences: 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

[2]On September 8, 2016, NMFS issued a final rule that revised the global listing status of the humpback whale by dividing the species into 14 distinct DPSs. Of these 14 DPS, NMFS listed four. The endangered Central America DPS and the threatened Mexico DPS occur within the CCE and are considered discrete. Calambokidis et al. (2017 as reported in Carretta et al. 2019) reported that approximately 70% of whales photographed in the breeding grounds of these two DPSs have been matched to California and Oregon waters.

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 minutes 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.

In the CCRA, several commercial fisheries interactions involving humpback whales were reported in Carretta *et al*. (2018 and 2019). Carretta *et al.* (2018) reported 123 human-related interactions involving humpback whales between 2012 and 2016. Both serious and non-serious injuries were recorded, and mortality involving pot/trap fisheries (57), unidentified fishery interactions (49), vessel strikes (13), gillnet fisheries (3) and marine moorings (1). The number of deaths and injuries for each humpback whale feeding group that are human related are unknown but based on the proportion of the overall abundance of the California-Oregon (82%), Washington and southern British Columbia feeding groups, a majority of fishery interactions with humpbacks likely involve whales from the California-Oregon feeding group that includes nearly all of the endangered Central American population (Calambokidis *et al*. 2017).

Fifty-seven interactions with pot and trap fisheries were observed between 2012 and 2016 (Carretta *et al.* 2018). There were 18 records of non-serious injuries resulting from human intervention to remove gear, or cases where animals were able to free themselves. Two dead whales were recorded, including one humpback found in sablefish pot gear in Oregon while severed humpback flukes were also found entangled in California Dungeness crab gear in southern California (Carretta *et al.* 2018, 2019). The remaining 36 pot/trap fishery entanglements, or 6.4 humpback whales annually (Carretta *et al*. 2019) were taken primarily in several Dungeness crab pot fisheries in California and Oregon. In May 2017, a California Department of Fish and Wildlife Working Group began a process to consider these risks and develop actions to address them.

Collisions with ships is a primary source of mortality for several species of large whales including humpback whales. Carretta et al. 2018 and 2019 reported 13 humpback whales (8 deaths, 2.6 serious injuries, and 2 non-serious injuries) struck by vessels between 2012 and 2016 (). Rockwood et al. (2017)

estimated that 22 humpback whale ship strikes occurred annually from 2012-2016, though this includes only the period July–November when whales are most likely to be present in the U.S. West Coast EEZ. Based on the population size of the stock (2,900 whales), the annual mortality (22 humpback whales) represents approximately 0.7% of the stock (Carretta et al. 2019).

***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).

4.1.17. 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. 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. Underwater they are slate blue; above water, they appear mottled light and dark shades of gray.

***Status and Trends**:* The size of the feeding stock of blue whales off the U.S. West Coast has been estimated by line-transect and mark-recapture methods. 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 can provide an estimate of total population size if differences in capture heterogeneity are addressed.

Abundance estimates from line-transect surveys have been highly-variable and this variability is attributed to northward distributional shifts of blue whales out of U.S. waters linked to warming ocean temperatures (Barlow and Forney 2007, Calambokidis *et al*. 2009, Barlow 2010; 2016 as cited in Carretta *et al*. 2019). Generally, the highest abundance estimates from line-transect surveys occurred in the mid-1990s, when ocean conditions were colder than present-day. Since that time, line-transect abundance estimates within the California Current have declined, while estimates from mark-recapture studies have remained stable. Evidence for a northward shift in blue whale distribution includes increasing numbers of blue whales found in Oregon and Washington waters during a 1996-2014 line-transect surveys (Barlow 2016; as cited in Carretta *et al.* 2019) and satellite tracks of blue whales in Gulf of Alaska and Canadian waters between 1994 and 2007 (Bailey *et al*. 2009). An analysis of line-transect survey data from 1996-2014 provided a range of blue whale estimates from a high of approximately 2,900 whales in 1996 to a low of 900 whales in 2008 (Barlow 2016; as cited in Carretta *et al.* 2019). The mean abundance estimate from the two most-recent line-transect surveys conducted in 2008 and 2014 is 1,146 (CV=0.33) whales. The minimum population estimate is from mark-recapture studies is 1,551 whales and the PBR is 2.3 individuals per year.

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.

During the period 2012-2016, a blue whale was seriously injured in an unidentified pot/trap fishery while two blue whales were seriously injured in California Dungeness crab pot gear and a third (Carretta *et al*. 2018). Entanglements of blue whales in the California swordfish drift gillnet fishery have not been observed during a 27-year observer program that began in 1990 (Carretta *et al.* 2018). 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 in those fisheries.

Rockwood *et al*. 2017 estimated ship strike mortality for blue whales in the U.S. West Coast EEZ. Based on a moderate level of vessel avoidance, the estimated number of annual ship strike deaths was 18 blue whales, approximately 1% of the estimated population size of the stock. However, this number was only for the months July–November when whales are most likely to be present in the EEZ and the season that overlaps with cetacean habitat models (Becker *et al*. 2016, Rockwood *et al*. 2017 as cited in Carretta *et al*. 2019).

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. 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 minutes when foraging and to 68 m and for 4.9 minutes 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).

4.1.18. 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. 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. The pigmentation also is shown in the baleen plates, which are gray and yellowish.

Status and Trends*:* The pre-whaling population of fin whales in the North Pacific was estimated to be 42,000-45,000 (Ohsumi and Wada 1974; as cited in Carretta *et al*. 2019). In 1973, the North Pacific population was estimated to have been reduced to 13,620-18,680 (Ohsumi and Wada 1974; as cited in Carretta *et al*. 2019), of which 8,520-10,970 were estimated to belong to the eastern Pacific stock. Indications of recovery in CA coastal waters date back to 1979/80 (Barlow 1994; as reported in Carretta *et al.* 2019), but there is now strong evidence that fin whale abundance increased in the California Current between 1991 and 2008 based on analysis of line transect surveys conducted in the California Current between 1991 and 2014 (Nadeem *et al*. 2016 as referenced in Carretta *et al*. 2019). The best estimate of fin whale abundance in California, Oregon, and Washington waters out to 300 nmi is 9,029 (CV=0.12) whales, based on a trend analysis of 1991-2014 line-transect data (Nadeem *et al*. 2016 as cited in Carretta *et al*. 2019). The minimum population estimate is 8,127 whales and PBR for the species is calculated to be 81 whales per year.

The new abundance estimate is significantly higher than earlier estimates because the new analysis incorporates lower estimates of g(0), the trackline detection probability (Barlow 2015 as cited in Carretta *et al*. 2019). The trend-model analysis incorporates information from the entire 1991-2014 time series for each annual estimate of abundance, and given the strong evidence of an increasing abundance trend over that time (Moore and Barlow 2011and Nadeem *et al*. 2016 as cited in Carretta *et al*. 2019), the best estimate of abundance is represented by the estimate for the most recent year, or 2014. This is probably an underestimate because it excludes some fin whales that could not be identified in the field and were recorded as “unidentified rorqual” or “unidentified large whale”.

Fin whales in the North Pacific were given protected status by the IWC in 1976. They 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.

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^{o} 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 (Aguillar 2009).

Collisions with ships is a primary source of mortality for several species of large whales including fin whales. During the months July–November, approximately <0.5% of the estimated population of fin whales (43/9,029 whales) Aare killed annually due to ship strike in the U.S. West Coast EEZ (Rockwood *et al.* 2017 as cited in Carretta *et al.* 2019).

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).

4.1.19. 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. 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.

Status and Trends: The best current estimate of abundance for California, Oregon, and Washington waters is the unweighted geometric mean of the 2008 and 2014 estimates, or 519 (CV=0.40) sei whales

(Barlow 2016; as cited in Carretta *et al.* 2019). The minimum population estimate is 374 whales and the calculated PBR is 0.75 sei whales per year.

Ohsumi and Wada (1974; as cited in Carretta *et al*. 2019) estimated the pre-whaling abundance of sei whales to be 58,000-62,000 in the North Pacific. Tillman (1977; as cited in Carretta *et al*. 2019) estimated sei whale abundance in the North Pacific and revised this pre-whaling estimate to 42,000 (Carretta *et al*. 2019). 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 considered as a depleted and strategic stock under the MMPA.

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).

4.1.20. Common Minke Whale (Balaenoptera acutorostrata scammoni) California, Oregon, Washington Stock

Description*:* As summarized by, 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*:* 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). 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 most recent abundance estimate for the California/Oregon/Washington stock is based on the geometric mean of estimates obtained from ship line transect surveys in summer and autumn in 2008 and 2014, or 636 (CV=0.72) whales (Barlow 2016 as reported in Carretta *et al*. 2019). The minimum population estimate is 369 whales, and the calculated PBR for this stock is 3.5 whales (Carretta *et al*. 2019). They are not listed under the ESA and are not considered strategic or depleted under the MMPA.

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. They typically occur as single animals, rather than in groups. 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. 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. 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).

4.1.21. 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*:* There are two populations, the western North Pacific stock that migrates along Asia and into the Okhotsk Sea, and the eastern North Pacific stock 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. While western North Pacific gray whales could be part of the large number of gray whales migrating through the CCRA, the probability that a western North Pacific gray whale would interact with SWFSC research would be extremely small. The western North Pacific population is not considered further.

The most recent estimate of abundance for the eastern North Pacific population is from the 2015/2016 southbound survey and is 26,960 (CV=0.05) whales (Durban *et al*. 2017; as reported in Carretta *et al*. 2019). The minimum population estimate is 227 animals and PBR for the stock is the default recovery factor of 0.5 animals per year (Carretta *et al*. 2019). They are not listed under the ESA and are not considered strategic or depleted under the MMPA.

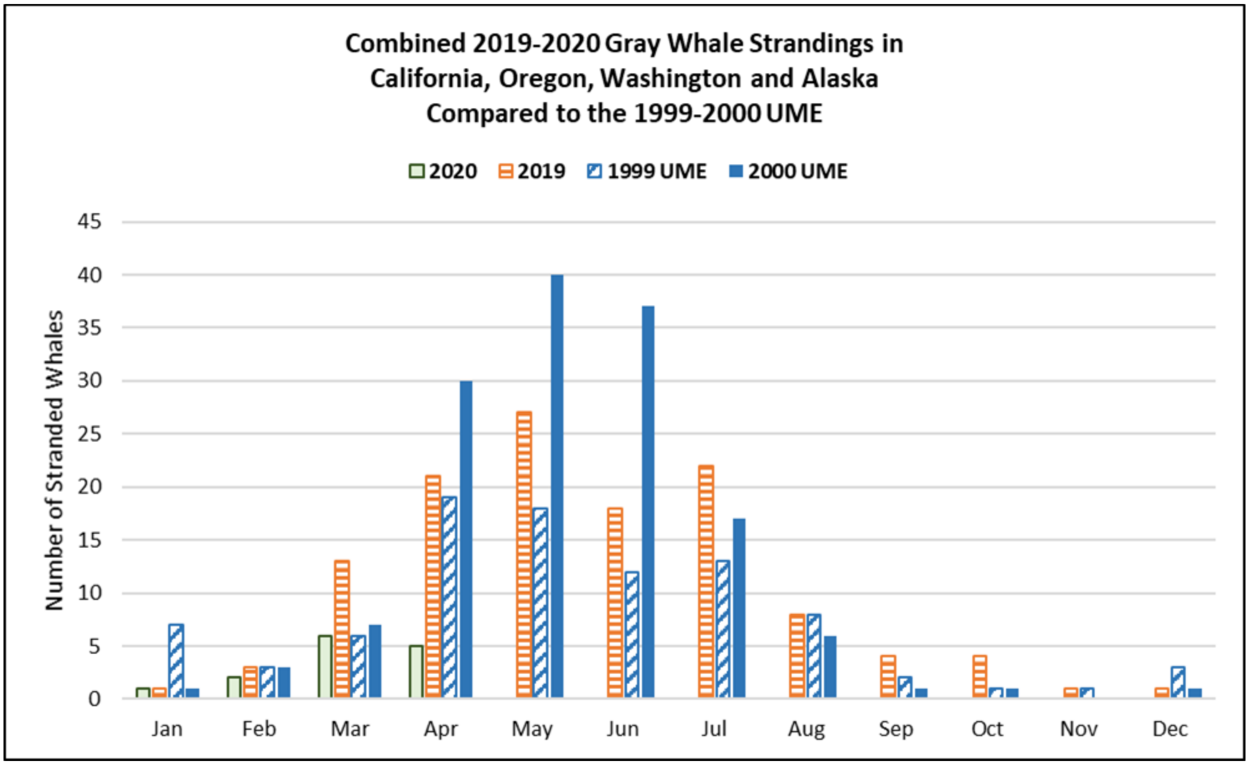
The population size of the North Pacific gray whale stock has increased over several decades despite an UME in 1999 and 2000 (Carretta *et al*. 2019) and a recent UME in 2019-2020[3]. Durban *et al*. (2017; as reported in Carretta *et al*. 2019) noted that a recent 22% increase in ENP gray whale abundance over 2010/2011 levels is consistent with high observed and estimated calf production (Perryman *et al.* 2017; as cited in Carretta *et al*. 2019). Recent increases in abundance also support hypotheses that gray whales may experience more favorable feeding conditions in arctic waters due to an increase in ice-free habitat that might result in increased primary productivity in the region (Perryman *et al*. 2002; as cited in Carretta *et al.* 2019, Moore 2016; as cited in Carretta *et al.* 2019).

Since January 1, 2019, gray whale strandings have been documented along the west coast of North America from Mexico through Alaska. This event has been declared an Unusual Mortality Event (UME), and as of March 13, 2020 a total of 264 whales have stranded[2]. Figure 4-1 compares the number of whales stranded during this recent event to numbers stranded during the larger event in 1999-2000. Full or partial necropsy examinations were conducted on a subset of the whales stranded in 2019-2020. Preliminary findings in several of the whales have shown evidence of emaciation. These findings are not consistent across all of the whales examined.

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 sightings in studied

[3]https://www.fisheries.noaa.gov/national/marine-life-distress/2019-2020-gray-whale-unusual-mortality-event-along-west-coast.

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).



Source: https://www.fisheries.noaa.gov/national/marine-life-distress/2019-2020-gray-whale-unusual-mortality-event-along-west-coast

FIGURE 4-1. 2019-2020 GRAY WHALE STRANDINGS COMPARED TO 1999-2000 UME

***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.

4.1.22. California Sea Lion (Zalophus californianus) U.S. Stock

***<u>Description</u>**:* 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.

***<u>Status and Trends</u>**:* California sea lion population size was estimated from a 1975-2014 time series of pup counts (Lowry *et al.* 2017; as reported in Carretta *et al.* 2019), combined with mark-recapture estimates of survival rates (DeLong *et al.* 2017; as reported in Carretta *et al*. 2019; Laake *et al.* 2018; as reported in Carretta *et al*. 2019). Population size in 2014 was estimated at 257,606 animals, which corresponded with a pup count of 47,691 animals along the U.S. west coast (Lowry *et al.* 2017 and Laake *et al*. 2018; as cited in Carretta *et al.* 2019). Minimum population size for 2014 is taken as the lower 95% confidence interval (CI) of the 2014 population size estimate, or 233,515 animals (Laake *et al*. 2018; as reported in Carretta *et al.* 2019), and the PBR is 14,011 California sea lions per year.

Age- and sex-specific survival rates of California sea lions were estimated by DeLong *et al.* (2017 as reported in Carretta *et al*. 2019), and female survivorship exceeds that of males. Annual pup survival was 0.600 and 0.574 for females and males, respectively. Maximum annual survival rates corresponded to animals 5 years of age (0.952 and 0.931 for females and males, respectively). Survival of pups and yearlings declined with increasing sea surface temperatures.

Elevated strandings of California sea lion pups have been occurring in Southern California since January 2013[4]. This event has been declared a UME, and is confined to pup and yearling California sea lions. Many of the sea lions are emaciated, dehydrated and very underweight for their age. Research to date indicates that a change in the availability sardines is a likely contributor to the large number of strandings. Sardine spawning grounds shifted further offshore in 2012 and 2013, and while other prey were available (market squid and rockfish), these may not be providing adequate nutrition in the milk of sea lion mothers supporting pups, or for newly-weaned pups foraging on their own.

California sea lions in the U.S. are not listed as endangered or threatened under the ESA or as strategic or depleted under the MMPA.

***<u>Distribution and Habitat Preferences</u>**:* 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

[4] https://www.fisheries.noaa.gov/national/marine-life-distress/2013-2017-california-sea-lion-unusual-mortality-event-california

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 2008).

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).

4.1.23. Steller Sea Lion (Eumetopias jubatus monteriensis) Eastern DPS

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: 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 71,562. This stock is listed as threatened under ESA and depleted under the MMPA.

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^{o} 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 2005). 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 nautical mile (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. 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).

4.1.24. 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.

Status and Trends: 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). As reported in Carretta *et al.* (2019), surveys conducted between 2008 and 2010 resulted in a total estimated population size of approximately 20,000 animals, with ~17,500 at Isla Guadalupe and ~2,500 at Isla San Benito (García-Capitanachi 2011, Aurioles-Gamboa 2015; both as reported in Carretta *et al.* 2019). These estimates are corrected for animals not seen during the surveys. All the individuals of the population cannot be counted because all age and sex classes are never ashore at the same time and some individuals that are on land are not visible during the census (Carretta e*t al*. 2019). Direct counts of animals at Isla Guadalupe and Isla San Benito during 2010 resulted in a minimum of 13,327 animals and 2,503 animals respectively, for a minimum population size of 15,830 animals (García-Capitanachi 2011 as reported in Carretta *et al.* 2019). The PBR is calculated to be 542 seals per year.

A UME for Guadalupe fur seals has been occurring since 2015 along the entire coast of California; strandings have been eight times higher than the historical average. In 2019, strandings in Washington and Oregon became elevated and these states were added to the UME[5]. Strandings are seasonal and generally peak in April through June of each year. Guadalupe fur seals are stranding alive and dead. Those stranding are mostly weaned pups and juveniles (1–2 years old). The majority of stranded animals showed signs of malnutrition with secondary bacterial and parasitic infections.

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 Guadalupe fur seal is listed under the ESA as a threatened species, which automatically qualifies this stock as depleted and strategic under the MMPA. There is insufficient information to determine whether fishery mortality in Mexico exceeds the PBR for this stock, but given the observed growth of the population over time, this is unlikely. The population is growing at approximately 10% 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. The Guadalupe fur seal occurs in low numbers seasonally in California waters. 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.

[5]https://www.fisheries.noaa.gov/national/marine-life-distress/2015-2020-guadalupe-fur-seal-unusual-mortality-event-california.

<u>Behavior and Life History</u>: 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).

<u>Acoustics and Hearing</u>: 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).

4.1.25. Northern Fur Seal (Callorhinus ursinus) California Stock

<u>Description</u>: 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.

<u>Status and Trends</u>: Two separate stocks of northern fur seals are recognized within U.S. waters: an Eastern Pacific stock and a California stock (including San Miguel Island and the Farallon Islands). The most recent population estimate for the entire stock of California northern fur seals, which incorporates estimates from San Miguel Island and the Farallon Islands in 2013, is 14,050 (Carretta *et al.* 2019). The total minimum population size is the sum of the minimum population sizes at San Miguel Island (6,858) and the Farallon Islands (666) in 2013, or 7,524 northern fur seals. The PBR for the stock is 451 animals per year.

As reported in Carretta *et al.* (2019), northern fur seals were extirpated on San Miguel Island and the Farallon Islands during the late 1700s and early 1800s. Immigrants from the Pribilof Islands and Russian populations recolonized San Miguel Island during the late 1950s or early 1960s. The colony has increased steadily, since its discovery in 1968, except for severe declines in 1983 and 1998 associated with El Niño events in 1982-1983 and 1997-1998 (DeLong and Antonelis 1991, Melin *et al.* 2008). El Niño events impact population growth of northern fur seals at San Miguel Island and are an important regulatory mechanism for this population (DeLong and Antonelis 1991; Melin and DeLong 2000; Melin *et al.*, 2008; Orr *et al*. 2012, as reported in Carretta *et al.* 2019).

The California northern fur seal stock is not considered to be depleted under the MMPA or listed as threatened or endangered under the ESA.

<u>Distribution and Habitat Preferences</u>: NMFS (2007) summarized the 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^{o} 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, California (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).

4.1.26. Harbor Seal (Phoca vitulina richardsi) California and Oregon/Washington Coastal, 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*:* The California stock of harbor seals is estimated to number 30,968 seals with a minimum population estimate of 27,348 seals; the calculated PBR is 1,641 California stock harbor seals per year (Carretta *et al*. 2019). The Oregon/Washington coastal stock was estimated to number 24,732 in 1999. Because the most recent abundance estimate is >8 years old, there is no current estimate of abundance and consequently no estimate of PBR(Carretta *et al*. 2019).

Harbor seals are not considered to be depleted under the MMPA or listed as threatened or endangered under the ESA.

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).

4.1.27. Northern Elephant Seal (Mirounga angustirostris) California Breeding Stock

Description*:* Northern elephant seals are the largest pinniped in the CCE. 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. Both males and females are gray to brown in color.

Status and Trends*:* 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 counts of elephant seals at U.S. rookeries in 2010, Lowry *et al*. (2014; as cited in Carretta *et al.* 2019) reported that

40,684 pups were born. Lowry *et al*. (2014; as cited in Carretta *et al.* 2019) applied a multiplier of 4.4 to extrapolate from total pup counts to a population estimate of approximately 179,000 elephant seals. (Carretta *et al*. 2019). The minimum population size for northern elephant seals in 2010 can be estimated very conservatively as 81,368 seals, which is equal to twice the observed pup count (to account for the pups and their mothers). The calculated PBR for this stock is 4,382 (Carretta *et al*. 2019).

Elephant seals are not listed as either threatened or endangered under the ESA, nor designated as depleted under the MMPA.

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^{o} 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).

4.2. Antarctic Living Marine Resources Ecosystem

4.2.1. 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: Abundance and density estimates are not available, and this species has not been observed during AMLR visual surveys. Given that the International Union for Conservation of Nature (IUCN) Red List Assessment for this species indicates that it is sighted less frequently than the hourglass dolphin, it is assumed the density of this species within the AMLR study area is not greater than that of hourglass dolphin (0.0015/km) from observations during AMLR surveys. As a result, the harassment of spectacled porpoise from active acoustic systems used on SWFSC research surveys may be overestimated. The species is not listed under the ESA or designated as depleted under the MMPA.

Distribution and Habitat Preferences: spectacled porpoise 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 two 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).

4.2.2. Hourglass Dolphin (Lagenorhynchus cruciger)

Description: As with spectacled porpoise, 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: Current population trends for hourglass dolphins are unknown (Braulik 2018). Sighting surveys conducted from 1976/77 to 1987/88 as reported by Kasamatsu and Joyce (1995) produced an abundance estimate of 144,300 hourglass dolphins for waters south of the Antarctic

Convergence (CV = 17%). This is currently the only abundance estimate available. 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; Santora 2011). 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.

4.2.3. Killer Whale (Orcinus orca)

Please refer to Section 4.1.9 above for a full description of the killer whale. At least four distinct forms of killer whales are found in Antarctic and Southern Ocean waters (Pitman and Ensor 2003; Pitman *et al*. 2010), with distinct genetic differences (LeDuc *et al.* 2008). They are purported prey specialists on Antarctic minke whales (*Balaenoptera bonaerensis*), seals, and fish, respectively (LeDuc *et al.* 2008; Pitman *et al*. 2010). 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.

4.2.4. Sperm Whale (Physeter macrocephalus)

Please refer to Section 4.1.15 above for a full description of the sperm whale. There is no information on status and trends of sperm whales within the SWFSC AMLR survey area. 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. In the absence of information to the contrary, this estimated density is presumed to be equivalent within the AMLR. The species is listed as endangered under the ESA and depleted under the MMPA.

4.2.5. Arnoux's Beaked Whale (Berardius arnuxii)

Description: Arnoux'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. Mean body length is 8.5-9.6 m.

Status and Trends: Data on population abundance and density for the AMLR study area are limited, and this species has not been identified during past surveys. The IUCN Red List Assessment (iucnredlist.org) for this species indicates that it is rarer than the southern bottlenose whale, which has been observed during AMLR surveys at a density of 0.0006/km. Because no other abundance or density estimates exist, the estimated density of southern bottlenose whales is used for Arnoux's beaked whale with acknowledgment that this is likely high and will result in an overestimate of behavioral takes of Arnoux's beaked whales by active acoustic systems. 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 4.1.11.

Acoustics and Hearing: Please refer to section 4.1.12 for information on Baird's beaked whale.

4.2.6. 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 reach 6-9 m in length. They are chocolate brown to yellow in color, and lighter on the flanks and belly. Males possess a single pair of conical teeth at the tip of the lower jaw; they do not erupt in females.

Status and Trends: There is no information on population status or trends for this species 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^{o} 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.

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).

4.2.7. 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 4.1.10 in that the flippers are marginally longer and they exhibit a noticeable elbow (Olson 2009).

Status and Trends: 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^{o} 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).

4.2.8. Antarctic Minke Whale (Balaenoptera bonaerensis)

Description: Antarctic minke whales are similar in shape and coloration to the common minke whale (see section 4.1.20) 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.

Status and Trends: 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^{o}S to the ice edge during the austral summer then retreat in the austral winter to breeding grounds in mid-latitudes 10^{o}-30^{o}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. 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).

4.2.9. 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: According to the most recent estimate, the southern Hemisphere abundance of the southern right whale was about 15,000 in 2010 (Bannister 2010; Brandão et al. 2010c; IWC 2012b all as cited in NMFS 2015b). The total abundance of Southern right whales in 1997 was 7,571 whales with those in some areas increasing at 7-8% annually (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) over an area of 1,583,100 km^2 (equaling an estimated density of 0.001/km^2). 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.

<u>Distribution and Habitat Preferences</u>: Southern right whales are found in the middle latitudes of the Southern Ocean between approximately 20^o and 60^o 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.

<u>Behavior and Life History</u>: 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 minutes 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 minutes, 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.

<u>Acoustics and Hearing</u>: 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).

4.2.10. Fin Whale (Balaenoptera physalus)

Please refer to Section 4.1.18 for a full description of the fin whale. Abundance in the AMLR 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.

4.2.11. Blue Whale (Balaenoptera musculus)

Please refer to Section 4.1.17 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.

4.2.12. Humpback Whale (Megaptera novaeangliae)

Please refer to Section 4.1.16 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.

4.2.13. 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. Some individuals on South Georgia Island have a white (not albino) pelage.

Status and Trends: Presently the species numbers about 1,600,000 animals throughout its range and is increasing at about 9.8% per year (Arnould 2009). Antarctic fur seals were 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. 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).

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).

4.2.14. 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. Both males and females are gray to brown in color.

Status and Trends: 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. They spend as much as 80% of their annual cycle at sea, migrating long distances to favorable foraging locations.

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).

4.2.15. 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. They have finely divided lobed teeth (hence the scientific name lobodon) with multiple cusps that interlock to filter crustaceans.

Status and Trends: Crabeater seals 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, Erickson and Hanson (1990) reported the most recent estimated density of 5.39/nm^2 (0.175/km^2). 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.

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 minutes (up to 23 minutes), 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).

4.2.16. Weddell Seal (Leptonychotes weddelli)

Description: Weddell seals are large pinnipeds that 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: 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. Erickson and Hanson (1990) reported the most recent estimated density of 0.30/nm^2 (0.0097/km^2). 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.

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. 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).

4.2.17. 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: There have been no systematic, large-scale population census studies of this species 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.

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).

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).

5. TYPE OF INCIDENTAL TAKE AUTHORIZATION REQUESTED

The MMPA (16 USC 1372 Section 102 (a) prohibits takes of marine mammals by any person or vessel, within certain exceptions, in waters or on lands under U.S. jurisdiction. Certain exceptions under Section 101(a)(5) include the authorization of take incidental to activities other than commercial fishing (see Section 1.2). This section describes the types of incidental take requested by the SWFSC associated with fisheries and ecosystem research.

The SWFSC is petitioning NMFS for regulations pursuant to Section 101(a) (5) (A) of the MMPA, 16 USC Section 1371.101 (a) (5), and 50 CFR Section 216, Subpart I, effective approximately October 2020 through October 2025 to allow the potential incidental taking of small numbers of marine mammals incidental to the research activities. Since issuance of the LOAs on October 30, 2015, the SWFSC has implemented specific mitigation and monitoring measures to ensure the least practicable impact on marine mammal species and their habitats, many of which will continue to be implemented (see Sections 11 and 13). However, to be precautionary the SWFSC is requesting incidental takes based on a quantitative analysis described in more detail in Section 6. The types of incidental taking requested in this application include:

- Level A harassment (i.e., non-serious injury). Level A take associated with auditory injury or permanent threshold shift is not possible from acoustic gear used for research (see Section 6.2) and therefore is not part of this request;
- Level B harassment (i.e., behavioral disturbance or temporary [hearing] threshold shift); and
- Mortality or serious injury (M/SI). 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. A serious injury must contribute to the death or likely death of the animal to be classified as such.

As discussed in Section 1, SWFSC surveys in the CCE involve the use of gear that has the potential to take marine mammals, including mid-water trawl nets and pelagic longlines. Incidental take during the use of the modified Cobb mid-water trawl nets, Nordic 264 two-warp rope trawl net, and purse seine may cause entanglement that could result in mortality and serious injury or non-serious injury (i.e., Level A harassment). These gear types are used during or in conjunction with the Coastal Pelagic Species (CPS) surveys in the CCE. Incidental takes that could result in mortality and serious injury may also occur during Highly Migratory Species (HMS) surveys in the CCE using longline gear.

Level B harassment may occur during the use of certain underwater equipment that emits underwater noise such as an EK60 echosounder (see Section 6). No hearing loss or physiological damage (permanent threshold shift, Southall *et al.* 2019) is expected to occur to marine mammals by the acoustic gear or vessel movements during SWFSC surveys in the CCE or the AMLR regions. Level B harassment may occur if pinnipeds are hauled out on land or ice and disturbed during the close approach of a survey vessel that may be deploying or retrieving unmanned gear such as AUVs, gliders or UASs.

The MMPA and its implementing regulations have not provided a clear operational definition of “take by harassment” especially for minor, temporary behavioral disturbance. As a result, there has been much debate concerning how substantial and prolonged a change in behavior must be before it constitutes a "take by harassment". There is general recognition that minor and brief changes in behavior generally do not have biologically significant consequences for marine mammals and do not "rise to the level of taking" (National Research Council [NRC] 2005). Criteria and procedures for assessing the impact of behavioral disturbance on marine mammals are still being refined (Southall *et al*. 2007, 2019; Ellison *et al*. 2012). To be precautionary, the SWFSC is requesting takes for potential behavioral disturbance as described in detail in Section 6.

6. TAKE ESTIMATES FOR MARINE MAMMALS

Authorization for incidental takes is requested for activities described in Section 2. In order to determine the potential for interaction during SWFSC research activities, a variety of factors are considered including estimated marine mammal densities in each research area, a summary of historical interactions between marine mammals and SWFSC research (specifically the period 2015–2018 since the last LOA was issued), historical marine mammal interactions between commercial fisheries that may use the same gear, and other biological factors such as feeding behavior or propensity to travel in groups. This section also includes a description of the area of potential disturbance due to noise sources used during research, and a discussion of the potential for behavioral responses or serious injury or mortality due to research activities. Marine mammals with no records of historical interaction with SWFSC research gear and no documented mortality or serious injury in relevant commercial fisheries are not considered in this section or in the SWFSC request for takes.

6.1. Marine Mammal Densities

As described in Section 3, the most recent Stock Assessment Reports (SARs), data from NOAA's CetSound webpage (https://cetsound.noaa.gov/cda) and other available literature were used to calculate marine mammal stock/DPS abundance and two-dimensional densities (animals/km^2) within the Action Area (see also Appendix A). To calculate two-dimensional densities for species with only abundance data, stock/DPS abundance was divided by the area used to determine densities in the 2015 final rule published by NMFS (80 FR 58982). For AMLR species, recent abundance estimates are not available, and densities are the same as those reported in the 2015 PEA (NMFS 2015a).

To account for marine mammal diving behavior and the effect this has on their potential exposure to underwater sound sources, a volumetric density of marine mammal species was determined and considered in this application (see Appendix A) This value is estimated as the abundance averaged over the vertical range (i.e., depth) of typical habitat for the population. As described in the 2015 proposed rule (80 FR 8165), habitat ranges were categorized into two generalized depth strata, surface-associated (0-200 m) or deep-diving (0 to >200 m). These depth strata were based on empirical measurements from tagging data and reasonable assumptions of behavior (from Reynolds and Rommel 1999; and Perrin *et al*. 2008). Animals in the shallow diving strata were assumed to spend a majority of their lives (>75%) at depths of 200 m or shallower. In contrast, species in the deeper diving strata were assumed to regularly dive deeper than 200 m and spend significant time at these greater depths. As such, exposures by marine mammals to sounds that might exceed the Level B harassment threshold of 160 dB rms consider volumetric densities and the area of water that may be ensonified by equipment used by SWFSC. 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). Density estimates are presented in Tables 6-1 and 6-2. Please refer to footnotes for explanations of how densities were calculated when abundance was not available.

TABLE 6-1. MARINE MAMMAL DENSITIES WITHIN THE CCE

Common Name	Scientific Name	Stock Abundance Estimate[1]	Density (per km^2)[2]	Volumetric Density (per km^2)
Cetaceans				
Harbor Porpoise[3]	*Phocoena phocoena*	35,769	0.03411	0.17057
Dall's Porpoise	*Phocoenoides dalli*	25,750	0.04631	0.23154
Pacific White-sided Dolphin	*Lagenorhynchus obliquidens*	26,814	0.02084	0.10420
Risso's Dolphin	*Grampus griseus*	6,336	0.01057	0.05283
Bottlenose Dolphin[4]	*Tursiops truncatus*	2,377	0.00313	0.01565
Striped Dolphin	*Stenella coeruleoalba*	29,211	0.04464	0.22321
Short-beaked Common Dolphin	*Delphinus delphis*	969,861	0.72962	3.64808
Long-beaked Common Dolphin	*Delphinus capensis*	101,305	0.07207	0.36033
Northern Right Whale Dolphin	*Lissodelphis borealis*	26,556	0.03107	0.15534
Killer Whale[5]	*Orcinus orca*	77	0.00064	0.00318
Short-finned Pilot Whale	*Globicephala macrorhynchus*	836	0.00034	0.00068
Baird's Beaked Whale	*Berardius bairdii*	2,697	0.00262	0.00523
Mesoplodont Beaked Whales	*Mesoplodon* spp.[6]	3,044	0.00306	0.00612
Cuvier's Beaked Whale	*Ziphius cavirostris*	3,274	0.00584	0.01167
Pygmy Sperm Whale	*Kogia breviceps*	4,111	0.00774	0.01548
Sperm Whale	*Physeter macrocephalus*	1,997	0.00350	0.00699
Humpback Whale CA/OR/WA stock[7]	*Megaptera novaeangliae*	2,900	0.00117	0.00585
Blue Whale	*Balaenoptera musculus*	1,647	0.00090	0.00449
Fin Whale	*Balaenoptera physalus*	9,029	0.00629	0.03144
Sei Whale	*Balaenoptera borealis*	519	0.00037	0.00185
Minke Whale	*Balaenoptera acutorostrata scammoni*	636	0.00096	0.00480
Gray Whale[8]	*Eschrichtius robustus*	26,960	0.02697	0.13483

Common Name	Scientific Name	Stock Abundance Estimate[1]	Density (per km^2)[2]	Volumetric Density (per km^2)
Pinnipeds				
California Sea Lion	*Zalophus californianus*	257,606	0.25761	1.28803
Steller Sea Lion, Eastern DPS[9]	*Eumetopias jubatus monteriensis*	71,562	0.06261	0.31306
Guadalupe Fur Seal	*Arctocephalus townsendi*	15,830	0.01583	0.07915
Northern Fur Seal[10]	*Callorhinus ursinus*	637,561	0.63680	3.18399
Harbor Seal[11]	*Phoca vitulina richardsi*	30,968	0.05633	0.28167
Northern Elephant Seal	*Mirounga angustirostris*	179,000	0.17900	0.35800

[1]Carretta *et al*. (2019).
[2]Densities were determined as described in Section 3 and Appendix A.
[3]N. CA/ S. OR stock
[4]Coastal plus offshore stocks
[5]Stock with lowest abundance used – S. Resident stock
[6]Includes six mesoplodont beaked whale species
[7]Change in ESA-listing status (81 FR 62259, September 8, 2016). The Central America (endangered) and Mexico (threatened) DPSs occur in the CCE. However, for MMPA purposes the operable unit is the CA/OR/WA stock. Therefore the abundance estimate from Carretta *et al*. (2019) for this stock is shown here.
[8]Eastern Pacific stock
[9]De-listed since the 2015 PEA (81 FR 62259, September 8, 2016).
[10]Pribilof Island/Eastern Pacific stock; declining trend continues; Muto *et al.* 2018
[11]California stock.

TABLE 6-2. MARINE MAMMAL DENSITIES WITHIN THE AMLR

Common Name	Scientific Name	Estimated Number in AMLR[1]	Density[2] (per km^2)	Volumetric Density (per km^2)
Cetaceans				
Spectacled Porpoise	*Phocoena dioptrica*	n/a	0.00150	0.00750
Hourglass Dolphin	*Lagenorhynchus cruciger*	n/a	0.00150	0.00750
Killer Whale	*Orcinus orca*	25,000	0.00150	0.00750
Sperm Whale	*Physeter macrocephalus*	n/a	0.00065	0.00130
Arnoux's Beaked Whale	*Berardius arnuxii*	n/a	0.00060	0.00120
Southern Bottlenose Whale	*Hyperoodon planifrons*	n/a	0.00060	0.00120
Long-finned Pilot whale	*Globicephala melas*	n/a	0.00760	0.01520
Antarctic Minke Whale	*Balaenoptera bonaerensis*	1,544	0.00180	0.00900
Southern Right Whale[3]	*Eubalaena australis*	1,755	0.00041	0.00203
Fin Whale[4]	*Balaenoptera physalus*	n/a	0.08390	0.41950
Blue Whale[5]	*Balaenoptera musculus*	4,487	0.00012	0.00062
Humpback Whale[6]	*Megaptera novaeangliae*	1,829	0.03610	0.18050
Pinnipeds				
Antarctic Fur Seal	*Arctocephalus gazella*	n/a	0.09990	0.49950
Southern Elephant Seal	*Mirounga leonina*	640,000	0.00030	0.00060
Crabeater Seal	*Lobodon carcinophaga*	5-10,000,000	0.64865	3.24324
Weddell Seal[7]	*Leptonychotes weddelli*	500-100,000	0.05405	0.27027
Leopard Seal	*Arctocephalus gazella*	220,000	0.01622	0.08108

[1]There were relatively few abundance estimates provided for Antarctic species (exceptions were killer whale, southern right whale. and most pinnipeds) in the 2015 PEA (NMFS 2015a). Rather, densities-at-sea calculated from 2008/2009 AMLR surveys, or literature, rather than abundance estimates were provided for most Antarctic species. Abundance estimates were in literature (as indicated) from IWC surveys.

[2]Estimated densities are not changed from those reported in the 2015 PEA and used in the 2015 rule.

[3]Williams *et al*. (2006)

[4]Santora *et al.* (2009)

[5]Williams *et al*. (2006)

[6]Humpback whale DPSs that forage in Southern Hemisphere were delisted (81 *FR* 62259, September 8, 2016). Density from Williams *et al.* (2006)

[7]SWFSC research would take Weddell seals on pack ice, so the density provided estimates the number of seals in pack ice areas, not at-sea.

6.2. Sources of Potential Mortality and Serious Injury Due to Research

The number of takes authorized under the 2015 final rule (80 FR 5898) for SWFSC research were based on historical take that occurred during research for the period 2008–2012; those estimates were considered to be precautionary (i.e., overestimated as compared to historical data). Although that amount of take has not occurred since, and proposed research effort is expected to be reduced from previous years, the take request for M/SI for 2020-2025 is based on the take estimates for 2015, with the addition of takes for new purse seine and deepset buoy/sablefish surveys as well as consideration for marine mammal group sizes as described in this section.

6.2.1. Mid-water and Surface Trawl Surveys

Marine mammals have the potential to be caught in the modified Cobb mid-water and NETS Nordic 264 trawl nets used by the SWFSC. 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. These nets are also used in juvenile salmon surveys between southern California and Oregon during daytime trawls that last approximately 45 minutes at the target depth.

Compared to the Nordic 264 trawl, takes of marine mammals by Modified-Cobb trawl have been historically small. While the Nordic 264 rope trawl is intended to fish at the surface, the Cobb trawl is typically fishing at 30 m headrope depth, thus it is rarely at the surface aside from the deployment and retrieval stages. Fishing at depth, at slower speeds, and for shorter duration, along with having a smaller opening and mesh size, mitigate marine mammal takes by the modified-Cobb.

Table 6-3 summarizes the number of trawls, fishing depth and average tow time for modified cobb and Nordic 264 trawl gear over the period 2015-2018. The table shows that while Nordic 264 gear is used more frequently, the total number of trawls using this gear has been reduced while the use of Modified Cobb gear has remained at generally the same level.

For comparison, research in the Scotia Sea (AMLR) using trawl gear (Tucker) in 2015-2016 conducted a total of 106 tows at a depth of 170 m. Tow durations ranged from 20 to 30 minutes during this effort. No trawl surveys were conducted in AMLR in 2017 or 2018. Additionally, no surveys of any kind were conducted in ETP during the period 2015–2019.

TABLE 6-3. TRAWL SURVEY METADATA USING MODIFIED COBB AND NORDIC 264 GEAR 2015-2018

Year	Modified Cobb Trawl			Nordic 264 Trawl		
	Total No. Tows	Fishing Depth Range (m)	Average Tow Duration of Active Fishing (minutes)	Total No. Tows	Fishing Depth Range (m)	Average Tow Duration of Active Fishing (minutes)
2015-2016[1]	137	10-54	5-15	273	0-16	30-45
2017[2]	109	3-50	15	147	0-16	42
2018[3]	136	3-50	15	169	0-15	45
Average 2015-2018	127	3-54 (range)	5-15 (range)	196	0-16 (range)	30-45 (range)
TOTAL 2015-2018	382	n/a	n/a	589	n/a	n/a

[1]Annual Report under Section 7(a)(2) of the ESA and 101(a)(5)(A) of the MMPA for Fisheries and Ecosystem Research Activities Conducted by Southwest Fisheries Science Center during August 31, 2015 – December 31, 2016.
[2]Annual Report under Section 7(a)(2) of the ESA and 101(a)(5)(A) of the MMPA for Fisheries and Ecosystem Research Activities Conducted by Southwest Fisheries Science Center during January 1, 2017 – December 31, 2017
[3]Annual Report under Section 7(a)(2) of the ESA and 101(a)(5)(A) of the MMPA for Fisheries and Ecosystem Research Activities Conducted by Southwest Fisheries Science Center during January 1, 2018 – December 31, 2018.

Historically, California sea lions, northern fur seals, northern right whale dolphins, and Pacific white-sided dolphins have been caught during SWFSC research surveys in trawl nets. Given the timing and geographic scope of SWFSC trawl surveys, it is possible that surveys could take any age class of species for which takes are requested. Adult female California sea lions breed in the California Channel Islands during May-June. Therefore, both pups and adult female California sea lions may be caught in close proximity to these islands during this period. Male sea lions of breeding age could also be present in these areas. Similarly northern fur seals pup and breed during June-August at San Miguel Island and could be taken. Pacific white-sided dolphins calve during May–September. Animals caught during this period may be part of the California-Oregon-Washington stock. The calving season for Northern right whale dolphins is not well known however small calves are seen in winter and early spring (Carretta *et al*. 2019).

As shown in Table 6-4, ten Mortality/Serious Injury [M/SI] takes of Pacific white sided dolphins occurred during trawl surveys in the CCE between August 15, 2015 and December 31, 2016. Three M/SI takes of Pacific white sided dolphins and a California sea lion occurred during trawling in 2018; five Pacific white sided dolphins and one long beaked common dolphin were taken in 2019. These takes did not exceed the numbers authorized by the 2015 rule and LOA for trawling (i.e., 35 for Pacific white-sided dolphins, 20 California sea lions, and 11 long-beaked common dolphins, respectively). Also as stated in the 2015 PEA, the PBR for white sided dolphins and long-beaked common dolphins is 193 and 610, respectively. The California sea lion PBR is 9,200 (see Section 6.4). Therefore, the total number of takes were well below the PBR for each of these species. No other species were taken by M/SI due to entanglement in gear or ship strikes during SWFSC research surveys since 2015.

Several mitigation measures intended to minimize adverse interactions with protected species during SWFSC research surveys were initiated in 2008. Since 2015, SWFSC researchers have implemented the specific measures outlined in the LOA issued in October of that year (80 FR 58982). The SWFSC estimates that for the upcoming authorization period (2020–2025), about the same number of tows will likely be deployed using these nets as during previous years (i.e., up to 250 tows per year).

TABLE 6-4. TAKES OF MARINE MAMMALS IN TRAWL GEAR DURING SWFSC CCE SURVEYS 2012-2019

Species	2012[1]		2013[2]		2014[3]		2015-2016[4]		2017[5]		2018[6]		2019[7]	
	Killed	Alive (disposition unknown)	Killed	Alive (disposition unknown)	Killed	Alive (disposition unknown)	Killed	Alive (disposition unknown)	Killed	Alive (disposition unknown)	Killed	Alive (disposition unknown)	Killed	Alive (disposition unknown)
Coastal Pelagic Species/California Current Ecosystem Survey														
Pacific white sided dolphin	3	1	1	2	0	0	8	1	0	0	2	0	5	0
Long-beaked common dolphin	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Rockfish Recruitment and Ecosystem Survey														
Pacific white sided dolphin	0	0	0	0	1	0	1	0	0	0	1	0	0	0
California sea lion	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Juvenile Salmon Fall Survey														
Pacific white sided dolphin	0	0	3	0	0	0	0	0	0	0	0	0	0	0

[1]For 2008-2011 takes please see Table 4.2-7 of the 2015 PEA. 2012 information is taken from the PEA.
[2]2013 Protected Species Incidental Take (PSIT) Report
[3]2014 PSIT Report
[4]Annual Report under Section 7(a)(2) of the ESA and 101(a)(5)(A) of the MMPA for Fisheries and Ecosystem Research Activities Conducted by Southwest Fisheries Science Center during August 31, 2015 – December 31, 2016.
[5]Annual Report under Section 7(a)(2) of the ESA and 101(a)(5)(A) of the MMPA for Fisheries and Ecosystem Research Activities Conducted by Southwest Fisheries Science Center during January 1, 2017 – December 31, 2017
[6]Annual Report under Section 7(a)(2) of the ESA and 101(a)(5)(A) of the MMPA for Fisheries and Ecosystem Research Activities Conducted by Southwest Fisheries Science Center during January 1, 2018 – December 31, 2018.
[7]Personal communication Elise Kohli SWFSC, Nov 1, 2019.

6.2.2. Purse Seine Surveys

The SWFSC proposes to conduct purse seine surveys in nearshore areas. Seining based on NOAA-SWFSC and Washington Department of Fish and Wildlife protocols to allow dip-netting of fish from the seine for sample processing onboard is planned for the period 2020–2025. As an example, a seine net 230 fathoms in length, 2800 meshes deep, with a mesh size of 11/16 may be used for this research. Complementary echosounder, sonar, and purse-seine sampling along nearshore areas during surveys conducted by the ship, Lasker, may occur over a period of approximately 28 days.

Transects may occur from the northernmost sampling location to the vicinity of Eureka, California in the nearshore area approximately 5 nmi apart, alternating direction (east-west and vice versa) for 3-7 transects each day, ideally coincident with Lasker's surveys, for about 100 total transects. SWFSC may set an average of 3 times/day for 60 minutes for approximately 60 sets total. To conduct day-night comparative surveys, SWFSC may set approximately 4/day in a 24-hour period (each for 60 minutes) over about 5 days (i.e., minimum of 2 sets each during daytime and nighttime for a total of 20 sets).

The 2019 List of Fisheries (NMFS 2019) categorizes commercial purse seine fisheries in California, Washington and Oregon as having "remote likelihood of or no known interactions" (Category III) with marine mammals. Within the last five years, the limited entry commercial purse seine fishery for anchovy, sardines and tuna in California have documented takes of California sea lions and harbor seals. These species have been observed to enter operational purse seines to depredate the catch, then exit the net unharmed (83 FR 36370). Pinnipeds are adept at jumping into and out of these nets without getting entangled.

During the period 2004–2008, there were two observed mortalities of California sea lions in the California anchovy, mackerel, sardine and tuna purse seine fishery (Table 1 in Carretta *et al.* 2019). According to Heyning *et al.* (1994 as cited in Carretta *et al*. 2019), Risso's dolphins have been killed in the squid purse seine fishery although these animals were probably intentionally killed to protect catch rather than incidentally caught in purse seine gear. During the period 2004–2008, no Risso's dolphins were taken in this fishery. Short-beaked common dolphins have also entangled in the squid purse seine fishery with one mortality observed in 2005 and a serious injury in 2006 (Carretta *et al.* 2019). The California squid purse seine fishery has not been observed since 2008. While historically, short-finned pilot whales have also been killed in the squid purse seine fishery off southern California however, this species is not considered more rare in this region and between the period 2004-2008, no pilot whales were observed during this fishery (Carretta *et al.* 2019).

As described in the 2018 SAR, between 2004 and 2006, a NMFS pilot observer program began in the anchovy and sardine purse seine fishery. During a total of 93 sets observed, there was one California sea lion killed, 54 sea lions released alive, and one sea otter released alive. During the same period, over a total of 19 trips and 15 sets, there were no marine mammal interactions observed in the tuna purse seine fishery (Carretta *et al.* 2019).

Certain species that are found in the coastal areas within the CCE and that may occur in mixed schools (e.g., Pacific white-sided dolphins, northern right whale dolphins, Risso's dolphins, and striped dolphins) may become entangled in purse seine gear. While bottlenose dolphins have also been taken in this commercial fishery, it's been more than five years since such an event has occurred (2019 List of Fisheries). Therefore, the potential risk of entangling this species during SWFSC is considered unlikely given the limited surveys planned by SWFSC. The California commercial purse seine fishery for squid has documented takes of short-beaked and long-beaked common dolphins along the West Coast (2019 List of Fisheries). For example, short-beaked common dolphins have entangled in the squid purse seine fishery with one mortality observed in 2005 and a serious injury in 2006 (Carretta *et al.* 2019). However this fishery occurs in areas farther offshore than the planned SWFSC purse seine research surveys. As described in Section 4.1.6, during summer and fall when the purse seine surveys would be occurring, these dolphins primarily occur further offshore in waters deeper than 200 m, although these species may be observed in shallower depths less than 200 m. As a precaution, the SWFSC is requesting M/SI takes for common dolphins due to proposed use of purse seine gear.

In 2018, NMFS authorized takes associated with the use of purse seine gear by the Northwest Fisheries Science Center (NWFSC) for some species in the CCE that, based on the LOF, had no record of interaction with commercial fisheries (83 FR 36370). Due to the proposed use of purse seine gear by SWFSC and following the precautionary approach applied by NMFS in 2018 for similar NWFSC research, takes for Dall's porpoise, Pacific white-sided dolphin, Risso's dolphin, northern right whale dolphin, Steller sea lion, and harbor porpoise have been included in this LOA application for the SWFSC. For harbor porpoise, vulnerability for take in purse seine gear necessitates a higher requested take than other species that may be encountered (see Table 6-10). Due to their occurrence in coastal water along Oregon and California, delphinid species may be at risk of entanglement and because they often occur in mixed schools and could be caught together in purse seines.

To be precautionary, SWFSC requests M/SI takes for the following species over the five-year authorization period due to purse seine gear: harbor porpoise, Dall's porpoise, Pacific white-sided dolphin, Risso's dolphin, striped dolphin, both species of common dolphin, northern right whale dolphin, California sea lion, and harbor seals. The M/SI takes requested for each of these species are presented in Table 6-10.

6.2.3. Longline Surveys

The HMS surveys are conducted June-July from a NOAA vessel or a charter vessel. Table 6-5 summarizes longline and hook and line survey efforts over the period 2015-2017; longline and hook and line surveys were not conducted in 2018. Thresher shark surveys are not planned for the 2020-2025 survey period; however given that HMS surveys for other species will continue, SWFSC requests a similar number of takes based on the anticipated surveys.

As described in the 2015 SWFSC LOA Application for research (NMFS 2015, Table 6.1), during the period 2008–2011, four California sea lions were taken during SWFSC longline surveys and released alive; no other species interacted with longline gear during this period. One California sea lion was taken by longline gear in 2012, 2013, and 2014; the individuals were injured but released (Table 6-6). Five M/SI takes per year of California sea lions are authorized under the 2015 LOA and are also requested herein (see Table 6-10). Longline gear was not used in 2017, 2018 or 2019. Figure 6-1 shows the locations of the M/SI takes in 2015-2019.

TABLE 6-5. TRAWL SURVEY METADATA USING LONGLINE AND HOOK AND LINE GEAR 2015-2017[1]

Gear type	Survey	2015-2016[2]	2017[3]	Total 2015-2017
Longline	Juvenile Thresher **Shark Survey**[4]			
	Total No. Sets	68	n/a	68
	No. of Hooks	6,800	n/a	6,800
	Total Hook Hours	17,527	n/a	17,527
	Fishing Depth (m)	6-9	n/a	n/a
Hook and Line	**Rockfish Recruitment Survey**[5]			
	Total No. Sets	5	n/a	5
	No. of Hooks	128	n/a	128
	Total Hook Hours	12.5	n/a	12.5
	Fishing Depth (m)	30-119	n/a	n/a
	Rockfish Tagging and Release Device Testing[6]			
	Total No. Sets	-	-	-
	No. of Hooks	-	4	4
	Total Hook Hours	1,143	32	1,175
	Fishing Depth (m)	42-152	70-110	n/a

[1]Longline and hook and line gear were not used in 2018
Annual Report under Section 7(a)(2) of the ESA and 101(a)(5)(A) of the MMPA for Fisheries and Ecosystem Research Activities
[2]Conducted by Southwest Fisheries Science Center during August 31, 2015 – December 31, 2016.
[3]Annual Report under Section 7(a)(2) of the ESA and 101(a)(5)(A) of the MMPA for Fisheries and Ecosystem Research Activities Conducted by Southwest Fisheries Science Center during January 1, 2017 – December 31, 2017
[4]Hook type: 13/0 offset circle. Note: the juvenile thresher shark survey was not conducted in 2017
[5]Hook type: shrimp fly. Note: hook and lines were not used in the Rockfish Recruitment Survey in 2017
[6]Hook type: J hook.

TABLE 6-6. TAKES OF MARINE MAMMALS IN LONGLINE GEAR DURING SWFSC CCE SURVEYS, 2012–2016[1]

Species	2012[2]			2013[3]			2014[4]			2015-2016[5]		
	Killed	Alive injured	Alive uninjured	Killed	Alive injured	Alive uninjured	Killed	Alive injured	Alive uninjured	Killed	Alive injured	Alive uninjured
California sea lion	0	1	0	0	1	0	0	1	0	0	0	0

[1]Longline gear was not used in 2017, 2018, or 2019.
[2]For 2008-2011 takes please see Table 4.2-8 of the 2015 PEA. 2012 information is taken from the PEA.
[3]2013 PSIT Report
[4]2014 PSIT Report
[5]Annual Report under Section 7(a)(2) of the ESA and 101(a)(5)(A) of the MMPA for Fisheries and Ecosystem Research Activities Conducted by Southwest Fisheries Science Center during August 31, 2015 – December 31, 2016.

FIGURE 6-1. LOCATION OF MARINE MAMMAL TAKES DURING SWFSC RESEARCH 2015-2019

Source: Southwest Fisheries Science Center

Based on the proposed gear and methods to be utilized, the SWFSC does not anticipate deep-set buoy surveys to result in any marine mammal takes. The gear is specifically designed to eliminate protected species interactions. No historical takes using deep-set buoy gear have occurred in the Pacific during the previous 54 sets (approximately 2,200 hook hours). In the Atlantic, no protected species interactions have been taken in the Swordfish Buoy Fishery that uses similar gear configuration and has higher effort levels than surveys conducted in the Pacific. The SWFSC does not anticipate that sablefish or rockfish life history surveys will result in any marine mammal takes. This survey's extremely small scale and low level of effort (approximately 200 hooks per month) makes the likelihood of taking marine mammals extremely rare. In addition, because this gear fishes at the bottom it poses a significantly reduced risk of hooking and entanglement relative to surface gears. Therefore, takes from deployment of deep set buoy gear and longline gear in the sablefish and rockfish life history surveys are not expected. However, as a precaution for each cetacean species that may occur near research, two takes for M/SI are requested for longline gear in the unlikely event of an M/SI take in either of these surveys (see Table 6-10).

In general, marine mammal interactions in SWFSC longline surveys have been isolated events never exceeding one animal per set (Table 6-6). As with marine mammal interactions in trawl gear, the potential take in longline gear could include animals of multiple age classes.

6.2.4. Potential SWFSC Interactions with Marine Mammals Not Historically Taken During Research

Based on historical interactions between marine mammals and SWFSC longlines or trawl nets, it is possible that other species with similar behaviors, distributions, etc. may interact with these gears. As such, the application considers: 1) that some species with which SWFSC has not historically interacted may interact with these gears in the future; 2) variation between sets may result in interactions; and 3) many species occur in groups. Therefore, takes must account for average group size, particularly if trawl gear is used. This approach accounts for the possibility that these “other” species could interact with SWFSC surveys, though such events would likely be rare. Recognizing these uncertainties, additional mitigation measures may be implemented in the future if takes exceed the maximum number estimated per year to the extent that it appears the total estimated take over the 5-year authorization period may be exceeded.

Several species in the CCE may be vulnerable to trawl gear based on factors such as density, abundance, behavior, feeding ecology, tendency to travel in groups, association with other species historically taken, prior interactions with commercial fisheries that use similar gear based on the List of Fisheries (NMFS 2018), or reported interactions with other NMFS Science Center surveys (i.e., NWFSC). To account for these factors, takes projected for species known to interact with trawl or longline gear have been used as a proxy for requesting takes for these “other” species. For example, as described in the 2015 LOA Application for SWFSC research (NMFS 2015, Appendix C Table 6.1), during the 5-year period between 2008 and 2012, 27 Pacific white-sided dolphins were killed and seven were released alive during trawl surveys conducted by SWFSC. The 2015 LOA Application estimated an average of 6.4 interactions with Pacific white-sided dolphins equating to approximately 35 interactions over the 5-year period (NMFS 2015, Appendix C). Between 2015 and 2019, there were 18 takes of Pacific white sided dolphins due to entanglement in trawl gear. To account for the possibility of entanglement or injury from trawl gear, SWFSC is requesting a conservative number of M/SI takes for each of the following species: harbor porpoise, Dall’s porpoise, Risso’s dolphin, both stocks of bottlenose dolphin, striped dolphin, short-beaked common dolphin, long-beaked common dolphin, and northern right whale dolphins (Table 6-10). SWFSC expects the likelihood of interaction between Pacific white-sided dolphins and trawl gear to be higher; therefore, the takes for Pacific white-sided dolphins are higher than takes requested for these other species that may occur in mixed groups. Additionally, there were a total of four M/SI takes of California sea lions in trawl (one take) and longline (three takes) gear between 2015 and 2019. Therefore, assuming Steller sea lions and harbor seals may also be vulnerable to entanglement in these gear types, the SWFSC is requesting M/SI takes each for these species for these gear types.

An estimate of potential takes for species that may interact with trawl gear considers the higher likelihood that more than one individual may be taken in a trawl at any given time, such as high pinniped densities in survey locations or documented takes of porpoises in trawls by commercial fisheries and other NMFS Science Centers. The SWFSC does not anticipate any takes of Guadalupe fur seals in trawls due to *their* lower abundance in the CCE. Furthermore, the SWFSC is not requesting the take of large whales or 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.).

While the SWFSC has not historically interacted with large whales or other cetaceans in longline gear, it is well documented that some of these species are taken in commercial longline fisheries. The List of Fisheries (NMFS 2018) classifies commercial fisheries based on prior interactions with marine mammals. Although specific cetaceans and large whales are known to interact with longline gear, other factors were taken into account including but not limited to relative survey effort, survey location, similarity in gear type, animal behavior, and prior history of SWFSC interactions with longline gear etc. In light of these other factors, the relatively small research areas and the short-term nature of research surveys, potential takes for several species during SWFSC longline surveys are not expected for the period 2020–2025. The exception is pygmy sperm whales (*Kogia breveceps*).

6.2.5. Unidentified Species

Occasionally, there are incidental takes of animals that cannot be identified to species with certainty. For example, a female California sea lion may be difficult to differentiate at sea from other otariids or large phocids in poor lighting making exact identification difficult. Similarly some cetaceans may be difficult to identify to species under poor field conditions. Thus, the SWFSC requests a small number of 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 the CCE.

6.2.6. AMLR Surveys

The SWFSC has no historical interactions with marine mammals in the bottom trawl gear used in the Scotia Sea Antarctic ecosystem. Researchers operating in the AMLR 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 no future planned survey effort incorporating bottom trawls, no M/SI take of marine mammals resulting from gear interaction is anticipated while conducting fisheries research in the Antarctic ecosystem. As a result, the SWFSC is not requesting takes for M/SI or Level A harassment due to research activities in the AMLR.

6.3. Sources of Disturbance Due to Research

The potential sources of disturbance to marine mammals during SWFSC research activities are associated with the physical presence of human activities (i.e., vessels) and noise (i.e., underwater equipment such as echosounders). It should be noted that the proposed action does not include intentional approaches to marine mammals on land or ice. Rather, any disturbance due to physical presence of humans or vessels would be incidental to research activities and would likely only occur in the AMLR.

Disturbance of an animal due to physical presence of vessels or noise from underwater equipment does not automatically imply that harassment has occurred. The MMPA and its implementing regulations do not have a clear operational definition of “take by harassment”. There is recognition that minor and brief changes in behavior generally do not have biologically significant consequences for marine mammals and do not "rise to the level of taking" (NRC 2005). Also, Southall *et al*. (2007) emphasized the need to distinguish minor, short-term changes in behavior with no lasting biological consequences from biologically significant effects on critical life functions such as growth, survival, and reproduction. The biological relevance of a behavioral response to noise exposure depends, at least in part, on how long the response persists. Southall *et al.* (2007) noted that "a reaction lasting less than 24 hours is not regarded as particularly severe unless it could directly affect survival or reproduction."

The 2015 proposed rule (80 FR 8165) describes two categories of active sound sources that may be used during SWFSC research. Different operating characteristics of sound sources result in differing potential for acoustic impacts on marine mammals. Category 1 active acoustic sound sources with high frequencies (higher than 180kHz) that are outside the known functional hearing range of marine mammals. Acoustic Zooplankton Fish Profilers (AZFP) fall into this category. For this reason, these high frequency sources are not likely to cause behavioral disturbance and are not considered further.

The SWFSC also uses a variety of echosounders, sources used to determine the trawl net orientation, and current profilers (e.g., Acoustic Doppler Current Profiler [ADCP] that are considered Category 2 sources. Output frequencies in Category 2 are generally within marine mammal hearing range (i.e., 10 to 180 kHz). While many of the Category 2 sound sources may be audible to marine mammals, many tend to be highly directional and/or have short ping durations which may reduce the likelihood that marine mammals receive the signal. Some of these sources may also be operated in different output modes (i.e., distributed across multiple beams versus a single beam) which may further reduce perception by animals in the water (80 FR 8165). SWFSC vessels may be equipped with multiple devices that emit sound underwater and some equipment may use a range of frequencies.

The SWFSC also proposes to use unmanned systems which may include both in-air (unmanned aerial systems [UAS]) and underwater (autonomous underwater vehicles [AUV]) devices. Unmanned operations and impacts were not covered in the 2015 LOA or the 2015 PEA. A 2016 publication by Christiansen *et al.* reported that noise heard underwater from in-air UASs only occurred above background noise (at 1 m depth) when flying at altitudes of 5 and 10 m, resulting in broadband received levels between 95 and 101 dB re μPa rms (i.e., for the Splashdrone and Inspire, respectively). It should be noted the specific aerial vehicles to be used in SWFSC research will vary and these results are provided to represent the anticipated noise levels from these types of equipment in water. In response to the significant increase in the use of this technology, a 2017 publication (Mustafa *et al.* 2018) summarizing available literature on the potential effects of disturbance from unmanned systems on marine wildlife in Antarctica also highlighted expert knowledge on this topic as well as the data gaps to be addressed in future research. Anecdotal observations reported in Mustafa *et al.* (2018) concluded the following: 1) sudden changes in UAS noise intensity are more likely to elicit a response; 2) take-offs or altitude changes may also elicit behavioral responses; and 3) habituation to UAS has not yet been observed during short-term studies. Krause *et al.* (2017) also reported on the use of UAS for collecting morphometric measurements on Antarctic pinnipeds concluding that the use of such technology is less invasive than manual techniques (i.e., capture) and has promising potential for minimizing disturbance to marine wildlife.

Table 6-7 provides operating characteristics of SWFSC active acoustic sources which are described in more detail in the following section.

TABLE 6-7. OPERATING CHARACTERISTICS OF SWFSC ACTIVE ACOUSTIC SOUND SOURCES

Active Acoustic System	Operating Frequencies	Maximum Source Level (dB)	Single Ping Duration (ms) and Repetition Rate (Hz)	Orientation/ Directionality	Nominal Beam Width
Simrad EK500, EK60 and EK80 narrow beam echosounders	18, *38*, *70*, *120*, *200*, 333 kHz[1]	226[2]	Variable; most common settings are 1 ms and 0.5 Hz	Downward looking	7°
Simrad ME70 multibeam echosounder	70–120 kHz	205	0.06–5 ms; 1–4 Hz	Primarily Downward looking	130°
Simrad MS70 multibeam sonar	75–112 kHz	206	2–10 ms; 1–2 Hz	Primarily side-looking	60°
Simrad SX90 narrow beam sonar	20–30 kHz	219	Variable	Omnidirectional	4-5° (variable for tilt angles from 0-45° from horizontal)
Teledyne RD Instruments ADCP Ocean Surveyor	75 kHz	224	0.2 Hz	Downward looking	30°
Simrad ITI Catch Monitoring System	27–33 kHz	214	0.05–0.5 Hz	Downward looking	40°
Simrad FS70 Third Wire Net Sonde	120 kHz	Unknown, maximum transmit power is 1 kilowatt	Variable	Downward looking	40°
Autonomous Underwater Vehicles	100–5,000Hz	124	N/A	Omnidirectional	N/A
Unmanned Aerial Systems	600–6,000 Hz[3]	91–102 dB (@5-10m altitude)[4]	N/A	Omnidirectional	N/A

[1]Primary frequencies italicized

[2]Source level values for the EK80 configured with different transducers ranged between 226 and 212 dB re 1 µPa at 1 m (Macaulay 2018).

[3]Intaratep *et al.* (2016) reported that an unloaded motor spectrum of a quadcopter indicates that the motors noise contributes to the overall noise signature of the drone in the mid-frequency range (600-6000 Hz).

[4]The specific equipment for which these results are reported is only an example for reference. The specific model of an unmanned aerial vehicle used by SWFSC may vary.

6.3.1. *Multi-frequency Narrow Beam Echosounder*

The SWFSC deploys multi-frequency sensors to acoustically map resources including fish abundance and biomass, plankton, schooling behavior and migration patterns, and avoidance reactions to survey vessels among other purposes. Simultaneous use of echosounder frequencies can be used to map larger fish and even be used for species identification. The SWFSC operates Simrad EK500, EK60 and EK80 systems, which transmit and receive at six frequencies ranging from 18-333 kHz (see Appendix B). Since the 2015 LOA was issued, SWFSC plans to use an EK80 echosounder in future research. The EK80 has a different hardware and software design to the EK60 and validation that the EK80 gives near-identical results to the EK60 is an essential prerequisite to the use of EK80s for quantitative acoustic surveys. The narrowband mode of the EK80 uses short transmit pulses that are nominally at a single frequency, but due to finite pulse durations have a bandwidth of several kHz (the EK80 can also generate and process broadband pulses that, when combined with a transducer, can have bandwidths about between 10 and 200 kHz) (Macauley *et al*. 2018). Frequency ranges for the EK80 are the same as the EK60 previously used. Source level values for the EK80 configured with different transducers ranged between 226 and 212 dB re 1 µPa at 1 m (ICES 2018). Therefore, it is reasonable to assume noise propagation from the EK80 would be the same as previously evaluated for the EK60 (see Table 6-7).

As described in the 2015 MMPA final rule (80 FR 58982), underwater sounds from an echosounder are brief (<1 second), intermittent, broadband, and consist of a high peak pressure with rapid rise time and rapid decay (ANSI 1986; NNIOSH 1998 as cited in 80 FR 58982). As described by Au *et al*. 1988; Dolphin *et al*. 1995; Supin and Popov 1995; and Mooney *et al*. 2009 (all as cited in 80 FR 58982), marine mammals have fine auditory temporal resolution and can detect signals separately. For this reason, marine mammals are not likely to perceive underwater sound from the echosounder as continuous. Therefore, given that this sound would be perceived as intermittent, not continuous, the threshold of 160 dB is more appropriate to use than the 120 dB threshold for estimating takes associated with acoustic harassment incidental to such sources (80 FR 58982).

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 (NMFS 2015a).

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 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 this LOA application includes no quantitative estimates for Level A harassment from these sources.

6.3.2. Multibeam Echosounder and Sonar

Multi-beam echosounders operate in a similar fashion to equipment described above but multiple acoustic beams allow coverage of a greater area compared to single beam sonar. These systems are typically used for mapping the seafloor or conducting bathymetry surveys but also may be used to map fish schools and biomass. The Simrad ME70 and MS70 are systems often used by SWFSC and emit frequencies ranging from 70 to 120 kHz.

6.3.3. Single-Frequency Omnidirectional Sonar

Single-frequency omni-directional sonar is used to prevent interference by vessels and operate between frequencies of 20 to 30 kHz. Systems such as the SX90 used by SWFSC can provide omnidirectional imaging around the source with three different vertical beam widths available (single or dual vertical view and 4-5° variable for tilt angles from 0 to 45° from horizontal) (see Appendix B).

6.3.4. Acoustic Doppler Current Profiler (ADCP)

ADCPs are used to measure water current velocities simultaneously at a range of depths and operate by transmitting a series of "pings" which bounce off particles in the water column towards the device. Depending on their distance from the device, particles will emit different frequencies which then results in a profile of the current speed at different depths. ADCPs operate between frequencies ranging from 75 to 300 kHz.

Net Monitoring System

The SWFSC uses a range of net sensors to monitor the position of gear as well as the position and concentrations of fish relative to gear. To monitor the trawl net opening, SWFSC uses the Simrad FS70 Third Wire Net Sonde. The Simrad ITI Catch Monitoring System is also used to monitor the exact position of trawl gear.

Table 6-8 provides a summary of total km^2 surveyed each year 2015–2018 by equipment type in the CCE as compared to what was estimated in the 2015 LOA. There are several factors that influence the level of research effort from year-to-year including but not limited to funding, changes in priorities, or staff availability, the SWFSC used a conservative level of effort to be precautionary for assessing potential impacts on marine mammals. For the future research period 2020–2025, the SWFSC is using these same conservative numbers to estimate the potential interactions with marine mammals during research.

Table 6-9 provides a summary of total km^2 surveyed in the AMLR using the EK60 compared to what had been estimated in the 2015 LOA.

Based on the information available on these devices, it is highly unlikely that the potential behavioral effects from SWFSC research would result in anything more than minor, biologically insignificant consequences for any individual animal or for the population. There is compelling evidence that factors other than received sound level, including the activity state of animals exposed to different sounds, the nature and novelty of a sound, and spatial relations between the sound source and receiving animals (i.e., the exposure context) strongly affect the probability of a behavioral response (Ellison *et al.* 2012). These limited effects have not resulted in any documented biologically significant consequences for individual animals and have had no documented population consequences. However, to be precautionary, the

SWFSC is requesting takes due to the potential for marine mammal species listed in Tables 6-1 and 6-2 to occur in the Action Area and to be exposed to signals from SWFSC active acoustic sources.

TABLE 6-8. TOTAL LINE KILOMETERS (KM) OF DOMINANT ACOUSTIC SOURCES IN THE CCE

Gear	2015 LOA Application (Estimated Annual)		2015-2016		2017		2018		Estimated Annual 2020-2025	
Depth Range (m)	*0-200*	*>200*	*0-200*	*>200*	*0-200*	*>200*	*0-200*	*>200*	*0-200*	*>200*
SX90	33,880	33,880	8,417	8,417	1,258	2,879	1,680	4,577	33,880	33,880
EK60/EK80	79,912	99,640	22,610	49,574	9,993	29,720	6,883	24,248	79,912	99,640
ME70	19,728	0	26,414	0	1,186	0	725	0	19,728	0

TABLE 6-9. TOTAL LINE KILOMETERS (KM) USING THE EK60 IN THE AMLR

Gear	2015 LOA Application (Estimated Annual)		2015-2016		2017[1]		2018[1]		Estimated Annual 2020-2025	
Depth Range (m)	*0-200*	*>200*	*0-200*	*>200*	*0-200*	*>200*	*0-200*	*>200*	*0-200*	*>200*
EK60	20,486	20,486	5,200	5,200	n/a	n/a	n/a	n/a	20,486	20,486

[1]Surveys were not conducted in AMLR in 2017 and 2018

6.3.5. Unmanned Aerial Systems (UAS)

UASs are aerial survey platforms that complement research objectives. The UAS technology allows the SWFSC to conduct aerial surveys and collect biological samples at decreased costs, which facilitates additional survey time that will improve our population assessments. SWFSC UAS projects may use multi-engine, vertical lift-off and landing (VTOL) hexacopters to carry a small, high resolution digital camera. Projects would vary in time of year and location depending on the species and question of interest. Projects may also be conducted independently or in conjunction with other projects during land or at-sea based studies. Photogrammetry work using UAS would typically fly slowly above a target species at altitudes between 100 and 200 ft depending on the size of the targeted species. Incidental harassment of non-target species is not expected to occur during these activities; UASs will not be flown directly over pinniped haulouts during SWFSC surveys. Takes associated with directed research on marine mammals using UASs are covered under individual research permits separate from this application.

6.3.6. All Other Gear Types

All other gears used in SWFSC fisheries research (e.g., a variety of plankton nets, CTDs, ROVs) do not have the expected potential for marine mammal interactions and are not known to have been involved in any marine mammal interaction anywhere.

Specifically, CTDs, eXpendable BathyThermographs (XBTs), CUFES, ROVs, small trawls (such as the Oozeki, IKMT, MOCNESS, and Tucker trawls), plankton nets (Bongo, Pairovet, and Manta nets), and vertically deployed or towed imaging systems are considered to be no-impact gear types.

6.4. Take Requests

6.4.1. Potential Mortality or Serious Injury

For purposes of estimating potential takes for M/SI and Level A harassment, the SWFSC calculated the average number of reported interactions for each marine mammal species in both trawl and longline gear deployed during 2015-2019 as well as historical interactions prior to that period (see Section 6.3). The annual SWFSC take estimates for M/SI and Level A harassment were calculated by gear, then rounded up to the nearest whole number. Annual estimates were then multiplied by five to account for the 5-year authorization period. 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 the recent authorization period (2015-2019), the SWFSC expects some variability in the actual number of gear interactions. This is taken into account by using an estimated annual survey distance (in line km) for the take request. As described in Section 6.4.2, the annual line km distances are used to calculate potential area ensonified. Furthermore, mitigation measures intended to reduce interactions have been implemented over the past five years and are proposed for the future 2020–2025 period as described in Section 11. M/SI takes requested for the period 2020–2025 are presented in Table 6-10.

TABLE 6-10. MORTALITY AND SERIOUS INJURY (M/SI) TAKE ESTIMATES FOR CCE[1]

Common Name	Scientific Name	Stock Abundance Estimate[2]	5-Year Midwater Trawl M/SI Takes Requested	5-Year Purse Seine M/SI Takes Requested	5-Year Longline M/SI Takes Requested[3]	5-Year Total M/SI Take Requested
Cetaceans						
Harbor Porpoise[4]	*Phocoena phocoena*	35,769	5	1	0	6
Dall's Porpoise	*Phocoenoides dalli*	25,750	5	1	0	6
Pacific White-sided Dolphin	*Lagenorhynchus obliquidens*	26,814	40	1	0	41
Risso's Dolphin	*Grampus griseus*	6,336	11	1	2	14
Bottlenose Dolphin (all stocks)[5]	*Tursiops truncatus*	2,377	-	-	1	1
Bottlenose Dolphin (CA/WA/OR offshore)			8	0	0	8
Bottlenose Dolphin (CA coastal)			3	0	0	3
Striped Dolphin	*Stenella coeruleoalba*	29,211	11	1	2	14
Short-beaked Common Dolphin	*Delphinus delphis*	969,861	11	1	2	13
Long-beaked Common Dolphin	*Delphinus capensis*	101,305	11	1	2	13
Northern Right Whale Dolphin	*Lissodelphis borealis*	26,556	10	1	0	11
Short-finned Pilot Whale	*Globicephala macrorhynchus*	836	0	0	2	2
Kogia sp.[6]	*Kogia breviceps*	4,111	0	0	2	2
Unidentified cetacean			1	0	0	1

Common Name	Scientific Name	Stock Abundance Estimate[2]	5-Year Midwater Trawl M/SI Takes Requested	5-Year Purse Seine M/SI Takes Requested	5-Year Longline M/SI Takes Requested[3]	5-Year Total M/SI Take Requested
Pinnipeds						
California Sea Lion	*Zalophus californianus*	257,606	20	5	5	30
Steller Sea Lion, Eastern DPS[7]	*Eumetopias jubatus monteriensis*	71,562	9	0	1	10
Northern Fur Seal[8]	*Callorhinus ursinus*	637,561	5	0	0	5
Harbor Seal[9]	*Phoca vitulina richardsi*	30,968	9	5	0	14
Northern Elephant Seal	*Mirounga angustirostris*	179,000	5	0	0	5
Unidentified pinniped			1	1	0	2

[1]M/SI takes are not requested for AMLR research as described in Section 6.2.5.1.
[2]Carretta et al. (2019).
[3] Where requested for cetaceans only, includes takes for deep set buoy gear and sablefish surveys.
[4]N. CA/ S. OR stock
[5]Assumes that a maximum of one total take of a bottlenose dolphin from either stock may occur in longline gear.
[6]Most likely to be Pygmy sperm whales (K. breviceps). See section 4.1.14
[7]De-listed since the 2015 PEA (81 FR 62259, September 8, 2016).
[8]Pribilof Island/Eastern pacific stock; declining trend continues; Muto et al. 2018
[9]California stock

6.4.2. Potential Disturbance from Underwater Noise

Potential disturbance to marine mammals during SWFSC research may result from underwater noise that exceeds the Level B threshold of 160 dB rms. Based on the operating parameters for each sound source described in Section 6.3, an estimated volume of water ensonified at or above the 160 dB rms threshold was determined. In all cases where multiple sources are operated simultaneously, the one with the largest estimated acoustic footprint was considered to be the "dominant" noise source. For each depth stratum (0–200 m and >200 m), an estimate of the volume of water ensonified was calculated using a simple model of sound propagation loss, which accounts for the loss of sound energy over increasing range. Following the approach used in the 2015 LOA Application (NMFS 2015a; Appendix C), a spherical spreading model (where propagation loss = 20 * log [range]; such that there would be a 6-dB reduction in sound level for each doubling of distance from the source) accounts for the frequency-dependent absorption coefficient (a at 15°C and 33 parts per thousand [ppt]) and beam pattern of sound sources used in SWFSC research which are generally highly directional. For systems that operate over a range of frequencies, the lowest frequency was used. Because the equipment used and the type of research has not changed, this approach using updated marine mammal density numbers where available, remains valid.

Following the determination of effective sound exposure area for transmissions considered in two dimensions, the next step was to determine the effective three dimensional volume of water ensonified at or above 160 dB rms for the entirety of each survey in each region. For each of the three predominant sound sources, the volume of ensonified water is estimated as the athwartship cross-sectional area (in square kilometers) of sound at or above 160 dB rms (as illustrated in Figure 6-1) multiplied by the expected annual distance traveled (in line km) by the ship (see Tables 6-8 and 6-9).

If different sources operate simultaneously, the predominant noise source at each depth strata was taken into account (see Table 6-11). This enabled an estimate of exposure that is depth-specific based on two factors: whether the species is shallow-diving or deep-diving, and also which noise source predominates at a specific depth. For deep-diving species that may encounter noises from different sources when diving from the surface to depths greater than 200 m, this is accounted for by using the specific ensonified area based on which equipment predominates at each depth strata (i.e., 0–200 m and >200 m).

As described in Section 3 and following the approach used in the 2015 proposed rule (80 FR 58982) to estimate potential Level B exposure by acoustic disturbance, an area of exposure was calculated based on the volume of water expected to be ensonified by SWFSC equipment (i.e., EK60 or SX90). For example, the estimated source-specific, ensonified area is based on depth (i.e., shallow strata between 0–200 m or deep strata >200 m) and the number of annual line-kilometers surveyed. Importantly, different sound sources predominate at specific depth strata. For example, as shown in Table 6-11, at depths >200 m, an EK60 is predominant approximately 75% of the time whereas the SX90 is predominant approximately 25% of the time. This is an important factor when calculating the ensonified area. Again this approach remains valid because the equipment and type of research has not changed.

TABLE 6-11. PREDOMINANT SOURCE TYPE AT TWO DEPTH STRATA (% OF DISTANCE SURVEYED)

Source	Dominant Source % at 0-200 m Depth	Dominant Source % at >200 m Depth
SX90	25	25
EK60/EK80	60	75
ME70	15	0

Source: NMFS 2015a, Appendix C

Total cross sectional area based on sound source and depth is multiplied by marine mammal volumetric density for each stratum (i.e., 0–200 m or >200 m).

For example, to estimate Level B exposure of harbor porpoise to the EK60 in the CCE during the period 2015–2019 at a depth of 0–200 m, the total area of exposure is calculated by estimating the cross sectional area of water ensonified.

$$0.013072 \text{ km}^2 * 66{,}760 \text{ km} * 60\% = 872.65 \text{ km}^3$$

(Cross sectional area for EK60 0–200 m * Survey distance * % as Predominant Source (%) = km^3)

Then, to calculate potential Level B takes, the total area of exposure is multiplied by volumetric density of harbor porpoise in the CCE:

$$TAE \; x \; D = TE$$

$$TE \; x \; 5 = TE5$$

TAE = Total Area of Exposure
D = Density
TE = Total Exposed (animals)
TE5 = Total Exposed (animals) Over 5-Year Period

$$872.65 \text{ km}^3 * 0.17057 \text{ animals/km}^3 = 89.3 \text{ (rounded up to 90 animals)}$$

$$90 * 5 = 450 \text{ harbor porpoise over the 5-year period}$$

A total of Level B takes were added for each type of equipment that may be used by SWFSC to calculate total annual takes and the total 5-year takes for each species as shown in Table 6-12. Based on the exposure estimates, the SWFSC requests takes for Level B harassment for the 5-year period as shown in Tables 6-12 and 6-13 by equipment and for each research area.

TABLE 6-12. MARINE MAMMAL LEVEL B TAKES REQUESTED WITHIN THE CCE

Common Name	Typical Vertical Habitat		Density (per km^2)[1]	Volumetric Density (per km^2)	Annual Level B Take				Total 5-Year Level B Take
					EK60/80	ME70	SX90	Total[2]	
Cetaceans	**0-200m**	**>200m**							
Harbor Porpoise[3]	X		0.03411	0.17057	178	138	359	675	3,375
Dall's Porpoise	X		0.04631	0.23154	242	187	487	916	4,580
Pacific White-sided Dolphin	X		0.02084	0.10420	109	84	219	412	2,060
Risso's Dolphin	X		0.01057	0.05283	55	43	111	209	1,045
Bottlenose Dolphin[4]	X		0.00313	0.01565	16	13	33	62	310
Striped Dolphin	X		0.04464	0.22321	233	180	470	883	4,415
Short-beaked Common Dolphin	X		0.72962	3.64808	3,811	2,943	7,676	14,430	72,150
Long-beaked Common Dolphin	X		0.07207	0.36033	376	291	758	1,425	7,125
Northern Right Whale Dolphin	X		0.03107	0.15534	162	125	327	614	3,070
Killer Whale[5]	X		0.00064	0.00318	3	3	7	13	65
Short-finned Pilot Whale[6]		X	0.00034	0.00068	22	4	4	30	150
Baird's Beaked Whale		X	0.00262	0.00523	57	4	11	72	10
Mesoplodont Beaked Whales		X	0.00306	0.00612	66	5	13	84	420
Cuvier's Beaked Whale		X	0.00584	0.01167	126	9	25	160	800
Pygmy Sperm Whale		X	0.00774	0.01548	167	12	33	213	1,065
Sperm Whale		X	0.00350	0.00699	76	6	15	96	480
Humpback Whale[7]	X		0.00117	0.00585	6	5	12	23	115
Blue Whale	X		0.00090	0.00449	5	4	9	18	90
Fin Whale	X		0.00629	0.03144	33	25	66	124	620

Common Name	**Typical Vertical Habitat**		**Density (per km²)[1]**	**Volumetric Density (per km²)**	**Annual Level B Take**				**Total 5-Year Level B Take**
					EK60/80	**ME70**	**SX90**	**Total[2]**	
Sei Whale[6]	X		0.00037	0.00185	4	2	4	10	50
Minke Whale	X		0.00096	0.00480	5	4	10	19	95
Gray Whale[8]	X		0.02697	0.13483	141	109	284	533	2,665
Pinnipeds	**0-200m**	**>200m**							
California Sea Lion	X		0.25761	1.28803	1,345	1,039	2,710	5,095	25,475
Steller Sea Lion, Eastern DPS[9]	X		0.06261	0.31306	327	253	659	1,238	6,190
Guadalupe Fur Seal	X		0.07915	0.07915	83	64	167	313	1,565
Northern Fur Seal[10]	X		0.63680	3.18399	3,326	2,569	6,700	12,595	62,975
Harbor Seal[11]	X		0.05633	0.28167	294	227	593	1,114	5,570
Northern Elephant Seal		X	0.17900	0.35800	3,874	289	753	4,916	24,580

[1]Densities were determined as described in Section 3 and Appendix A.
[2]No Level B takes are anticipated from the ADCP or MS70.
[3]N. CA/ S. OR stock
[4]Coastal plus offshore stocks
[5]Stock with lowest abundance used – S. Resident stock
[6]Takes adjusted to consider group size.
[7]Change in ESA-listing status (81 FR 62259, September 8, 2016). The Central America (endangered) and Mexico (threatened) DPSs occur in the CCE. However, for MMPA purposes the operable unit is the CA/OR/WA stock. Therefore the abundance estimate from Carretta *et al*. (2019) for this stock is shown here.
[8]Eastern Pacific stock
[9]De-listed since the 2015 PEA (81 FR 62259, September 8, 2016).
[10]Pribilof Island/Eastern pacific stock; declining trend continues; Muto et al. 2018
[11]California stock

TABLE 6-13. MARINE MAMMAL LEVEL B TAKES REQUESTED WITHIN THE AMLR

Common Name	Typical Vertical Habitat		Density[1] (per km^2)	Volumetric Density (per km^2)	Annual Level B Take[2]	TOTAL 5-Year Level B Take
Cetaceans[3]	**1-200m**	**>200m**				
Spectacled Porpoise	X		0.00150	0.00750	10	50
Hourglass Dolphin	X		0.00150	0.00750	10	50
Killer Whale	X		0.00150	0.00750	10	50
Sperm Whale[4]		X	0.00065	0.00130	5	25
Arnoux's Beaked Whale		X	0.00060	0.00120	2	10
Southern Bottlenose Whale		X	0.00060	0.00120	10	10
Long-finned Pilot whale		X	0.00760	0.01520	21	105
Antarctic Minke Whale	X		0.00180	0.00900	5	25
Southern Right Whale[5]	X		0.00041	0.00203	0	0
Fin Whale[6]	X		0.08390	0.41950	57	285
Blue Whale[7]	X		0.00012	0.00062	0	0
Humpback Whale[8]	X		0.03610	0.18050	25	125
Pinnipeds[9]	**1-200m**	**>200m**				
Antarctic Fur Seal	X		0.09990	0.49950	68	340
Southern Elephant Seal		X	0.00030	0.00060	1	5
Crabeater Seal	X		0.64865	3.24324	884	4,420
Weddell Seal	X		0.05405	0.27027	37	185
Leopard Seal	X		0.01622	0.08108	11	55

[1]Estimated densities are not changed from those reported in the 2015 PEA and used in the 2015 rule. See Section 3.
[2] Takes adjusted to consider group size.
[3]Level B takes for AMLR cetaceans would be due to underwater noise from the EK60. No Level B takes are anticipated from the ME70, ADCP or MS70 as this equipment will not likely be used I the AMLR.
[4]Takes consider that in high latitudes usually males are encountered travelling in small groups.
[5]Williams *et al*. (2006)
[6]Santora *et al.* (2009)
[7]Humpback whale DPSs that forage in Southern Hemisphere were delisted (81 *FR* 62259, September 8, 2016). Density from
[8]Williams *et al.* (2006)
[9]Level B takes of AMLR pinnipeds would be due to use of acoustics and visual disturbance on close approach when hauled out.

6.4.3. Potential Disturbance from Unmanned Aerial Systems (UAS)

The types of UAS likely to be used during SWFSC research are extraordinarily quiet, sound levels are equivalent to a whisper (less than 5 dB) at 30m; the UAS operates almost silently and results

in minimal to no disturbance to animals. The unit will likely be launched from a survey vessel or from shore and would fly at an altitude of 100-200 feet above sea level (ASL) in order to photograph pinnipeds. After photographs are collected, the UAS would return to its launch site.

In a 2015 review of UAS impacts, Smith *et al.* (2015), concluded that there was an overall lack of directed studies on the effects of UAS on marine mammals and that additional studies were needed. Mustafa *et al.* (2018) also concluded that an assessment of the current state of UAS-wildlife response research is required and recommendations for future work are needed. Mulero-Pazmamh *et al*. (2017) found that reactions of wildlife and marine mammals depended on both UAS attributes and the characteristics of the animals such as species, life-history stage and group dynamics.

Additionally, the application for the SWFSC directed research permit 20599 for work conducted in AMLR, reports that noise levels for the unmanned aircraft at various distances and altitudes are included in Goebel *et al.* (2015). Operating under directed research permit 20599, SWFSC researchers have flown UAS over leopard seals, Antarctic fur seals, Northern Resident Killer Whales, Blue Whales, and bottlenose dolphins. At altitudes of 100 ft or higher, reactions from animals have not been documented due to the presence of the UAS. Behavioral reactions of killer whales were also assessed under this permit by flying over groups at different altitudes. At the lowest altitude of 30 ft, the SWFSC documented no reaction. Finally, when the SWFSC (under permit 20599) conducted UAS passes to obtain breath samples of blue whales at 8 ft, no reaction to the presence of the UAS was noted. Small UAS research activities planned for SWFSC fisheries and ecosystem research are far less invasive than manned aircraft previously used or the close-boat approaches used to take photo-identification photos and deploy tags.

Recognizing that the use of unmanned systems is increasing in scientific research, the Environmental Guidelines for operation of Remotely Piloted Aircraft Systems (RPAS) (i.e., unmanned aircraft systems) in Antarctica was published by the Secretariat of the Antarctic Treaty in 2018. The Environmental Guidelines for operation of RPAS in Antarctica are intended to provide input on how to assess the use of such technology and aim to aid in decision making regarding the use of RPAS through the current best available knowledge. Proposed mitigation measures discussed in Section 11 align with the guidance provided in the 2018 publication by the Secretariat of the Antarctic Treaty.

The use of UAS is expected to reduce on-ice disturbance of pinnipeds that would have otherwise occurred due to the presence of humans on the ice. Therefore, Level B disturbance from UAS is considered to be minor and not likely to result in biologically significant effects on species in the research area. However, to be precautionary, Level B takes have been requested for pinniped species that may occur in AMLR such as crabeater seals (see Table 6-13).

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7. ANTICIPATED IMPACT OF THE ACTIVITY ON SPECIES AND STOCKS

Although SWFSC surveys have the potential to adversely impact the health and condition of an individual marine mammal, adverse effects on annual rates of recruitment or survival of the affected marine mammal species or stocks are not anticipated. To illustrate this, the PBR can be compared to anticipated removals due to fishery research. In using PBR to evaluate the impact of SWFSC fisheries research activities on affected marine mammal stocks, two assumptions are made:

- All animals in the combined category for Level A injury, serious injury, and mortality will be seriously injured or killed (worst case assumption).
- The requested take will equal the actual take of marine mammals in fisheries research activities.

7.1. Physical Interactions with Gear

From 2015-2018, the SWFSC incidentally caught 19 marine mammals during research activities using trawl gear within the CCE from 2015 through 2019 (Table 6-4); no animals were caught in long line gear from 2016-2017 and longline gear was not used from 2017-2019 (Table 6-6). Of the 19 animals caught, fourteen Pacific white sided dolphins and one long-beaked common dolphin were killed during the CPS surveys. Two Pacific white-sided dolphins and one California sea lion were killed during the Rockfish Recruitment and Ecosystem Survey; one Pacific white-sided dolphin was caught alive, but injured in the CPS Survey. SWFSC also proposes to conduct purse seine surveys in the nearshore area in conjunction with CPS surveys. Purse seine gear has the potential to entangle marine mammals. Small numbers of pinnipeds may be attracted to purse seine operations and are frequently observed to enter operational purse seines to depredate the catch and exit the net unharmed (83 FR 36370). Dolphins and porpoise may also interact with purse seine gear because of their occurrence in nearshore areas. For these reasons, a small number of takes for M/SI due to these gear types is accounted for in the Level A take request as shown in Table 7-1.

Due to the low level of historical takes, as well as the low level of predicted future takes associated with the use of trawl and longline gear as well as purse seines for research activities in the CCE, these surveys are expected to: (1) 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) 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 the requested take is less than 10% of PBR for all stock except for coastal bottlenose dolphin. The requested take for coastal bottlenose dolphin is greater than 10% of PBR but less than overall stock PBR (Table 7-1). As the stock is increasing and not considered strategic the requested take is considered negligible based on the draft Guidance for Determining Negligible Impact under MMPA Section 101(a)(5)(E)[6]. Therefore the requested take is considered negligible for all stocks that may be taken in the CCE.

[6]https://www.fisheries.noaa.gov/action/guidance-determining-negligible-impact-under-mmpa-section-101a5e.

TABLE 7-1. M/SI TAKE REQUEST IN THE CCE RELATIVE TO PBR

Species	SWFSC Annual Take Level A, M/SI Request[1] (2020-2025)	PBR (Annual Potential Biological Removal)	% PBR Requested Annually
Harbor Porpoise[2]	1.2	25	4.80
Dall's Porpoise	1.2	172	0.70
Pacific White-sided Dolphin	7.2	191	3.77
Risso's Dolphin	2.8	46	6.08
Bottlenose Dolphin (OR, WA Offshore)	1.6	11	14.55
Bottlenose Dolphin (Coastal)	0.6	2.7	22.22
Striped Dolphin	2.8	238	1.17
Short-Beaked Common Dolphin	2.6	8,393	0.03
Long-Beaked Common Dolphin	2.6	657	0.40
Northern Right Whale Dolphin	2.2	179	1.23
Short-finned Pilot Whale	0.4	4.5	8.89
California Sea Lion	6.0	14,011	0.04
Steller Sea Lion (Eastern DPS)	2.0	2,498	0.08
Northern Fur Seal	1.0	451	0.22
Harbor Seal (CA stock)[3]	2.8	1,641	0.17
Northern Elephant Seal	1.0	4,382	0.02
Unidentified cetacean	0.2	0	-
Unidentified pinniped	0.4	0	-

[1]From Table 6-10
[2]Harbor porpoise take request is across all stocks, and PBR used is the lowest calculated for any stock (Monterey Bay).
[3]PBR for the Oregon/Washington Coastal stock cannot be calculated because there is no current estimate of minimum abundance.

The following subsections compare the Level A/Mortality and injury takes requested in Section 6 for trawl and longline surveys in the CCE. No trawl or longline surveys are planned for the AMLR; all planned AMLR surveys would be conducted unmanned systems such as gliders, ROVs, or UAS (see Table 1-2).

7.1.1. Mid-water Trawl and Longline Surveys in the California Current Ecosystem (CCE)

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. For each of the 16 stocks for which take is requested, no take request exceeds 10% of its PBR except coastal and offshore bottlenose dolphins for which the requested take is greater than 10% of PBR but less than overall stock 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 Survey Gears not Expected to Take Marine Mammals by Level A/Mortality/Serious Injury

The only SWFSC research gears that have historically taken marine mammals are mid-water trawls (NETS Nordic 264 and Modified Cobb) and longline gears used in surveys for sharks and HMS (see Tables 6-4 and 6-6). The other net and gear used in SWFSC fisheries research, which include a variety of plankton nets, CTDs, ROVs, and UAS have had no marine mammal interactions during the period 2015-2019. These gear types are not considered to have the potential to take marine mammals by M/SI given their physical characteristics, how they are fished, and the environments where they are used. Therefore, SWFSC is not requesting marine mammal take for these gears, and they are not expected to have an impact on marine mammal stocks in the SWFSC study areas.

7.2. Disturbance and Behavioral Responses Due to Acoustic Equipment

Several mechanisms exist by which research activities could potentially disturb marine mammals and alter behavior, including the physical presence of human activities (i.e., vessels or field crews on land), fishing gear, underwater sound from engines, hydraulic gear, or acoustical devices used for navigation and research. Marine mammals rely on sound to obtain detailed information about their surroundings, communicate, navigate, reproduce, socialize and avoid predators. Thus, the surrounding soundscape is a key component of marine mammal habitat and can be considered their acoustic habitat (Clark *et al*. 2009). Underwater sound comes from numerous natural sources (biological and physical processes) and anthropogenic sources. Biological sounds include marine life (marine mammals, fish, snapping shrimp). Physical sounds include wind and wave activity, rain, cracking sea ice, undersea earthquakes and volcano eruptions. Anthropogenic sound includes shipping and other vessel traffic, military activity, marine construction, oil and gas exploration and more. Some of these natural and anthropogenic sounds are present more or less everywhere in the ocean all of the time. Therefore, background sound in the ocean is commonly referred to as “ambient noise” (DOSITS 2019). Sound levels at a given frequency and location can vary by 10-20 dB from day to day (Richardson *et al*. 1995). The result is that, depending on the source type and its intensity, sound from a specified activity may be a negligible addition to the local soundscape or could form a distinctive signal that may affect marine mammals.

The impacts of anthropogenic noise on marine mammals have been summarized in numerous articles and reports including Richardson *et al.* (1995), NRC (2005), Southall *et al.* (2007) and Southall *et al.* (2019). Marine mammals use hearing and sound transmission to perform vital life functions. The distance to which anthropogenic sounds are audible depends on the level of ambient noise, anthropogenic sound source levels, frequency, ambient noise levels, the propagation characteristics of the environment, and sensitivity of the marine mammal (Richardson *et al.* 1995). Marine mammals exposed to high intensity sound repeatedly or for prolonged periods could experience hearing a threshold shift, resulting in the loss of hearing sensitivity at certain frequency ranges (Kastak *et al*. 1999; Schlundt *et al*. 2000; Finneran *et al*. 2002; 2005). Threshold shifts can be categorized as a permanent threshold shift (PTS) where loss of hearing sensitivity is unrecoverable, or a temporary threshold shift (TTS) in which case an animal may recover hearing sensitivity over time (Southall *et al.* 2007).

In 2019, Southall *et al.* (2019) published an update to the 2007 Marine Mammal Noise Exposure Criteria, proposing eight discrete hearing groups including: 1) low frequency cetaceans; 2) high frequency cetaceans; 3) very high frequency cetaceans; 4) sirenians; 5) phocid carnivores in water; 6) phocid carnivores in air; 7) other marine carnivores in water; and 8) other marine carnivores in air (Southall *et al*. 2019). The 2019 publication confirms the weighting functions and thresholds used by NMFS and cited in the 2018 revised NMFS Technical Guidance (NMFS 2018a). The NMFS Technical Guidance continues to be used for defining regulatory thresholds for calculating incidental takes of marine mammals under the MMPA and have been used in this MMPA LOA application.

The *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing* (NMFS 2018a) uses marine mammal hearing groups defined by Southall *et al*. (2007) with some modifications. These groups and their generalized hearing ranges are shown in Table 7-2. As shown in the table, marine mammals found in the SWFSC research areas fall into the following categories: baleen whales are low-frequency cetaceans; killer whales and Pacific white-sided dolphins are mid frequency cetaceans; Dall's porpoise are high frequency cetaceans; harbor seals are in the phocid category; and California sea lions are classified as otariids. NMFS (2018a) considered acoustic thresholds by hearing group to acknowledge that not all marine mammals have identical hearing ability or identical susceptibility to noise or noise-induced PTS. NMFS (2018a) also used the hearing groups to establish marine mammal auditory weighting functions (Table 7-3).

Although the 2018 guidance identifies dual criteria to assess auditory injury (Level A harassment) to five different marine mammal groups (based on hearing sensitivity) as a result of exposure to noise from two different types of sources (impulsive or non-impulsive), given the highly directional, e.g., narrow beam widths of acoustic equipment, NMFS does not anticipate animals would be exposed to noise levels resulting in injury. Potential effects of underwater noise on marine mammals have been evaluated for SWFSC research alternatives and are presented in the 2015 PEA and supplemented in this chapter as needed.

TABLE 7-2. GENERALIZED HEARING RANGES FOR MARINE MAMMAL HEARING GROUPS IN WATER

Hearing Group	Hearing Range
Low-frequency cetaceans (e.g. baleen whales)	7 Hz to 35kHz
Mid-frequency cetaceans (e.g. killer whales)	150 Hz to 160 kHz
High-frequency cetaceans (e.g. Pacific white-sided dolphins)	275 Hz to 160 kHz
Phocids (e.g. harbor seals)	50 Hz to 86 kHz
Otariids and other non-phocid marine carnivores (e.g. California sea lions)	60 Hz to 39 kHz

Source: NMFS (2018a).

TABLE 7-3. SUMMARY OF WEIGHTING AND EXPOSURE FUNCTION PARAMETERS

Hearing Group	*a*	*b*	f_1 (kHz)	f_2 (kHz)	*K* (dB)
Low-frequency cetaceans	1.0	2	0.20	19	0.13
Mid-frequency cetaceans	1.6	2	8.8	110	1.20
High-frequency cetaceans	1.8	2	12	140	1.36
Phocids in water	1.0	2	1.9	30	0.75
Otariids in water	2.0	2	0.94	25	0.64

Source: NMFS (2018a).

Animals exposed to natural or anthropogenic sound may experience physical and behavioral effects, ranging in magnitude from none to severe (Southall *et al.* 2007). Watkins (1986; as reported in NRC 2003) suggests that contextual factors influence whether or not a marine mammal becomes habituated to a particular disturbance or stimuli. For example, animals may tolerate a stimulus they might otherwise avoid if the benefits in terms of feeding, mating, migrating to traditional habitat, or other factors outweigh the negative aspects of the stimulus.

The actual radius of a behavioral effect is smaller than the radius of noise detectability (Richardson *et al*. 1995; Southall *et al*. 2007). As an example, during spring migration, bowheads were shown to continue through an area where the only available lead was within 200 m of a projector playing sounds associated with a drilling platform that produced received levels of 131 dB re 1 µPa (Richardson *et al.* 1991 as reported in NRC 2003). NMFS currently uses a behavioral threshold of 160 dB rms for intermittent noise sources which encompasses non-pulse echosounders such as the EK60/80 used in fisheries surveys. The interim behavioral effect threshold as applied by NMFS do not account for differences between species in hearing ranges and sensitivity to noise at different frequencies and are based on broadband unweighted sound levels.

These thresholds are conservative considering that many natural and anthropogenic noise sources can cause noise levels above these thresholds but not necessarily result in adverse behavioral effects to marine mammals. TTS is by definition recoverable rather than permanent and is treated as ‘‘Level B harassment’’ under the MMPA

In summary, 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 individuals would have to either be very close to and 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., 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 (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 Kastelein *et al*. 2006).

7.3. Disturbance and Behavioral Changes 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 and are shown in Table 6-12. These events are expected to be infrequent and cause only a very temporary disturbance (lasting for minutes). Relevant studies of pinniped populations that experience more regular vessel disturbance indicate that population level impacts are unlikely to occur.

Over the period August 31, 2015 to December 31, 2016, 92 crabeater seals were taken due to on ice disturbance during the Austral Winter Krill and Ecosystem survey. The authorized level of takes for the species over the period was only 7 animals. The SWFSC believes that the larger than expected numbers encountered may be within the natural range of variability for the species, and the population size is likely in excess of 5 million individuals and may be as large as 10 million. Based on higher population density estimates used in the take calculations discussed in Section 6, Level B takes of up to 884 crabeater seals per year are being requested if the Austral Winter Krill and Ecosystem survey is conducted again.

Disturbances resulting from research activities are brief and infrequent during SWFSC surveys conducted in the ALMR. Therefore, 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.

7.4. Active Acoustic Sources Used by the SWFSC

High frequency transient sound sources operated by the SWFSC are used for 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 6.3. The types of active sources employed in fisheries acoustic research and monitoring fall under one of two based on operating frequency (e.g., within or outside the known audible range of marine species) and other output characteristics (e.g., signal duration, directivity).

7.4.1. Category 1 Active Acoustic Sources

Some active fisheries acoustic sources (e.g., short range echosounders, acoustic Doppler current profilers) have 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 6.3). Additionally, passive listening sensors which 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.

Category 1 active sources are not expected to have adverse effects on marine mammals. The relative output frequency of these sources is greater than180 kHz and is above the known hearing capabilities of marine mammal species. 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).

7.4.2. Category 2 Active Acoustic Sources

Category 2 acoustic sources are present on most SWFSC fishery research vessels and 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.

Category 2 active acoustic sources are likely to be audible to some marine mammal species. 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 resulting in physiological damage (injury) is considered extremely low so as to be negligible in relation to realistic operations of these devices.

7.5. Surveys That May Take Marine Mammals by Level B Harassment

Level B harassment associated with use of active acoustics equipment may occur during SWFSC fisheries surveys. The SWFSC believes that the activities 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). Surveys conducted in the CCE that may take marine mammals by Level B harassment using Category 2 acoustic sources include:

- Coastal Pelagic Species (CPS) Survey (aka. Sardine Survey). Level B harassment associated with use of active acoustics may occur.
- Juvenile Salmon Survey. Level B harassment associated with use of active acoustics may occur.
- Rockfish Recruitment and Ecosystem Assessment 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.
- Highly Migratory Species (HMS) Surveys. 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.

Surveys conducted in the AMLR that may take marine mammals by Level B harassment using Category 2 acoustic sources:

- Antarctic Living Marine Resources Program (FREEBYRD). Gear interactions associated with this survey which uses autonomous underwater vehicles and gliders are not expected; however, Level B harassment associated with use of active acoustics may occur.
- Antarctic Living Marine Resources Program (Seabirds) - These are land-based surveys using UAS and telemetry. Gear interactions associated with this survey are not expected; however, Level B harassment associated with use of active acoustics may occur

7.6. Collision and Strike

Ship strikes and collisions with 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).

Jensen and Silber (2003) summarized large whale ship strikes worldwide 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 each (0.75%) was reported for a research boat, pilot boat, whale catcher boat, and dredge boat.

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). The relatively low speed of gliders or other autonomous surface vehicles (typically 1-3 knots with a maximum speed of 8 knots) reduce the risk of collision with marine mammals such that this potential effect is considered negligible. Monitoring and marine mammal watches in the vicinity of operations as described in Section 11 further reduce the risk of interactions.

7.7. Impacts of SWFSC Fisheries Research Activities on Marine Mammal Species and Stocks

SWFSC fisheries research activities have the potential to cause Level B harassment, Level A harassment (injury), and serious injury or mortality of marine mammals in the CCE 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.

- The requested annual Level A, mortality and/or injury takes associated with entanglement or hooking in SWFSC fisheries research surveys over the period 2020-2025 do not exceed any stock's PBR, and for most affected stocks the SWFSC take request is less than 10% of PBR.
- In the AMLR study area, SWFSC expects due to the density of pinnipeds particularly crabeater seals 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. However, these pinnipeds are quite abundant in the region and impacts would not be expected to result in population-level impacts.
- In the CCE 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, 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. ANTICIPATED IMPACTS ON SUBSISTENCE USES

The Makah Indian Tribe has requested authorization to hunt eastern North Pacific gray whales (*Eschrichtius robustus*). The right to take whales at usual and accustomed grounds is a Makah tradition secured by the 1855 Treaty of Neah Bay. This would be the only approved subsistence hunting of marine mammals in the CCE or AMLR.

The U.S. Ninth Circuit Court of Appeals ruled in 2004 that to pursue any treaty rights for whaling, the Makah Tribe must comply with the process prescribed in the MMPA for authorizing take of marine mammals otherwise prohibited by the MMPA's moratorium on take. Under the MMPA, "take" means to harass, hunt, capture, or kill any marine mammal or attempt such actions.

On February 14, 2005, the NMFS received a request from the Makah for a waiver of the MMPA's take moratorium. The Tribe had requested a waiver allowing the harvest of 20 eastern north Pacific (ENP) gray whales every 5 years and a limit of 7 strikes per hunting season, presuming that a struck whale would die. On April 5, 2019, NMFS published a proposed rule to issue a waiver under the MMPA and proposed regulations governing the hunting of eastern North Pacific gray whales by the Makah Tribe for a 10-year period and a related notice of hearing before an administrative law judge to consider the waiver and proposed regulations (84 FR 13604).

The ENP gray whale stock is not listed as threatened or endangered under the ESA and it is not a strategic stock under the MMPA (See Table 3-1). Gray whales migrate north though the CCE. However most SWFSC survey activity occurs offshore and is unlikely to interact with coastal species such as gray whales migrating north.

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9. ANTICIPATED IMPACTS ON HABITAT

The impact of SWFSC surveys on the availability of prey for marine mammals can be determined by considering biomass removals of high-quality prey species such as sardines, anchovies, mackerel, herring and squid (Table 9-1). Note the biomass numbers in Table 9-1 do not include jellyfish, salps, dogfish, sharks, rays or other organisms taken in CPS surveys that are not considered potential prey species for marine mammals.

TABLE 9-1. PREY BIOMASS REMOVED DURING CPS SURVEYS 2007-2019.

	Average per Year 2007-2011 (kg)[1]	2016 (kg)[2]	2017 (kg)[2]	2018 (kg)[2]	2019 (kg)[2,3]
Potential Prey Biomass Removed	11,700[4]	11,300	7,400	5,100	2,400

Source: SWFSC
[1]Data from Table 4.2-5 2015 PEA. Does not include Pacific herring and market squid.
[2]Includes Pacific sardine, northern anchovy, chub and jack mackerels, market squid, Pacific herring and Pacific hake only.
[3]Data set not complete; does not include rockfish surveys; additional data requested.

Table 9-1 shows that biomass of prey species removed during surveys varies but has decreased from 2016 likely due to reduced level of survey efforts. The total amount of these species taken in research surveys is very small relative to their overall biomass in the area. In addition to the small amount of biomass removed, the size classes of fish targeted in research surveys are juvenile individuals, some of which are only centimeters long; these small size classes are not known to be prey of marine mammals in the CCE. For these reasons it is determined that removal of prey biomass during SWFSC surveys will not change food availability and will have no effect on overall prey sources for marine mammals.

The overall effects of SWFSC research activities on fish populations found in the CCE 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. Physical impacts to seafloor habitat would not be expected because SWFSC research surveys do not use bottom trawl equipment.

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10. ANTICIPATED EFFECTS OF HABITAT IMPACTS ON MARINE MAMMALS

As stated in Section 9, the proposed activities are not anticipated to result in impacts to marine mammal habitats or to the food resources on which they depend. Therefore, long-term adverse impacts to marine mammals resulting from loss of or modification to marine mammal habitats as a result of the proposed activities are not expected.

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11.MITIGATION MEASURES

Mitigation measures for SWFSC surveys proposed over the period 2020-2025 are shown in Table 11-1.

11.1. Trawl Surveys

11.1.1. Monitoring Methods

Marine mammal watches will be initiated 15 minutes prior to arrival on station (or for the amount of time to travel between stations if less than 15 minutes) to determine if these species are near the proposed trawl set location. Either dedicated observers, the Officer on Deck (OOD), Chief Scientist (CS), and/or 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 (with the exception of baleen whales) are sighted within 1 nm of the planned set location in the 15 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. The 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 15-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 marine mammals, the vessel will resume trawl operations (when practicable) only when the mammals 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 any marine mammals 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 marine mammals, or any other protected species, are present.

11.1.3. Tow Duration

Standard tow durations of not more than 45 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 3 nm, 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

The NETS Nordic 264 trawl gear will be fitted with marine mammal excluder devices (MMEDs) 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. 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. Considerable effort has been given to developing MMEDs that allow marine mammals to escape from the net while allowing retention of the target species (e.g. Dotson et al. 2010). 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 (Figure A-1). 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. Wainright et al. (2019) developed a study to respond to a conservation conflict, bycatch of marine mammals versus retention of fish intended to be collected during studies using the Nordic 264. Using the MMED can provide some protection to marine mammals, but depending on the orientation of the device, it can have a strong effect on retention of some salmon species and other small pelagic fish. When oriented upward as originally designed, the MMED tends to reduce catch rates of small pelagic fishes such as coho salmon, northern anchovy and Pacific herring. When oriented in a downward direction, the MMED reduced catches of target salmon species but increased catches of nontarget fish.

TABLE 11-1. PROPOSED MITIGATION AND MONITORING MEAUSRES

	Mitigation and Monitoring Measures for Proposed Action
General Measures Applicable to All Surveys	• Coordination and Communication: In advance of each survey, coordination with the NOAA Office of Marine Aviation and Operations (OMAO) or other relevant parties to ensure clear understanding of the mitigation measures and the manner of their implementation. Conduct briefings at the outset of each survey and as necessary with the ship's crew. CS to coordinate with OOD or equivalent to ensure procedures are understood. • Vessel speed: if vessel crew or dedicated marine mammal observers sight marine mammals that may intersect the vessel, they will immediately communicate with the bridge for appropriate course alteration or speed reduction as possible. • Handling Procedures: Implement SWFSC established protocols to reduce interaction with marine mammals following a step-wise order; 1) ensure health and safety of crew; depending on how and where an animal is hooked or entangled, take action to prevent further injury to the animal; 3) take action to increase the animal's chance of survival; and 4) record detailed information on the interaction, actions taken and observations of the animal throughout the incident. Report any take to PSIT within 48 hours.
Surveys Using Trawl Gear	• Initiate marine mammal watches no less than 15 minutes prior to arrival on station. Scan the surrounding waters with the naked eye and range-finding binoculars. • If marine mammals are sighted (not including baleen whales) within 1 nm of the station within the 15-minute observation period, transit to a new location to maintain a minimum distance of 1 nm from the animal. If after moving, marine mammals remain within the 1nm exclusion zone, the vessel may move on or skip the station. • Conduct trawl operations upon arrival on station (after the 15-minute pre-watch) to the extent practicable. • Continue visual monitoring while gear is deployed. If marine mammals are sighted before gear retrieval, the CS, watch leader, or OOD will determine the best action to minimize interactions with animals. • During nighttime operations, observe with the naked eye and any available vessel lighting. • If deploying bongo plankton or other small net prior to trawl gear, continue visual observations until trawl gear is ready to be deployed. • Aside from the minimum 15-minute pre-trawl watch, the OOD/CS and crew standing watch will visually scan for marine mammals during all operations. • If trawling is suspended due to the presence of marine mammals, trawling will resume only when the animal is believed to be beyond the 1 nm exclusion zone. • Clean gear prior to deployment. Conduct standard tow durations of no more than 45minutes at target depth for distances less than 3 nm. • Empty gear as quickly as possible to ensure no marine mammals are entangled. • Nordic 264 trawl nets will be fitted with MMED • Deploy working pingers (acoustic deterrent devices) during all pelagic trawl operations and all mid-water trawl nets. Place two to four pingers along the footrope or headrope. Pingers must have operational depth of 10-200 meters (m), tones ranging from 100 milliseconds to seconds, variable frequency of 5–500 kHz, and maximum source level of 176 dB rms re 1 microPascal at 30-80 kHz.

	Mitigation and Monitoring Measures for Proposed Action
Purse Seine Surveys	• During purse seine surveys, the crew keep watch for marine mammals before and during sets. If an observer is on board, the observer informs the chief scientist and captain of any marine mammals detected near or at the sampling station. • If any killer whales, dolphins, or porpoises are observed within approximately 500 m of the purse seine survey location, the set will be delayed. If any dolphins or porpoises are observed in the net, the net will be immediately opened to let the animals go. • If pinnipeds are in the immediate area where the net is to be set, the set is delayed until the animals move out of the area or the station is abandoned. However, if fewer than 5 pinnipeds are seen in the vicinity but do not appear to be in the direct way of the setting operation, the net may be set.
Longline Surveys (include Hook and Line and Rod and Reel Surveys)	• Except for bottom longline or vertical longline operations, conduct visual monitoring as described for trawl surveys. • With one exception, haul-back may be postponed if marine mammals are believed at risk for interaction. If five or fewer California sea lions are sighted within the 1 nm exclusion zone during the 15-minute pre-clearance period, longline gear may be deployed. Initiate marine mammal watches no less than 15 minutes prior to arrival on station (or for as long as it takes to get to the station if less than 15 minutes). • If marine mammal interactions with longline gear increase possibly due to discarding bait, consider retaining spent.
Plankton Nets, Small-mesh Towed Nets, Oceanographic Sampling Devices, Video Cameras, and ROV Deployments	• 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.
UAS	• Use of UAS must comply with applicable Federal Aviation Administration (FAA) regulations. • UAS only to be flown by an experienced operator. Flights near Antarctic stations shall be coordinated in advance with the Operator of the station to reduce potential impacts on station operations. • UAS altitudes may range up to 400 ft[1] ASL depending on the method of use (i.e., flying transects or targeting specific species) or species involved. UASs will not be flown directly over pinniped haulouts. • UAS flights will be line of sight in accordance with FAA regulations.

[1]FAA currently restricts UAS flights above 400 ft ASL unless a specific waiver is obtained (81 FR 42209, June 28, 2016).

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 are designed to decrease the probability of entanglement or unintended capture of marine mammals (see Appendix B). 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 Barlow and Cameron 2003). 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.

The CPS Survey uses the Netguard 70 kHz dolphin pinger manufactured by Future Oceans and the Rockfish Recruitment and Ecosystem Assessment Surveys use the DDD-03H pinger manufactured by STM Products. 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. Maximum sound pressure level of 176 dB rms referenced to 1 μPa 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. Purse Seine Surveys

The crew will keep watch for marine mammals before and during a set. If a bird or marine mammal observer is on board, the observer(s) inform the CS and captain of any marine mammals detected at or near a sampling station. Observations focus on avoidance of cetaceans (e.g., dolphins, and porpoises) and aggregations of pinnipeds. Pinnipeds may be attracted to fish caught in purse seine gear but are known to jump in and out of the net without entanglement. If a small number of pinnipeds is in the area where surveys are to occur, the gear may be set.

If dolphins or porpoise are observed within 500 m of the set location, the gear will not be deployed until the animals move further away. If dolphins or porpoise are observed in the purse seine, the net will be immediately opened to free the animal(s). If any killer whales, dolphins, or porpoises are observed within approximately 500 m of the purse seine survey location, the set will be delayed.

11.3. Longline Surveys

11.3.1. 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 trawl 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 15 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 of the sampling station, deployment of gear would be suspended. 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. Groups of five 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.

11.3.2. Operational Procedures

SWFSC longline sets are conducted with drifting pelagic or anchored gear marked at both ends with buoys (Appendix B). 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, the SWFSC 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 marine mammals, or other 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 marine mammals, 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.

11.4. Plankton Nets, Oceanographic Sampling Devices, Video Camera and ROV and Unmanned System 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.

Use of UAS must comply with applicable FAA regulations. UAS deployments are only to be flown by an experienced operator. Flights near Antarctic stations shall be coordinated in advance with the Operator of the station to reduce potential impacts on station operations. UAS flights will be within the line of sight in accordance with FAA regulations. UAS altitudes may range up to 400 ft ASL depending on the method of use (i.e., flying transects or targeting specific species) or species involved. For pinnipeds, UAS flights will be at 100–200 ft depending on species (i.e., 100 ft for elephant seals and 200 ft for other species); in mixed aggregations, the most conservative altitude is used. UASs will not be flown directly over pinniped haulouts.

Recognizing that the use UAS is increasing in scientific research, in 2018 the Environmental Guidelines for operation of Remotely Piloted Aircraft Systems (RPAS) (i.e., unmanned aircraft systems) in Antarctica was published by the Secretariat of the Antarctic Treaty. The Environmental Guidelines for operation of RPAS in Antarctica are intended to provide input on how to assess the use of such technology and aim to aid in decision making regarding the use of RPAS through the current best available knowledge. Proposed mitigation measures align with the guidance provided in the 2018 publication by the Secretariat of the Antarctic Treaty.

11.5. Handling Procedures for Incidentally Captured Individuals

The SWFSC has implemented 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, the

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, the 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.

11.5.1. 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 guide to "Identification, Handling and Release of Protected Species" (NMFS 2015a, Appendix D) for more specific guidance on protected species handling. In addition to including this guide, Appendix D.1 of NMFS (2015a) 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, the SWFSC will record interaction information on the Marine Mammal Biological Data Form prepared by the Pacific Islands Regional Office Longline Observer Program (NMFS 2015a, Appendix D.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 (NMFS 2015a, Appendix D.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 activities, 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" (NMFS 2015a, Appendix D.4). Although the 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.

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12. MITIGATION MEASURES TO PROTECT SUBSISTENCE USES

As described in Section 8, in 2019 NMFS published a proposed rule to issue a waiver under the MMPA and proposed regulations governing the hunting of ENP gray whales by the Makah Tribe for a 10-year period. Mitigation measures described in Section 11 will protect grey whales in the rare event that their distribution overlaps with SWFSC surveys in the CCE.

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13. MONITORING AND REPORTING

13.1. Monitoring

Marine mammal monitoring measures are described in Section 11.1 and Table 11-1. Marine mammal watches are a standard part of fisheries research activities, particularly when using gears such as longlines, purse seines and mid-water trawls that would be expected, or are known to interact with marine mammals. While underway, watches are generally conducted by vessel crew or members of the scientific party (those navigating or working on the vessel and other crew) at all times when the vessel is being operated. These individuals are referred to as 'watch-standers'. The primary focus for this type of watch is to avoid striking marine mammals and to generally avoid navigational hazards. The watch-standers do not record or report marine mammal sightings except when gear is being deployed or retrieved. In most cases, these watches are not conducted by dedicated staff; these personnel may have other duties associated with navigation and other vessel operations.

Observing and monitoring for marine mammals is conducted prior to deploying longlines, purse seines and trawl gear, and continues until gear is returned on board. Observations and monitoring are conducted by dedicated scientists with no other responsibilities during the watch period. If marine mammals are sighted within 500 m of the purse seine survey location or within 1 nm of the longline or mid-water trawl survey location then the sampling station is either moved, delayed until the mammals have moved from the area, or canceled. However, if small numbers of pinnipeds (generally less than five) are seen in the vicinity but do not appear to be in the direct way of the setting operation, the purse seine may be set. Observers record the 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

The SWFSC will coordinate with the local Southwest Regional Stranding Coordinator and the NMFS Stranding Coordinator to report any unusual marine mammal behavior and any stranding, beached (alive or dead), or floating marine mammals that are encountered during field research activities. In addition, Cruise Leaders or Chief Scientists provide reports to SWFSC leadership and to the OPR by event, survey leg and cruise. When marine mammals interact with the gear and are killed or released alive, the report will fully describe any observations of the animals, the context (vessel speed 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 OPR to better evaluate the conditions under which takes are most likely occur and potentially avoid some of these situations in the future.

The NMFS has established a formal incidental take reporting system, the 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, the 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, the SWFSC will both input data into the PSIT database and provide detailed event reports.

A final and equally important component of reporting being implemented by the 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. The 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. SUGGESTED MEANS OF COORDINATION

The NMFS provides annual funding 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 conducts a variety of studies, convenes workshops and engages in other activities aimed at developing effective bycatch reduction technologies, gears and practices.

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.

Under the conditions of the 2015 LOA, SWFSC is required to conduct annual environmental compliance training for chief scientists and other personnel responsible for implementing mitigation measures, data collection and reporting requirements. A portion of the training must be dedicated to discussion on the use of best professional judgement to avoid marine mammal interactions to gain an understanding of successful versus unsuccessful decisions. In addition, annual forums with scientists are held post-completion of the year’s field season to discuss the following: 1) an overview of current mitigation measures and effect on the current year’s data collection; 2) the need/want for improvements of environmental compliance and incidental take authorization measures; and 3) implementation of new or additional mitigation measures to assist in reducing take while achieving survey goals.

To reduce marine mammal takes over time, the SWFSC maximizes efficient use of charter and NOAA ship time, and engages in operational planning with the Northwest and Pacific Islands Fisheries Science Centers to delineate respective research responsibilities and to reduce duplication of effort among the Centers. The SWFSC implements an adaptive management approach to evaluating actual takes and continues to revisit mitigation measures. In consultation with Office of Protected Resources, if actual takes exceed those estimated in Section 6 of this application SWFSC may change current mitigation strategy to improve efficacy or to implement additional measures to reduce take levels.

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APPENDIX A

CCE Marine Mammal Densities

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Species	Shallow	Deep	2015 abundance	2015 Density (from rule)	Area (Factor)	2018 Abundance	Calculated 2018 Density	Calculated 2018 Volumetric Density	CETSound Density Max[1] (in research area)	CETsound Density Min[1]	Calculated Volumetric Density from CETsound max	Notes	Link to CETsound map (s)
Harbor Porpoise N CA/S OR stock	x		39581	0.03775	1048503	35769	0.03411	0.17057	0.81000	0.64000	4.05000	2015 rule used density for coastal and inland WA waters as proxy. CETsound densities were only recorded to the OR border, and are patchy. A mid range density was chosen for Column J.	https://cetsound.noaa.gov/images/WC__laake_phocoena.png
Dall's Porpoise	x		42000	0.07553	556070	25750	0.04631	0.23154	0.35460	0.00400	1.77300	2016 report showed highest densities off of N. CA and WA/OR. However, the 2017 report showed high densities in S. CA waters where SWFSC surveys are concentrated in spring summer. The max density from the 2017 map was used in Column J.	https://cetsound.noaa.gov/images/WC__swfsc_cce_2016_Phocoenoides_dalli.png https://cetsound.noaa.gov/images/WC__swfsc_calcofi_2017_Phocoenoides_dalli.png
Pacific white sided dolphin	x		26930	0.02093	1286670	26814	0.02084	0.10420	0.41117	0.00700	2.05585	CETsound - the highest densities seem to be representative of the sampling locations. Winter densities are lower 0.06-0.3, but the majority of surveys are done in the summer so the max density from Becker et al. 2016 is used in Column J	https://cetsound.noaa.gov/images/WC__swfsc_cce_2016_Lagenorhynchus_obliquidens.png https://cetsound.noaa.gov/images/WC__swfsc_strata_cce_lag.obl_winter.png
Risso's dolphin	x		6272	0.01046	599618	6336	0.01057	0.05283	0.01500	0.00400	0.07500	CETsound - the highest densities are located in a narrow band close to shore. Because surveys occur outside of this both inside and well outside of this band, the 3rd highest density was used as a proxy in Column J. Winter densities range from 0 at the OR boarder to 0.2 at the Mexico border.	https://cetsound.noaa.gov/images/WC__swfsc_cce_2016_Grampus_griseus.png https://cetsound.noaa.gov/images/WC__swfsc_strata_cce_gra.gri_winter.png
Bottlenose dolphin -coastal+offshore	x		1329	0.00178	746629	2337	0.00313	0.01565	0.14985	0.00040	0.74925	CETsound data shows small areas of the max density but they are located in S.CA where many surveys are concentrated, especially in the summer so the highest density is used for Column J	https://cetsound.noaa.gov/images/WC__swfsc_cce_2016_Tursiops_truncatus.png
Striped dolphin	x		10908	0.01667	654349	29211	0.04464	0.22321	0.02000	0.00500	0.10000	Density of this species increases moving offshore. The mid range value of 0.02 was used as the proxy for all surveys.	https://cetsound.noaa.gov/images/WC__swfsc_cce_2016_Stenella_coeruleoalba.png
Short beaked common dolphin	x		411211	0.30935	1329274	969861	0.72962	3.64808	0.80000	0.01000	4.00000	CETsound data shows max densities off LA. However the max density area is limited and the second highest max density seems to be more representative of the research area	https://cetsound.noaa.gov/images/WC__swfsc_cce_2016_Delphinus_delphis.png https://cetsound.noaa.gov/images/WC__swfsc_calcofi_2017_Delphinus_delphis.png
Long beaked common dolphin	x		27046	0.01924	1405717	101305	0.07207	0.36033	0.37500	0.04000	1.87500	CETsound data shows areas of the max density are but close to shore in S.CA where many surveys are concentrated, especially in the summer. However they are sparse throughout most of the rest of the CCRA so the mid range density is used as a proxy for Column J.	https://cetsound.noaa.gov/images/WC__swfsc_cce_2016_Delphinus_capensis.png

Species	Shallow	Deep	2015 abundance	2015 Density (from rule)	Area (Factor)	2018 Abundance	Calculated 2018 Density	Calculated 2018 Volumetric Density	CETSound Density Max[1] (in research area)	CETsound Density Min[1]	Calculated Volumetric Density from CETsound max	Notes	Link to CETsound map (s)
Northern right whale dolphin	x		8334	0.00975	854769	26556	0.03107	0.15534	0.19737	0.00600	0.98685	CETsound - the highest densities seem to be representative of the sampling locations.	https://cetsound.noaa.gov/images/WC__swfsc_cce_2016_Lissodelphis_borealis.png
Killer whale - S. resident	x		86	0.00071	121127	77	0.00064	0.00318	0.00071	0.00025	0.00355	2015 rule used stock with the lowest abundance - S. Resident CETsound data - summer density used as max; winter density as min.	https://cetsound.noaa.gov/images/WC__swfsc_strata_cce_orc.orc_summer.png
Short finned Pilot whale		x	760	0.00031	2451613	836	0.00034	0.00068	0.00031	0.00031	0.00062	CETsound summer densities were 0.00031	https://cetsound.noaa.gov/images/WC__swfsc_strata_cce_glo.mac_summer.png
Baird's beaked whale		x	907	0.00088	1030682	2697	0.00262	0.00523	0.01731	0.00010	0.03462	studies overlap entire with entire range of CETsound densities	https://cetsound.noaa.gov/images/WC__swfsc_cce_2016_Berardius_bairdii.png
Mesoplodont beaked whales		x	1024	0.00103	994175	3044	0.00306	0.00612	0.00700	0.00370	0.01400	Highest densities are very patchy in research area. The third highest density is provided in Column J because it is most prevalent in research areas.	https://cetsound.noaa.gov/images/WC__swfsc_cce_2016_Mesoplodon_spp_and_Ziphius.png
Curvier's beaked whale		x	2143	0.00382	560995	3274	0.00584	0.01167	0.00700	0.00370	0.01400	Highest densities are very patchy in research area. Used third highest density for analysis, because it was most prevalent in research areas.	https://cetsound.noaa.gov/images/WC__swfsc_cce_2016_Mesoplodon_spp_and_Ziphius.png
Pygmy Sperm whale		x	579	0.00109	531193	4111	0.00774	0.01548	0.00108	0.00110	0.00216	CETsound summer densities were 0.00108	https://cetsound.noaa.gov/images/WC__swfsc_strata_cce_kog.spp_summer.png
Sperm whale		x	971	0.00170	571176	1997	0.00350	0.00699	0.00200	5.00000	0.00400	CETsound data shows density to be very patchy throughout the SWFSC survey area. Due to the patchiness, the mid range density was used in Column J. Winter density along the CA coast is higher at 0.0034, but most of the surveys occur in the summer so the lower value is used in Column J.	https://cetsound.noaa.gov/images/WC__swfsc_cce_2016_Physeter_macrocephalus.png
Humpback whale CA/WA/OR stock	x		2043	0.00083	2461446	**2900**	**0.00118**	**0.00589**	**0.00300**	**0.00060**	0.01500	For 2018 calculated density used CA/WA/Orstock only. CETsound data (2016) shows highest densities in a relatively thin band closer to shore. The mid range density was used o better represent the entire sampling area	https://cetsound.noaa.gov/images/WC__swfsc_calcofi_2017_Megaptera_novaeangliae.png https://cetsound.noaa.gov/images/WC__swfsc_cce_2016_Megaptera_novaeangliae.png
Blue whale	x		2497	0.00136	1836029	1647	0.00090	0.00449	0.02322	0.00050	0.11610	Highest densities are concentrated nearshore and overlap with the majority of studies. Lowest densities are off WA and OR but overlap with spring and summer studies. The max density was used in Column J.	https://cetsound.noaa.gov/images/WC__swfsc_cce_2016_Balaenoptera_musculus.png
Fin Whale	x		2642	0.00184	1435870	9029	0.00629	0.03144	0.02856		0.14280	Highest densities are concentrated nearshore and overlap with the majority of studies. Lowest densities are off WA and OR but overlap with spring and summer studies. The max density was used in Column J.	https://cetsound.noaa.gov/images/WC__swfsc_cce_2016_Balaenoptera_physalus.png

Species	Shallow	Deep	2015 abundance	2015 Density (from rule)	Area (Factor)	2018 Abundance	Calculated 2018 Density	Calculated 2018 Volumetric Density	CETSound Density Max[1] (in research area)	CETsound Density Min[1]	Calculated Volumetric Density from CETsound max	Notes	Link to CETsound map (s)
Sei whale	x		126	0.00009	1400000	519	0.00037	0.00185	0.00009	0.00009	0.00045	Summer densities off the coast of CA were very low at 0.00009	https://cetsound.noaa.gov/images/WC__swfsc_strata_cce_bal.bor_summer.png
Minke whale	x		478	0.00072	663889	637	0.00096	0.00480	0.00028	0.00028	0.00140	Only winter density is available on the CETsound website. Most surveys are done in the spring, summer, however.	https://cetsound.noaa.gov/images/WC__swfsc_strata_cce_bal.acu_winter.png
Gray whale (EP stock)[2]	x		19126	0.01913	999791	26960	0.02697	0.13483				CETsound only has total abundance for sampling dates in 2007, not density.	
CA Sea Lion[2]	x		296750	0.29675	1000000	257606	0.25761	1.28803					
Steller sea lion (eastern DPS)[2]	x		72223	0.06319	1142950	71562	0.06261	0.31306					
Guadalupe fur seal[2]	x		7408	0.00741	999730	**15830**	**0.01583**	**0.07917**					
Northern fur seal - P.I./EP[2]	x		653171	0.65239	1001197	637561	0.63680	3.18399					
Harbor seal - CA stock[2]	x		30196	0.05493	549718	30968	0.05633	0.28167					
Northern Elephant Seal[2]		x	124000	0.12400	1000000	179000	0.17900	0.35800					

[1] CETsound data is given in ranges so cannot get an average only max min.

[2] No CETsound data - use 2018 calculated data

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APPENDIX B

Gear and Vessel Descriptions

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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. 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. The Nordic 264 is also used in salmon (*Oncorhychus spp*.) research by the SWFSC Santa Cruz lab.

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. 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 (Figure B-1). 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. Wainright et al. (2019) developed a study to respond to a conservation conflict, bycatch of marine mammals versus retention of fish intended to be collected during studies using the Nordic 264. Using the MMED can provide some protection to marine mammals, but depending on the orientation of the device, it can have a strong effect on retention of some salmon species and other small pelagic fish. When oriented upward as originally designed, the MMED tends to reduce catch rates of small pelagic fishes such as coho salmon, northern anchovy and Pacific herring. When oriented in a downward direction, the MMED reduced catches of target salmon species but increased catches of nontarget fish.

Compared to the Nordic 264 trawl, takes of marine mammals by modified-Cobb trawl have been historically small. While the Nordic 264 rope trawl is intended to fish at the surface, 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. Fishing at depth, at slower speeds, and for shorter duration, along with having a smaller opening and mesh size, mitigate marine mammal takes by the modified-Cobb.

(Dotson et al. 2010)

Figure B-1 Marine Mammal Excluder Device installed in Nordic 264 pelagic trawl net.

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.

Two to four acoustic ‘pingers’ are attached to the headrope and footrope to deter marine mammals. Pingers often used by SWFSC may include those manufactured by STM Products (model DDD-03H) and Future Oceans (“Netguard” 70kHz Dolphin Pinger). Pingers operate 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. A workshop on non-lethal marine mammal deterrents (Long et al. 2015), characterized the level of acoustic trauma associated with pingers and other acoustic deterrents, in terms of S/MI. In general, acoustic deterrent devices (ADDs, source levels below 135 dB for pinnipeds, and below 179 dB for cetaceans) were expected to be below the level that would cause TTS for the most sensitive species.

Trawls with relatively low potential for interactions and no historical interaction with protected species

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 frame trawl with a 5 m^2 mouth area used for quantitative sampling of larval and juvenile pelagic fishes (Figure B-2). 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.

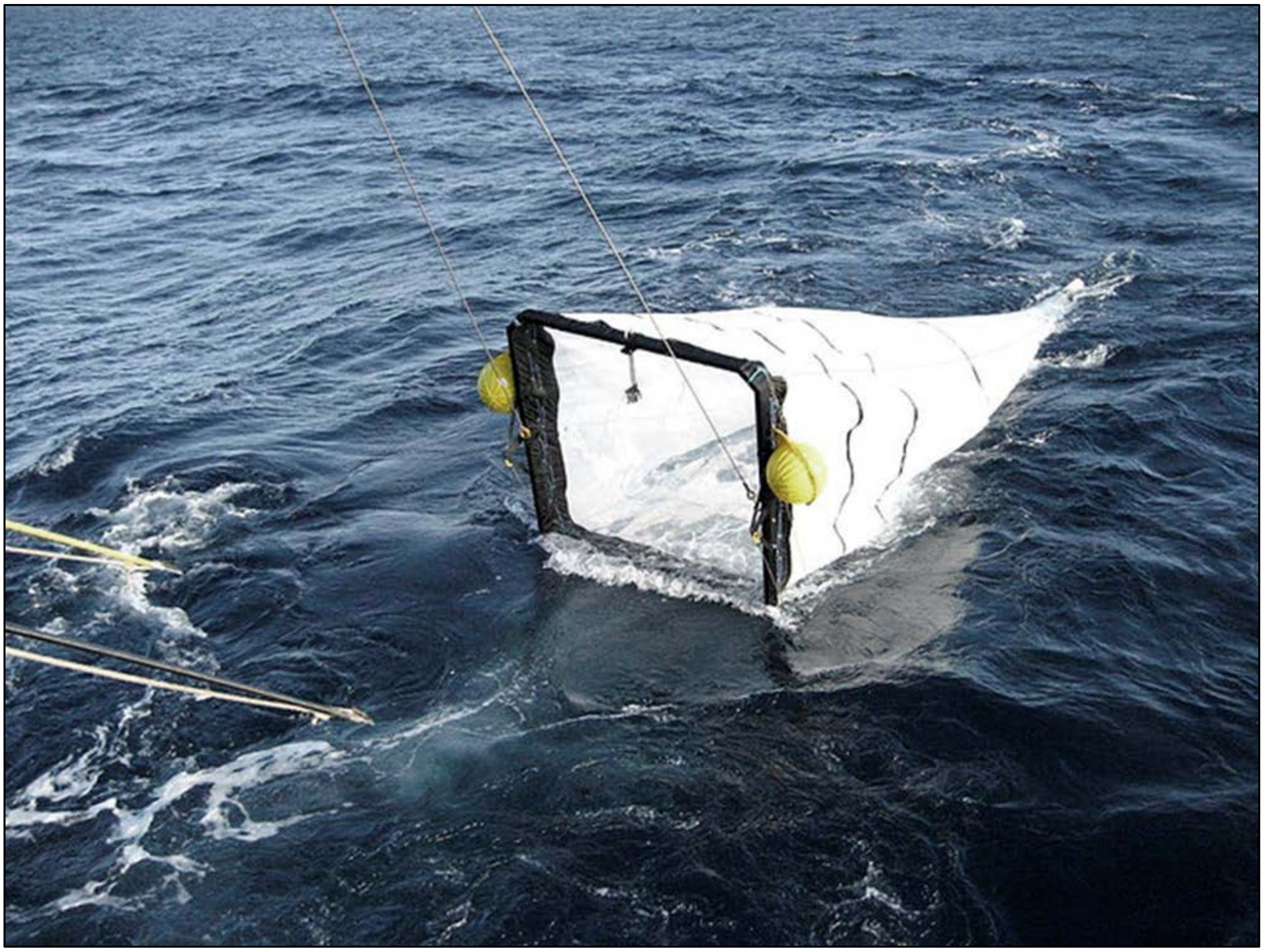


Figure B-2 Oozeki trawl at the surface as it is deployed from the vessel.

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 B-3).

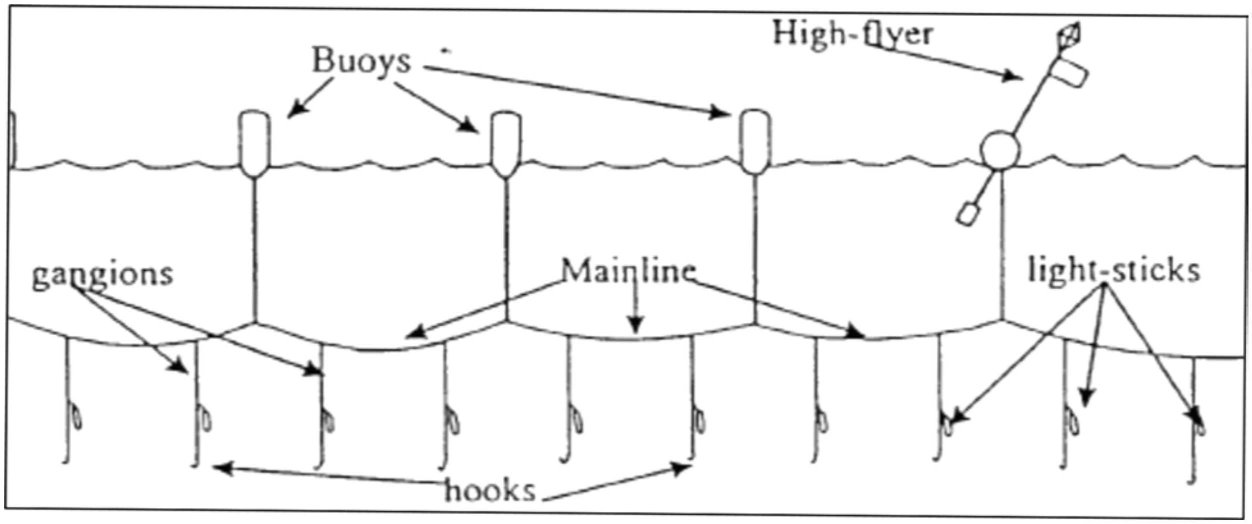


Figure B-3 Schematic example of pelagic longline gear.

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. 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 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. Chumming is prohibited. Visual monitoring for marine mammals is conducted prior to deploying the gear. If marine mammals are sighted within 1 nm the "move-on" rule is enacted. 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. Haul back may be postponed if marine mammals or sea turtles are believed to be at risk of interaction.

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. 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. There have been no known adverse interactions with seabirds during SWFSC research activities; there are no records of gear interactions or ship strikes. If seabird interactions with longline gear are documented in the future, the SWFSC would revisit whether use of streamer lines is warranted given the tradeoffs between the potential conservation benefit and operational and safety considerations

3. Deep-set buoy gear

Deep-set buoy gear is used to capture and tag HMS 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 B-4), 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.

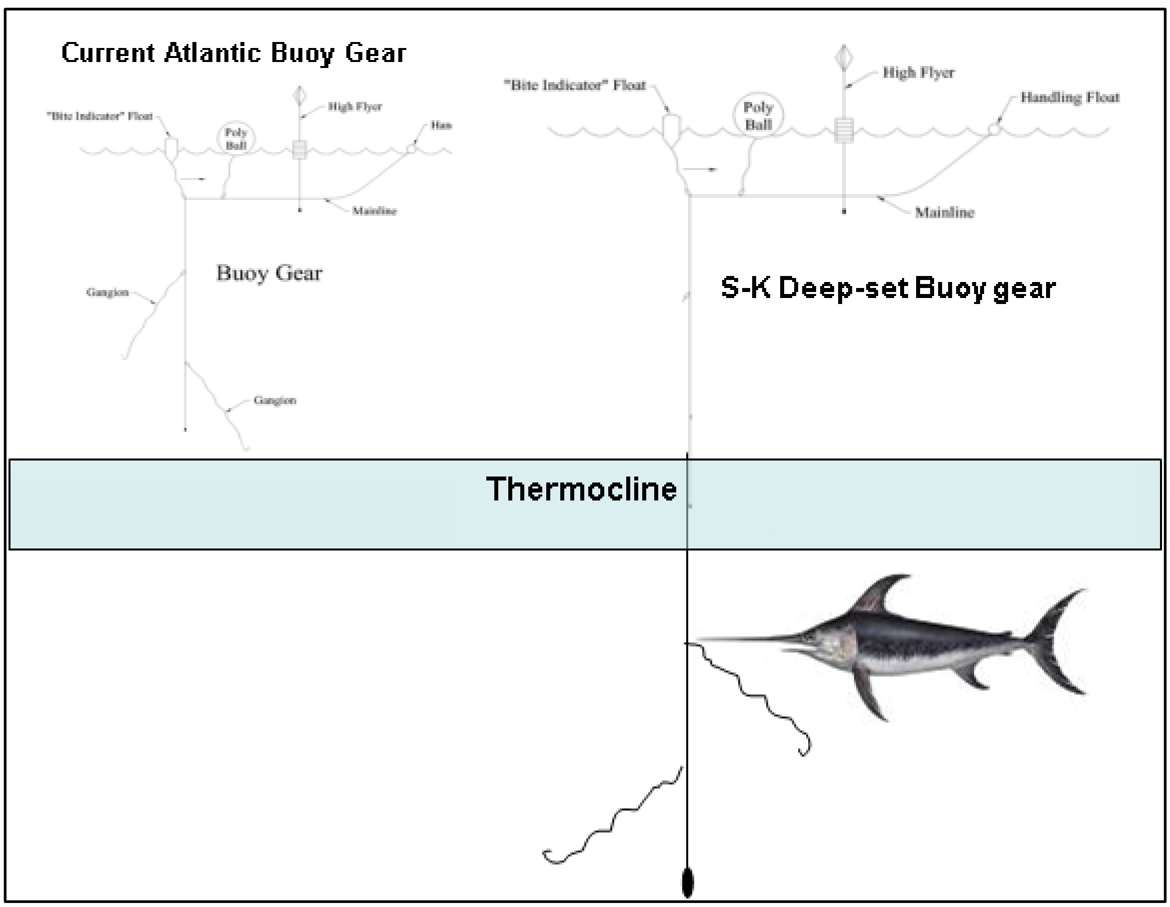


Figure B-4 Schematic of the Atlantic shallow-set buoy gear and swordfish deep-set buoy gear.

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. Purse Seine

SWFSC has worked with purse seine vessels to collect acoustic data and CPS specimens in the near shore areas to supplement sampling conducted by larger ships further offshore. Purse seining targets near-surface schools of fish by deploying the seine skiff attached to one end of the net. The larger vessel then attempts to surround the school and close up with the skiff. Figure B-5 shows the *F/V Barbara H.* a typical purse sein vessel (50 to 80 feet in length) and skiff. The two ends of the net are then brought aboard the larger vessel and a slip line running through the bottom of the net is cinched, which creates a “purse” or bowl (closed at the bottom and open at the top) containing the fish. Sometimes the skiff is used to pull the larger vessel or portions of the net to keep the bowl from collapsing. The float line (at the top of the net) is then brought in the larger vessel in order to make the bowl smaller and concentrate the fish. Ultimately a pump is submerged in the net and the fish are brought aboard as part of a slurry - hence the name "wet fish."

Figure B-5 Purse Seine Vessel F/V *Barbara H.*

5. Micro-Trolling

Micro-trolling can be used to capture juvenile salmon. Similar to typical trolling, a line is fished from the side of the boat with a series of hooks at regular depth intervals. Hooks include flashers that attract salmon. The primary difference between micro-trolling and typical trolling is the size of the hooks (much smaller here) and the speed of the boat towing the hooks (much slower here). The schematic below shows the arrange of the gear during fishing. This technique incurs very low hooking mortalities such that we can use it to return fish after we obtain morphometric measurements, genetic samples, and scales to age with.

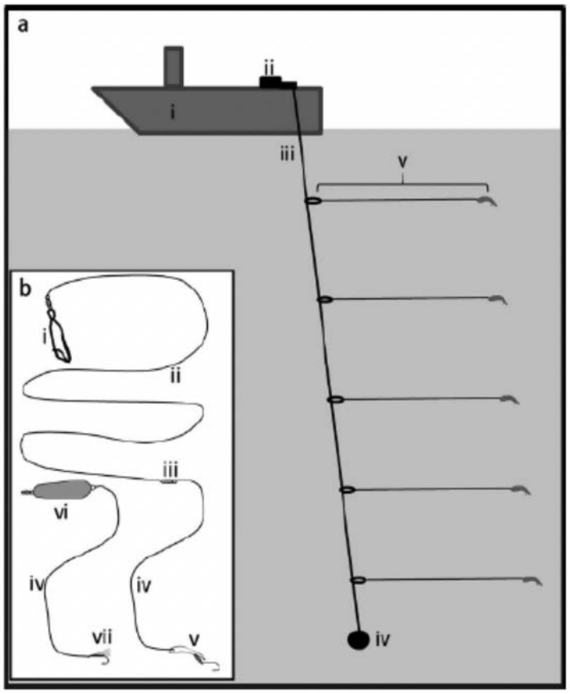


Figure B-6 Micro-trolling Schematic

6. Various plankton nets (Bongo / Pairovet, Manta, California Vertical Egg Tow)

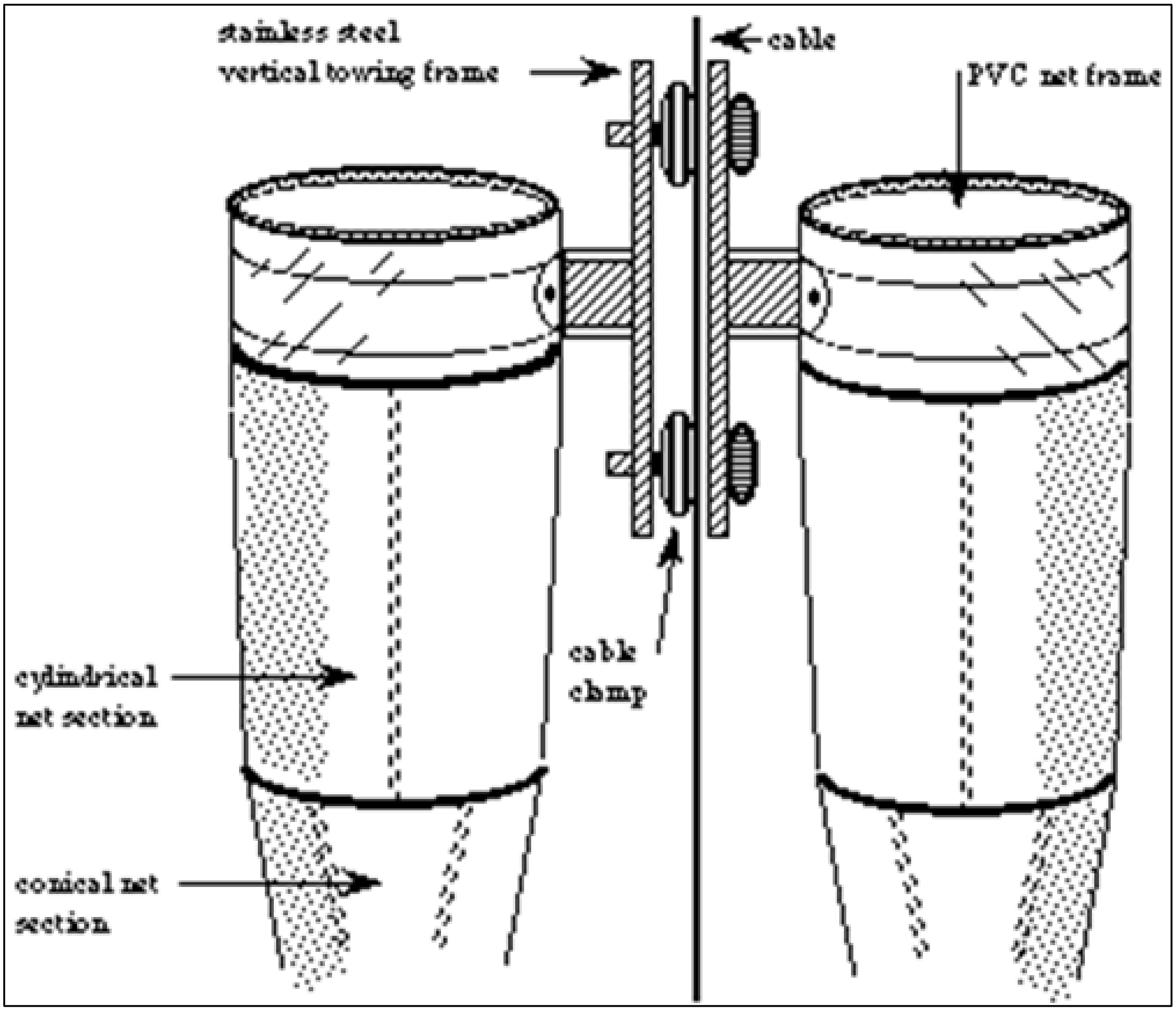
SWFSC research activities include the use of several plankton sampling nets that employ very small mesh to sample plankton and fish eggs from various parts of the water column. Plankton sampling nets usually consist of fine mesh attached to a weighted frame. The frame spreads the mouth of the net to 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 B-7).

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.

In future research, SWFSC may also deploy vertical egg tow (CalVET) nets for fisheries sampling. The mouth of the CalVET net is 0.05m^2, the tow is vertical to minimize the volume of water filtered per unit depth and the mesh size is approximately 0.150 mm. The conical mesh is the minimum size allows for efficient filtration, while the cylindrical portion reduces potential clogging during tows (Smith *et al*. 1985).

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 B-8). 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.



(Aquatic Research Instruments 2020)

Figure B-7 Bongo net diagram.

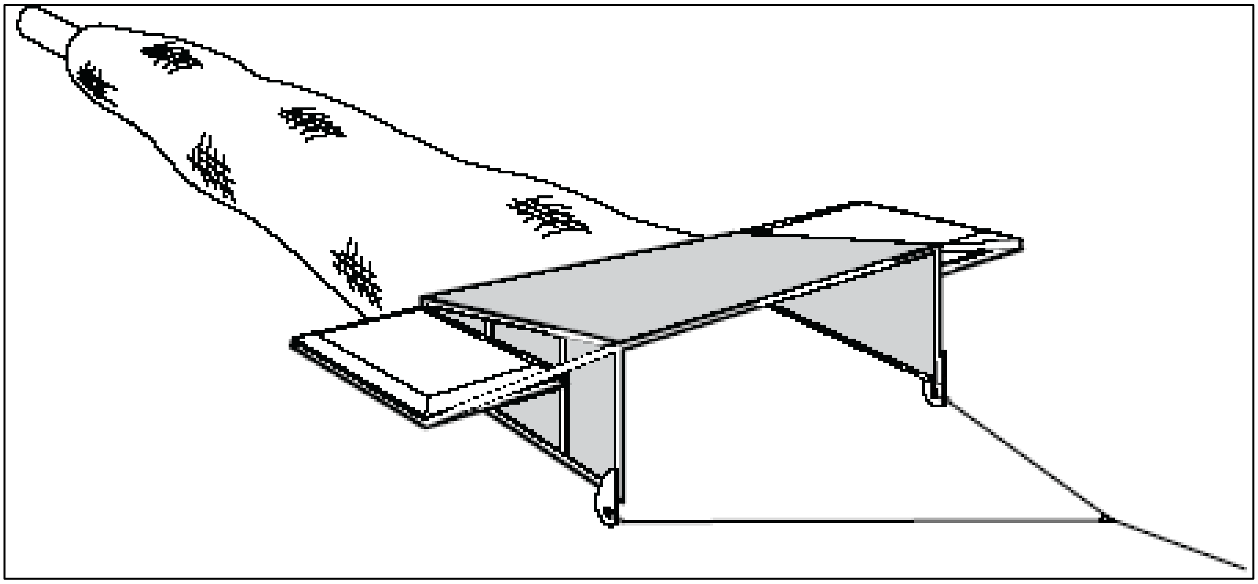
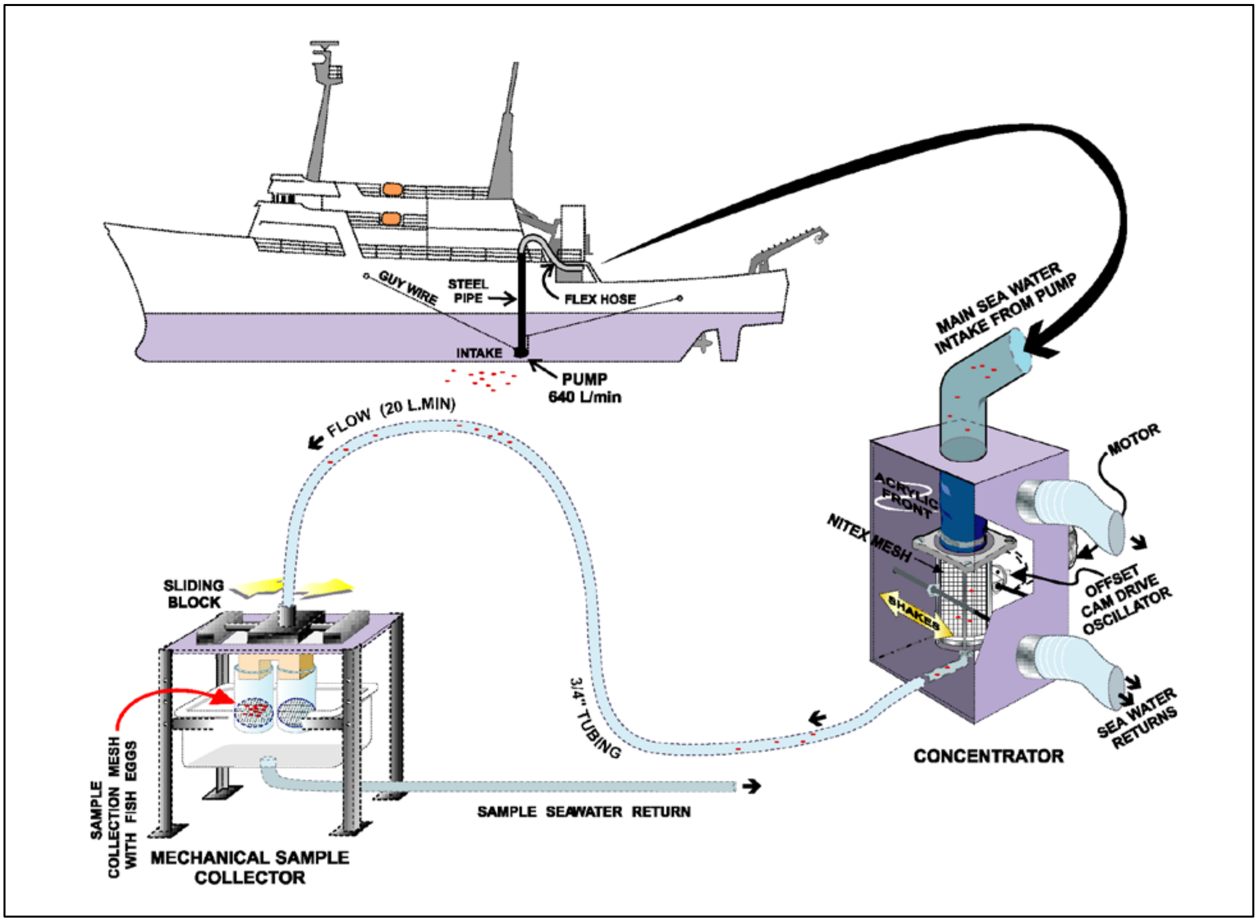


Figure B-8 Conceptual diagram of a Manta net.

The California Vertical Egg Tow (CalVET) net was devised by CalCOFl to estimate egg production in the central subpopulation of northern anchovy and similar fishes. The mouth PM of the CalVET net is 0.05 m2; the tow is vertical to minimize the volume of water filtered per unit of depth; the mesh size of 0.150 mm is selected for total retention of the anchovy eggs under all likely conditions. The mesh area of the net is three times the mouth area in the conical portion and five times the month area in the cylinder. The conical mesh is the minimum size necessary for highly efficient filtration, while the cylindrical portion reduces the probability of the net clogging during a single tow. A towmeter detects sequential clogging of the net during a series of tows. The net is lowered and raised rapidly to diminish the effects of ship drift and undersea currents which impose uneven trajectories on the net. The net is probably not capable of sampling active larvae 5 mm or longer, owing to the small mouth size and the disturbance to the net's path from the towing wire.

6. 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 B-9). 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.



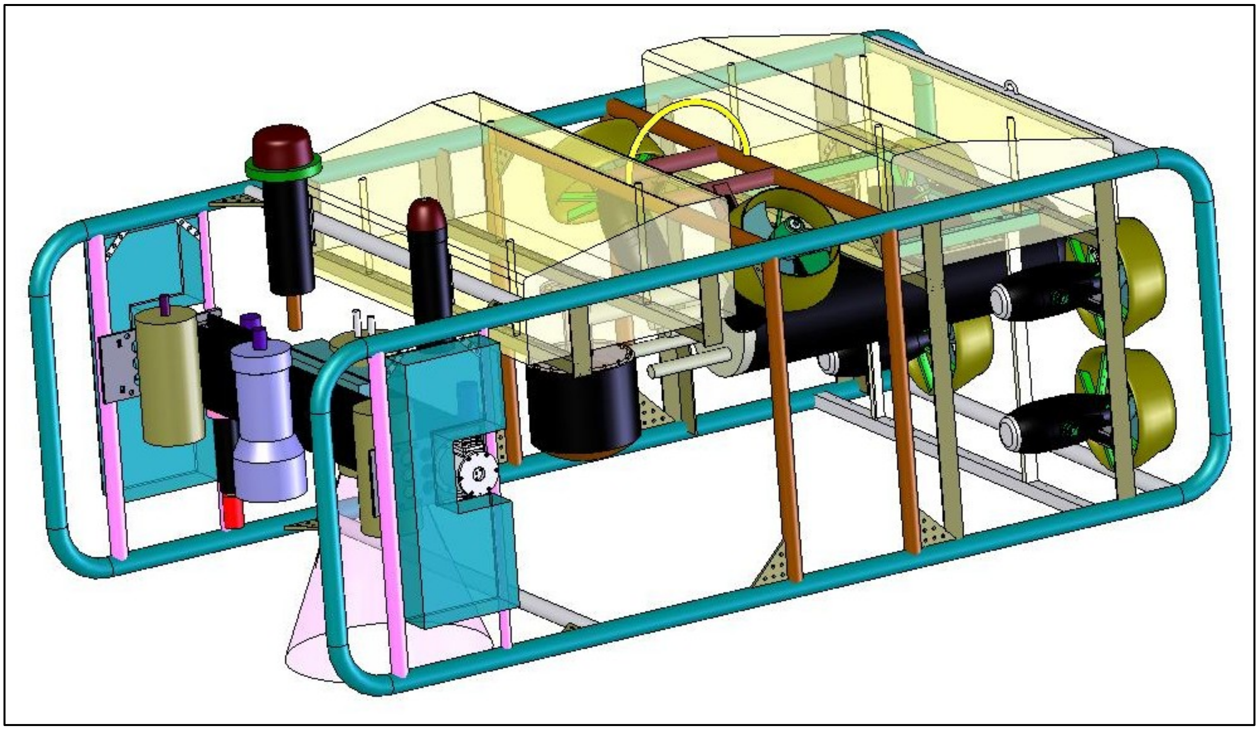
(Source: http://cufes.ucsd.edu/graf/egg-pump.pdf)

Figure B-9 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.

7. Still and video camera images taken from an ROV

The SWFSC maintains and deploys remotely operated vehicles (ROVs) 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.



(Source: SWFSC)

Figure B-10 High-Definition High-Voltage remotely operated vehicle.

The SWFSC Benthic Resources Group constructed a custom high-definition high-voltage (HDHV) remotely operated vehicle (ROV) for surveying groundfish and benthic invertebrates in deepwater environments (Figure B-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.

8. 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 B-1 and B-2, 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 B-1 Operating characteristics of active acoustic sources operated from the NOAA Ship *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 EK60 and EK80[1] Narrow Beam Scientific Echo Sounders	18, 38, 70, 120, 200, 333 kHz (or a subset). Primary frequencies are 38, 70, 120 and 200 kHz.	226 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°

[1]Source level values for the EK80 configured with different transducers ranged between 226 and 212 dB re 1 μPa at 1 m (ICES 2018).

Table B-2 Operating characteristics of active acoustic sources operated from the NOAA Ship *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 EK60 and EK80 Narrow Beam Scientific Echo Sounders	18, 38, 70, 120, 200, 333 kHz (or a subset). Primary frequencies are 38, 70, 120 and 200 kHz.	226 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°

9. Multi-frequency Narrow Beam Scientific Echo Sounders (Simrad EK60/80 Systems - 18, 38, 70, 120, 200, 333 kHz)

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.

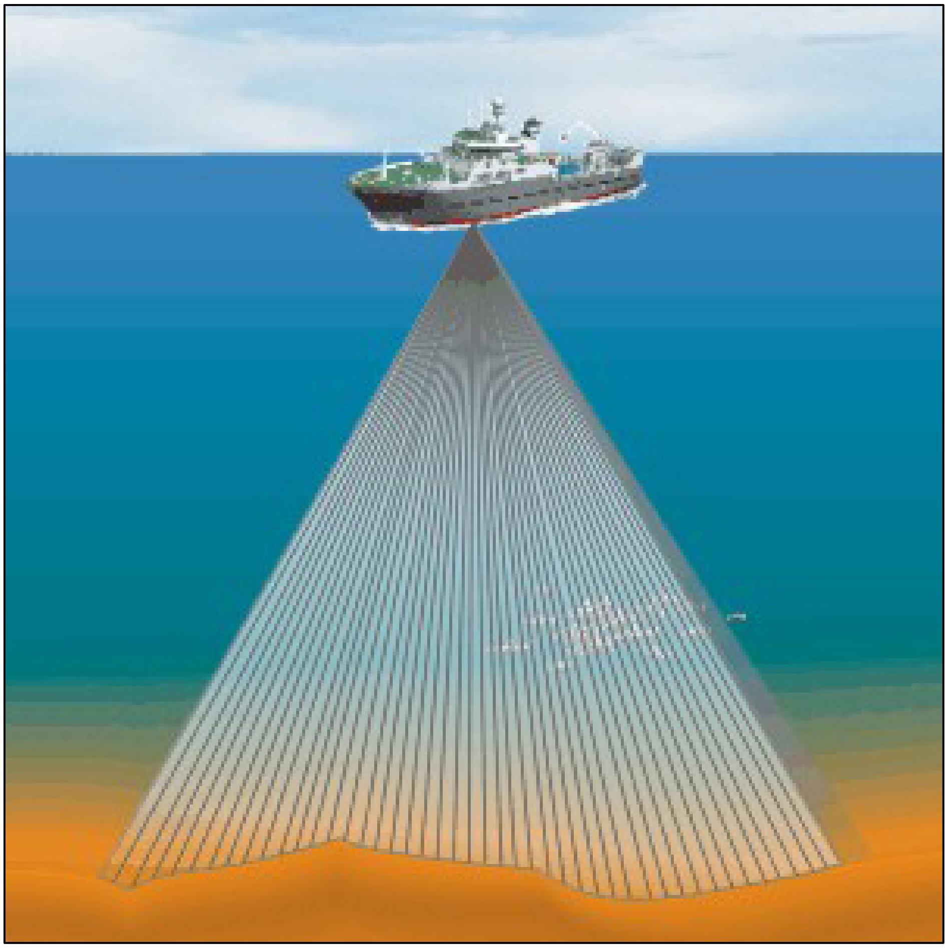
Since the 2015 LOA was issued, SWFSC plans to use an EK80 echosounder. The EK80 has a different hardware and software design to the EK60 and validation that the EK80 gives near-identical results to the EK60 is an essential prerequisite to the use of EK80s for quantitative acoustic surveys. The narrowband mode of the EK80 uses short transmit pulses that are nominally at a single frequency, but due to finite pulse durations have a bandwidth of several kHz (the EK80 can also generate and process broadband pulses that, when combined with a transducer, can have bandwidths about between 10 and 200 kHz) (Macauley et al. 2018). Frequency ranges for the EK80 are the same as the EK60 previously used. Source level values for the EK80 configured with different tranducers ranged between 226 and 212 dB re 1 μPa at 1 m (ICES 2018). Therefore, it is reasonable to assume noise propagation from the EK80 would be the same as previously evaluated for the EK60.

10. 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.

11. 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.



(Source: www.simrad.com)

Figure B-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 (Figure B-11). 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.

12. 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 2020). An ADCP instrument can also be mounted to a mooring, or to the bottom of a boat.

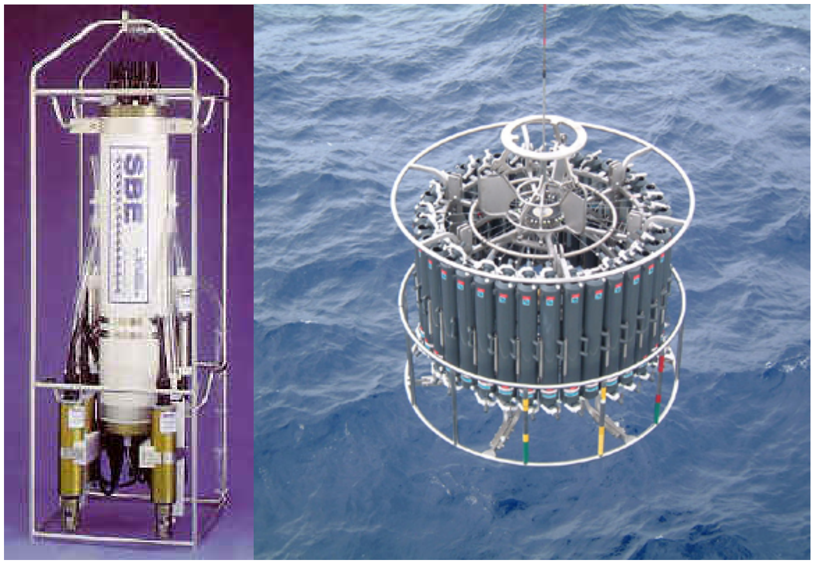
The ADCP measures water currents with sound, using the Doppler Effect. A sound wave has a higher frequency when it moves towards the sensor (blue shift) than when it moves away (red shift). The ADCP works by transmitting "pings" of sound at a constant frequency into the water. As the sound waves travel, they ricochet off particles suspended in the moving water, and reflect back to the instrument (WHOI 2020). 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 2020).

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 2020).

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 2020).

13. 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 (Figure B-12). 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. 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.



(Source: Sea-Bird Electronics, Bellevue WA)

Figure B-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 of seawater and the speed of sound traveling through it.

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.

14. Vessels used for SWFSC 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. SWFSC also encourages and routinely uses charters to conduct research.

The NOAA Ship *Reuben Lasker* (Figure B-13) came online in 2013 and was fully operational in 2014. Surveys are conducted aboard other NOAA ships (*Shimada*), University ships, and various charter vessels. Several small boats are located in Santa Cruz and La Jolla and may be deployed as far away as the Eastern Tropical Pacific and Antarctica.

NOAA-Operated Research Vessels

Reuben Lasker

The NOAA Ship *Reuben Lasker* is the fifth in a series of Oscar Dyson-class fisheries survey vessels and one of the most technologically advanced fisheries vessels in the world (Figure B-13). The ship's primary objective is to support fish, marine mammal, seabird and turtle surveys off the U.S. West Coast and in the eastern tropical Pacific Ocean. Reuben Lasker has a dynamic positioning system to steer along a pre-determined trackline and to accurately hold the ship in a fixed position.

Figure B-13 NOAA Ship *Reuben Lasker*

Bell M. Shimada

The NOAA Ship *Bell M. Shimada* is home-ported in Newport, Oregon and shared between the Northwest Fisheries Science Center (NWFSC) and the SWFSC (Figure B-14). 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 38 people, 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 B-14 NOAA Ship NOAA Ship *Bell M. Shimada*

Holliday

The SWFSC also deploys the trailerable 33-foot NOAA Ship *Holliday* (Figure B-15) 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 5 m Zodiacs used in the Antarctic, a 19-foot instrumented aluminum skiff, two Boston Whalers, and several small boats located at the Santa Cruz lab.

Figure B-15 NOAA Ship *Holliday*

University and Charter 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.

Bold Horizon

The R/V *Bold Horizon* is berthed in San Diego and is operated by the Eclipse Group, a privately held marine service provider (Figure B-16). 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 B-16 R/V *Bold Horizon*

Coral Sea

The R/V *Coral Sea* is owned by Humboldt State University and is 27.4 m (90 ft.) in length (Figure B-17). 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 B-17 R/V *Coral Sea*

R/V *Ocean Starr*

The R/V *Ocean Starr* is operated by Stabbert Maritime based in Seattle, Washington (Figure B-18). It is 52 m (171 ft) in length and provides 25 quarters. The Ocean Starr provides a broad range of scientific research capabilities with temperature-controlled aquaria and live specimen wells, walk-in freezer, dark room, data processing laboratory, and an underwater observation chamber in the bow and port side for studying fish behavior at sea. The ship has twin 500-horsepower diesel engines and a 10-knot cruising speed.

www.stabbertmaritime.com

Figure B-18 R/V *Ocean Starr*

15. Aircraft and Other Observation Platforms Developed and Used by SWFSC

Aircraft used by SWFSC:

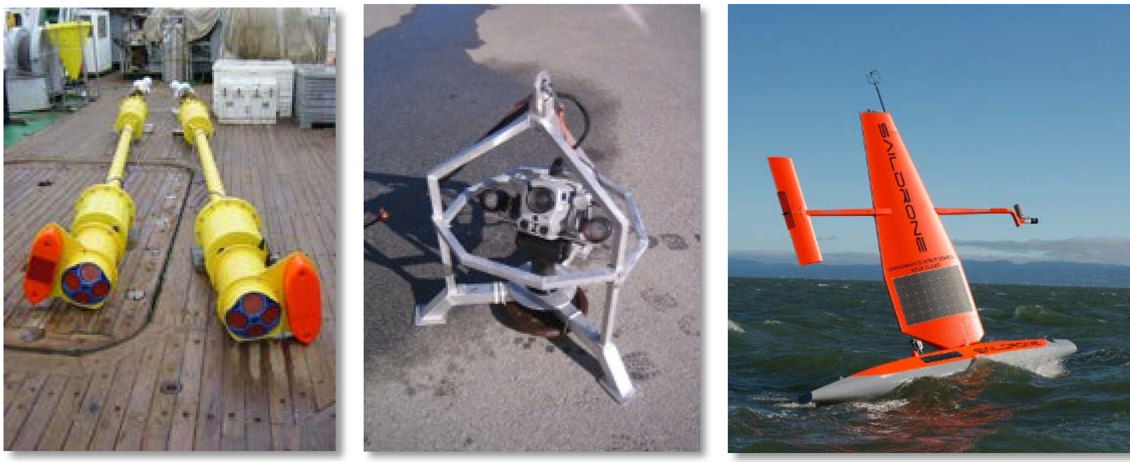
Unmanned aerial systems (UAS) can be used to conduct aerial surveys and can reduce disturbance to marine mammals due to human, vessel, or manned aircraft presence. Using UAS to conduct aerial surveys also may increase the number of aerial surveys, and could improve population assessments. The types of UAS that may be used include vertical take-off and lift (VTOL, e.g., quadrocopters, hexacopters) or small fixed wing UAS. Quadcopters/hexacopters are approximately 0.5 m square and 2 kg. These types, as well as others that may be used, are extraordinarily quiet with sound levels equivalent to a whisper (less than 5 dB) at 30m. Figure B-20 depicts a quadcopter.

Figure B-19 Aircraft used for SWFSC research

Other observation platforms developed and used by SWFSC:

- Underwater Autonomous Vehicles (UAVs) - buoyancy compensated gliders.
- Unmanned Surface Vehicles (USVs) - saildrones
- Light-Weight Instrumented Buoys
- Moored Instrument Arrays

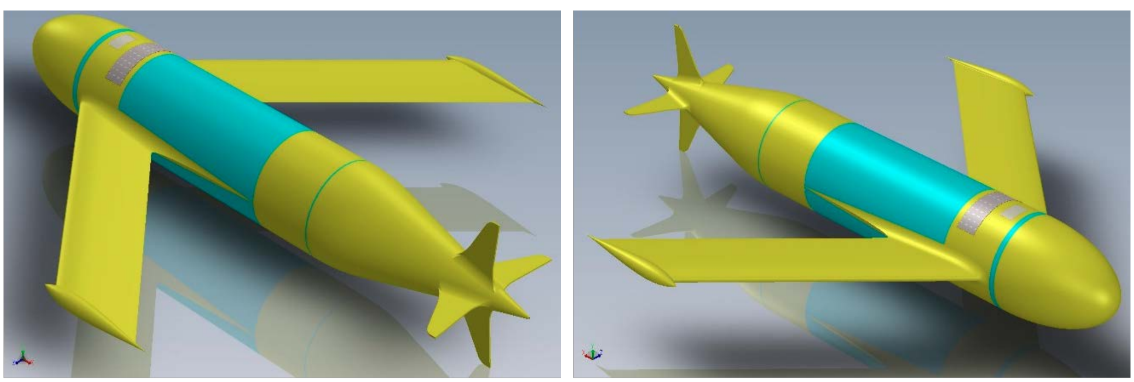
USVs such as the saildrone may be used for collecting oceanographic and other data during research cruises. As an example of such equipment, the saildrone vehicle consists of a narrow seven-meter-long hull, a five-meter-tall wing, and a keel with a 2.5-meter draft. Saildrone USVs weigh approximately 750 kg and can be launched and recovered from a dock. Figure B-20 depicts other observation platforms including buoys, instrument arrays, and saildrone.



www.saildrone.com

Figure B-20 Other observation platforms developed and used by SWFSC.

Buoyancy compensated gliders (Figure B-21) use hydrodynamic wings to convert vertical motion into horizontal motion, moving forward with very low power consumption (Petritoli et al. 2019). While not as fast as conventional UAVs, the glider, using buoyancy-based propulsion, offers increased range and endurance compared to motor-driven vehicles and missions may extend to months and to several thousands of kilometers in range.



Petritoli et al. 2019

Figure B-21 Example of a buoyancy compensated glider.

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