FINAL

SUPPLEMENTAL

PROGRAMMATIC ENVIRONMENTAL ASSESSMENT

for

FISHERIES RESEARCH CONDUCTED AND FUNDED

by the

SOUTHWEST FISHERIES SCIENCE CENTER

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ACRONYMS AND ABBREVIATIONS

Abbreviation	Definition
ABARES	Australian Bureau of Agricultural and Resource Economics
ADCP	Acoustic Doppler Current Profiler
AERD	Antarctic Ecosystem Research Division
AMLR	Antarctic Marine Living Resources
ARA	Antarctic Research Area
ASL	above sea level
AUV	Autonomous Underwater Vehicles
AZFP	Acoustic Zooplankton Fish Profiler
BA	Biological Assessment
BiOp	Biological Opinion
BMP	Best Management Practice
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CalVET	California Vertical Egg Tow
CA	California
CCAMLR	Convention for the Conservation of Antarctic Living Marine Resources
CCE	California Current Ecosystem
CCRA	California Current Research Area
Centers	Regional Fisheries Science Centers
CCEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cm	centimeter
COAST	Collaborative Optical Acoustical Survey Technology
Council	Pacific Fishery Management Council
CPS	Coastal Pelagic Species
CS	Chief Scientist
CTD	Conductivity, Temperature, and Depth
CUFES	Continuous Underway Fish Egg Sampler
CV	Coefficient of Variation
CZMA	Coastal Zone Management Act
D	Depleted under the MMPA
DAS	days at sea
dB	decibels
DNA	deoxyribonucleic acid
DON	Department of the Navy
DOSITS	Discovery of Sound in the Sea
DPS	Distinct Population Segment
E	Endangered under the Endangered Species Act
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat

Abbreviation	Definition
ENP	Eastern North Pacific
EO	Executive Order
ERD	Environmental Research Division
ENSO	El Niño Southern Oscillation
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
ETP	Eastern Tropical Pacific
ETPRA	Eastern Tropical Pacific Research Area
FAA	Federal Aviation Administration
FED	Fisheries Ecology Division
fm	fathom
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
FR	Federal Register
FRD	Fisheries Resources Division
FREEBYRD	Antarctic Living Marine Resources Program glider program
ft	feet
GAMMS	Guidelines for Assessing Marine Mammal Stocks
GPS	Global Positioning System
GRND	groundfish species
HMS	Highly Migratory Species
HSUS	Humane Society of the United States
Hz	hertz
IATTC	Inter-American Tropical Tuna Commission
ICUN	International Union for Conservation of Nature
IHA	Incidental Harassment Authorization
in.	inch
ITA	Incidental Take Authorization
ITR	Incidental Take Regulation
ITS	Incidental Take Statement
kg	kilograms
kHz	kilohertz
km	kilometers
km^2	square kilometers
LME	Large Marine Ecosystem
LNG	Liquid Natural Gas
LOA	Letter of Authorization
LOF	List of Fisheries
m	meters
mi	miles
mi^2	square miles
ms	millisecond

Abbreviation	Definition
MBARI	Monterey Bay Aquarium Research Institute
MBTA	Migratory Bird Treaty Act
MLLW	Mean low lower water
MMC	Marine Mammal Commission
MMED	Marine Mammal Excluder Device
MML	Marine Mammal Laboratory
MMPA	Marine Mammal Protection Act
MMTD	Marine Mammal and Turtle Division
MPA	Marine Protected Area
M/SI or M&SI	Mortality/Serious Injury
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NL	not listed under the ESA
NS	Not strategic under the MMPA
nm	nautical mile
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NRC	National Research Council
OCS	Outer Continental Shelf
OMAO	Office of Marine Aviation and Operations
ONMS	Office of National Marine Sanctuaries
OOD	Officer on Deck
OPR	Office of Protected Resources
OR	Oregon
PBR	Potential Biological Removal
PEA	Programmatic Environmental Impact Statement
%	percent
ppt	parts per thousand
PSIT	Protected Species Incidental Take
PSV	purse seine vessel
PTS	Permanent Threshold Shift
RFFA	Reasonably Foreseeable Future Action
rms	root mean square
ROV	Remotely Operated Vehicle
RPAS	Remotely Piloted Aircraft Systems
S	Strategic under the MMPA
SAFE	Stock Assessment Fishery Evaluation
SAMN	salmon
SAR	Stock Assessment Report

Abbreviation	Definition
Secretary	U.S. Secretary of Commerce
SEL	Sound Exposure Level
SI	serious injury
SPEA	Supplemental Programmatic Environmental Assessment
SPLASH	Structure of Populations, Levels of Abundance and Status of Humpback Whales
SRKW	Southern Resident Killer Whales
SSLF	Shallow-set longline fishery
SWFSC	Southwest Fisheries Science Center
T	Threatened under the Endangered Species Act
TTS	Temporary Threshold Shift
UAS	Unmanned Aerial Systems
UC	University of California
UME	Unusual Mortality Event
U.S.	United States
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
USV	Unmanned Surface Vehicle
μPa	microPascal
VTOL	vertical take-off and landing
WA	Washington
WCRO	West Coast Regional Office
WNPFMC	Western North Pacific Fishery Management Council

EXECUTIVE SUMMARY

BACKGROUND AND NEPA COMPLIANCE

This Final Supplemental Programmatic Environmental Assessment (Final SPEA) addresses fisheries and ecosystem research activities proposed by the Southwest Fisheries Science Center (SWFSC) for the period 2020-2025). The SWFSC previously analyzed the potential environmental effects of fisheries and ecosystem research for the period 2015-2020 and, in June 2015, published a Final Programmatic Environmental Assessment (PEA) for Fisheries Research Conducted and Funded by the SWFSC (NMFS 2015a). A Finding of No Significant Impact (FONSI) was signed on August 31, 2015. The 2015 PEA provides baseline descriptions of the physical, biological and human environments and analyses of the potential consequences of alternative approaches to fisheries and ecosystem research.

Concurrent with the 2015 PEA, SWFSC applied to NMFS for regulations and a five-year Letter of Authorization (LOA) for the incidental taking of marine mammals pursuant to Section 101(a)(5)(A) of the Marine Mammal Protection Act (MMPA). NMFS published the final rule and LOA authorizing the Taking Marine Mammals Incidental to SWFSC Research on October 30, 2015 (80 FR 58982).

This executive summary is a synopsis of the contents of the SWFSC Fisheries and Ecosystem Research final Supplemental PEA (SPEA). This SPEA addresses research activities that are proposed in the foreseeable future. Proposed research activities identified and analyzed within the Preferred Alternative will be subject to National Environmental Policy Act (NEPA) compliance review on a regular basis to determine whether activities conducted are within the scope of activities analyzed in this SPEA. Proposed research not identified and analyzed in this SPEA or the original 2015 PEA will be subject to a separate NEPA compliance review, the level of which will be determined when an application is submitted.

A notice of availability (NOA) for the Draft SPEA was published in the *Federal Register* on May 11, 2020 (85 FR 27719), and the Draft SPEA was made available on the internet. In response to a new MMPA LOA application for the future research period 2020-2025, the NOA of the proposed MMPA regulations was published in the *Federal Register* on May 8, 2020 (85 FR 27388). The final rule will be available on the NMFS Office of Protected Resources webpage: https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-research-and-other-activities

There was only one public comment letter received on the Draft SPEA during the comment period. Substantive comments requested NMFS to consider the impacts of fishing gear entanglements, potential acoustic disturbance from echosounders on killer whale prey and the potential for sea turtles to become entangled in research gear. These comments have resulted in revisions to the SPEA which are reflected in this final version (see Sections 4.3.2 Effects of Future SWFSC Research and 5.2.3.2 Cumulative Effects).

PURPOSE AND NEED

The federal action to be analyzed under this final SPEA is the proposed continuation of SWFSC fisheries research activities. The purpose of SWFSC fisheries research is to produce scientific information necessary for the management and conservation of living marine resources in the NMFS West Coast Region. SWFSC's research is needed to promote both the long-term sustainability of the resource and the recovery of certain species, while generating social and economic opportunities and benefits from their use.

The intent of this SPEA is to evaluate potential direct, indirect and cumulative effects of unforeseen changes in research that were not analyzed in the 2015 PEA, or new research activities. Where necessary, updates to certain information on species, stock status or other components of the affected environment are presented in this analysis.

This SPEA also provides information to support compliance with other statutes including the MMPA, ESA, National Marine Sanctuaries Act (NMSA), National Historic Preservation Act (NHPA), Coastal Zone Management Act, Executive Order 12114 (EO12114), Migratory Bird Treaty Act (MBTA), and Essential Fish Habitat (EFH) designated under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as well as to support consultation with native tribes within the Action Area.

DESCRIPTION OF ALTERNATIVES

The 2015 PEA Preferred Alternative (referred to in the 2015 PEA as Alternative 2) was implemented and provided the framework under which fisheries research has been conducted since 2015. The range of alternatives evaluated in this SPEA present the status quo/no action (i.e., current research) as Alternative 1 while Alternative 2 presents modifications to current research or new research activities that are planned for the future (i.e., 2020 – 2025). New future research proposed under Alternative 2 was not previously analyzed in the 2015 PEA. Table ES-1 summarizes research surveys by type or gear for a simple comparison of Alternatives 1 and 2. Table ES-2 summarizes the proposed mitigation measures for the Preferred Alternative (Alternative 2).

AFFECTED ENVIRONMENT

Chapter 3 of the 2015 PEA provides a comprehensive summary of physical, biological and socioeconomic resources that characterize the affected environment within the Project Area. As a supplement to the 2015 PEA, this SPEA describes updates and brings forward for analysis, only those resources that have exhibited a change in status or condition, or that may be affected by the new proposed research activities in a manner that was not previously considered in the 2015 PEA. Impacts to the resources described below are brought forward and summarized in tables below under Environmental Effects.

Physical Resources

Since 2015, there have been minor changes to a few special resources or areas within the Project Area: EFH, Closed Areas, and the Cordell Banks, Gulf of Farallones National Marine Sanctuary (NMS).

Fish

<u>ESA-Listed Fish</u>

ESA-listed fish species requiring analysis in this SPEA include: Pacific eulachon Distinct Population Segment (DPS), gulf grouper, and giant manta ray. Pacific salmonid and steelhead trout ESUs are also analyzed: Lower Columbia River, Upper Willamette River, Upper Columbia spring run and Puget Sound Chinook salmon; the Hood Canal summer run and Columbia River chum salmon; lower Columbia River coho salmon, Snake River and Lake Ozette sockeye salmon; and all 11 DPSs of steelhead trout found in the region including the following DPSs: Southern California; South-Central California; Central California Coast, California Central Valley; Northern California; Upper Columbia River; Snake River Basin; Lower Columbia River; Upper Willamette River; Middle Columbia River; and Puget Sound.

TABLE ES-1. SUMMARY OF RESEARCH BY ALTERNATIVE INCLUDING NEW PROPOSED ACTIVITIES UNDER ALTERNATIVE 2 AS SHOWN IN BOLD ITALICS

Survey Type	Alternative 1 No Action, Status Quo	Alternative 2 Future Research (Preferred Alternative)
Surveys Using Trawl Gear	• Coastal Pelagic Species (CPS) Survey (Sardine Survey) • Pacific Coast Ocean Observing Program (Northern and Central California) • Rockfish Recruitment and Ecosystem Assessment Survey -midwater trawls • Juvenile Salmon Survey	• CPS Survey (Sardine Survey) ***including nearshore areas*** • All other surveys same as Alt 1
Purse Seine Surveys	• Purse Seine Survey	• Purse Seine Survey may ***include nearshore areas in conjunction with CPS Survey***
Longline Surveys	• Highly Migratory Species (HMS) Surveys	• HMS Surveys ***including new gear (deep set buoy gear, troll and hook and line) for any HMS species***
Hook and Line and/or Rod and Reel Surveys	• Genetics Physiology and Aquaculture • Life History and Reproductive Ecology Investigations of Rockfish	• Life History and Reproductive Ecology Investigations of Rockfish including new target species, such as Sebastes species, using hook and line or other gear • Juvenile Salmon Survey including the use of micro-trolling (hook and line) and unmanned systems • All other surveys same as Alt 1
Unmanned Systems including ROVs	• California Current Ecosystem (CCE) spring and summer surveys conducted with available ship time • White Abalone Study using Remotely Operated Vehicles (ROV) • California Current Deep Sea Coral and Sponge Assessment • Antarctic Living Marine Resources Program (FREEBYRD) • Antarctic Living Marine Resources Program (Seabirds) - Land-based surveys using Unmanned Aerial Systems (UAS) and telemetry	• Antarctic Living Marine Resources Program (FREEBYRD) using various types of autonomous underwater vehicles, such as gliders, deployed for longer periods and greater depths • Juvenile Salmon Survey including the use of unmanned systems • Collaborative Optical Acoustical Survey Technology (COAST) Survey using unmanned systems • Ecosystem Based Fisheries Management and Stock Assessment including Monterey Bay or other regions within the California Current • All other surveys same as Alt 1
Multi-gear Surveys	• California Cooperative Oceanic Fisheries Investigations (CalCOFI) Winter, Spring, Summer and Fall Survey • Humboldt State University Cooperative Fisheries Oceanography Research Team: Trinidad Headlines	• Same as Alt 1

TABLE ES-2. MITIGATION AND MONITORING MEASURES FOR THE PREFERRED ALTERNATIVE.

Survey Type	Mitigation and Monitoring Measures for Preferred Alternative
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. Chief scientist (CS) to coordinate with Officer on Deck (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; 2) take action to increase the animal’s chance of survival; and 3) 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 (not including baleen whales [see MMPA Letter of Authorization (LOA) issued April 30, 2018]) are sighted 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 45 minutes at target depth for 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 Marine Mammal Excluder Devices (MMEDs). • Deploy 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 (ms) to seconds, variable frequency of 5 – 500 kilohertz (kHz), and maximum source level of 176 decibels (dB) root mean square (rms) re 1 microPascal at 30-80 kHz.

Survey Type	Mitigation and Monitoring Measures for Preferred Alternative
Purse Seine Survey	• 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 dolphins or porpoises are seen within 500 m of the vessel, the move-on rule is applied. If killer whales are • seen at any distance, the move-on rule is applied. If any cetaceans are seen within the net it is opened immediately. • 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 five 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 (including Hook and Line and Rod and Reel)	• 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 bait until all gear is retrieved. Chumming is prohibited.
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] Above Sea Level (ASL) depending on the method of use or species involved. For pinnipeds, UAS will fly at 100 – 200 ft depending on species; in mixed aggregations, the most conservative altitude is used. • 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).

<u>Target Fish and Highly Migratory Species (HMS</u>*)*

Of the target fish, only Chinook salmon, Pacific hake, and Pacific sardines had sufficient changes their statuses to warrant analysis in this SPEA. While there is some evidence of overfishing of HMS, the limited scope of proposed fisheries and ecosystem research by SWFSC does not warrant additional analysis of potential effects on these species beyond what is described in the 2015 PEA.

Marine Mammals

The statuses of the following CCE species have changed sufficiently to require analysis in this SPEA: the Morro Bay and Monterey Bay stocks of harbor porpoise; Dall's porpoise; Pacific white-sided dolphins; coastal and offshore stocks of bottlenose dolphins; striped dolphins; short-beaked common dolphins; long-beaked common dolphins; northern right whale dolphins; the southern resident killer whale DPS (endangered); Baird's beaked whales; *Mesoplodon spp.*; Cuvier's beaked whales; pygmy sperm whales; sperm whales (endangered); all four DPSs of humpback whales (Central America DPS is endangered and the Mexico DPS is threatened while the Brazil and Southeastern Pacific DPSs are not ESA-listed); and California sea lions. No Eastern Tropical Pacific (ETP) marine mammals were brought forward for analysis because no future research is planned in this region. In the Antarctic Research Area, only the humpback whale and crabeater seal are considered further.

There is only one stock of marine mammal species that forages in the Project Area within California/Oregon and Washington waters whose Endangered Species Act (ESA) listing status changed since the 2015 PEA. 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[1]. Of these 14 DPS, NMFS listed 4 DPSs as endangered and one DPS as threatened. The remaining nine DPSs were delisted, including the Hawaii DPS which forages in unspecified areas of the Antarctic Research Area. On September 19, 2019, NMFS proposed to expand critical habitat for the southern resident killer whale DPS based on information about their coastal range and habitat use[2]. The proposed 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.

Seabirds, Sea Turtles, and Invertebrates

The populations of these species have not significantly changed and potential impacts from future fisheries and ecosystem research (see Chapter 2) are not expected to result in different conclusions from those presented in the original 2015 PEA impact assessment, therefore these species are not discussed further in this SPEA.

Social and Economic Environment

The SWFSC fisheries and ecosystem research activities have direct and indirect influence on the economics of United States (U.S.) communities and ports in which they operate. As described in the 2015 PEA, SWFSC research funds are distributed among five research divisions and corporate services that

[1]81 FR 62260
[2]84 FR 49214

support them. Through direct expenditures on fisheries and ecosystem research, SWFSC contributes to the communities and ports in these regions.

ENVIRONMENTAL EFFECTS

Consistent with the approach used in the 2015 PEA, the criteria described in section 4 of this SPEA (Table 4-1) are used to evaluate SPEA Alternatives 1 and 2 only for those resources identified in Chapter 3 needing additional evaluation considering new information and/or the proposed scope of new research proposed 2020 – 2025.

Effects of the Status Quo/No Action Alternative

Effects on the Physical Environment

Table ES-3 summarizes the potential effects of the Status Quo/No Action Alternative on elements of the physical environment that have been added or updated since the 2015 PEA.

TABLE ES-3. SUMMARY OF POTENTIAL IMPACTS OF THE STATUS QUO/NO ACTION ALTERNATIVE ON PHYSICAL ENVIRONMENT

Physical Environment	Potential Impact of Status Quo/ No Action Alternative	Description
Essential Fish Habitat	Minor *Beneficial*	The combination of new and revised EFH conservation areas and the reopening of trawling in selected areas is anticipated to minimize adverse impacts to groundfish EFH from the effects of fishing. Any potential impacts due to this change are expected to be ***beneficial.***
Closed Areas	Minor *Beneficial*	See EFH above.
National Marine Sanctuaries *Cordell Banks* *Gulf of Farallones*	Minor *Beneficial*	On March 12, 2015, the boundaries of both sanctuaries were expanded.

Effects on ESA-Listed Fish

Table ES-4 summarizes the potential effects of the Status Quo/No Action Alternative on ESA-listed fish .

TABLE ES-4. SUMMARY OF POTENTIAL IMPACTS OF THE STATUS QUO/NO ACTION ALTERNATIVE ON ESA-LISTED FISH

ESA-listed Fish	Potential Impact of Status Quo/No Action Alternative		Description
	Mortality from Surveys	Disturbance Due to Sound Sources	
Pacific eulachon Southern DPS (T)	Minor *Adverse*	No Effect	SWFSC surveys have caught Pacific eulachon during surveys 2016-2017 and 2019, mostly during CPS surveys (see text). No eulachon were caught in 2018. The majority of eulachon bycatch occurs during offshore shrimp trawl fisheries (Gustafson *et al*. 2019).
Gulf Grouper (E)	No Effect	No Effect	Due to overfishing and reduction in numbers and range, NMFS listed the grouper as endangered in 2016. Gulf grouper are not likely to be caught incidentally in SWFSC due to their close proximity to shore.
Giant Manta Ray (T)	No Effect	No Effect	Giant manta rays are targeted and caught as bycatch, with high rates of removal from industrial purse seine and artisanal gillnet fisheries (83 Federal Register (FR) 2916). SWFSC are not likely to incidentally catch Giant manta rays during research.
Chinook Salmon Snake River, fall spring, and summer run Lower Columbia River Upper Willamette River Upper Columbia, spring run Puget Sound	Moderate *Adverse*	No Effect	SWFSC research exceeded anticipated take[1] for one or more ESUs of listed salmon, including Chinook during research 2016 - 2018. These recent bycatch events (2016 – 2018) likely result in a minor adverse effect on these populations.
Chum Salmon Hood Canal, summer run Columbia River	Minor *Adverse*	No Effect	SWFSC research did not exceed anticipated take[1] for chum salmon. Takes that did occur within the expected range are considered to have had a minor adverse effect on the population.
Coho Salmon S. Oregon/N. California Coast Oregon Coast Lower Columbia River	Moderate *Adverse* No Effect	No Effect	SWFSC research exceeded anticipated take[1] for ESA-listed salmon from S. Oregon/N. California in 2018 and therefore may have had a minor adverse effect on the population.
Sockeye Salmon Evolutionarily Significant Unit (ESUs) Snake River Lake Ozette	Minor *Adverse*	No Effect	SWFSC research did not exceed anticipated take[1] for sockeye salmon.

ESA-listed Fish	Potential Impact of Status Quo/No Action Alternative: Mortality from Surveys	Potential Impact of Status Quo/No Action Alternative: Disturbance Due to Sound Sources	Description
Steelhead Trout South California Coast South-central California Coast Central California Coast California Central Valley Northern California Upper Columbia River Snake River Basin Lower Columbia River Upper Willamette River Middle Columbia River Puget Sound	Minor *adverse*	No Effect	SWFSC research did not exceed anticipated take[1] for sockeye salmon. In 2018, there were 12 takes of the Northern California ESU. Takes that did occur in 2018 were above the anticipated take level but this did not occur again and would be considered to have had a minor adverse effect on the population.

[1]Takes that did occur within the expected ranges are considered to have had a minor adverse effect on the population.

Incidental Bycatch of Salmon

Genetic analysis of salmon caught in several SWFSC surveys between 2016-2018 has demonstrated that the origin of ESA-listed salmon caught as bycatch in SWFSC surveys can be estimated based on the location of the survey at the time of the bycatch, and the proximity of the survey to ESU natal streams (as reported in Shelton *et al*. 2019). The composition of the salmon bycatch during each of the survey periods, 2016 through 2018, was represented by fish whose natal origin was from the Oregon/California border north to, at least British Columbia, Canada. Salmon ESUs and steelhead DPSs originating below the northern California-southern Oregon border were not represented in these bycatch events. Salmon and steelhead would not be expected to be a part of the bycatch given the distance between the location of the bycatch events and the rivers of origin for DPSs in California.

Genetic analysis of salmon incidentally caught as bycatch or the proximity of bycatch to natal origins of ESA-listed salmon enables estimation of the origins of ESA-listed salmon caught by ESU in the SWFSC surveys. This is a significant finding as the SWFSC considers how SWFSC fisheries research may impact listed salmon in future surveys. Chinook were incidentally taken during the Rockfish Recruitment and Ecosystem Assessment Surveys in 2016, 2017 and 2018 with one, four and nineteen Chinook taken, respectively. Two steelhead were also incidentally caught in 2017 during the Rockfish Recruitment and Ecosystem Assessment Survey and CPS Survey (i.e., one fish during each survey was taken).

Despite the best scientific information available, it is not currently possible to differentiate between CPS species and juvenile salmon in acoustic backscatter data. Moreover, trawl data suggests that CPS species and juvenile salmon may cohabitate and jointly school in near-coastal habitats. SWFSC must continue to survey these areas to provide management with best estimates of CPS populations.

Effects on Target Species

Table ES-5 summarizes the potential effects of the Status Quo/No Action Alternative on California Current Research Area (CCRA) target fish that have been added or updated since the 2015 PEA; only three species of target fish from the CCRA changed sufficiently to warrant further analysis under the SPEA alternatives.

TABLE ES-5. SUMMARY OF POTENTIAL IMPACTS OF THE STATUS QUO/NO ACTION ALTERNATIVE ON CCRA TARGET FISH

Target Fish	Potential Impact of Status/Quo/No Action Alternative		Description
	Mortality from Surveys	Disturbance Due to Sound Sources	
Chinook Salmon (non-listed ESUs)	Minor *Adverse*	No effect	No change in ESA-listed status; however given recent bycatch events (2016 – 2018), additional analysis under SPEA alternatives is warranted. Low level mortality from research surveys is not expected to result in any measurable changes at the population level
Pacific Hake	Minor *Adverse*	No Effect	No change in status. Recent biomass assessment indicates there is an estimated 68% chance of the spawning biomass declining from 2019 to 2020, and an 84% chance of it declining from 2020 to 2021 under current level of catch. Low level mortality from research surveys is not expected to result in any measurable changes at the population level.
Pacific Sardine	Minor *Adverse*	No Effect	The fishery is closed due to precautionary measures built into sardine management to stop directed fishing when the population falls below 150,000 metric tons. The latest population estimate is below that level due to environmental conditions, and managers have closed the fishery. Low level mortality from research surveys is not expected to result in any measurable changes at the population level.

Effects on Marine Mammals

A number of ESA-listed and non-listed cetaceans in the CCRA and Antarctic Research Area (ARA) have had changes to status or condition as shown in Table ES-6, which summarizes the potential effects of the Status Quo/No Action Alternative on ESA-listed and non-listed cetaceans. No cetaceans or pinnipeds in the ETP Research Area (ETPRA) have changed sufficiently to warrant re-analysis under the SPEA alternatives.

TABLE ES-6. SUMMARY OF POTENTIAL IMPACTS OF THE STATUS QUO/NO ACTION ALTERNATIVE ON CCRA AND ARA ESA-LISTED AND NON-LISTED MARINE MAMMALS

Marine Mammals[1,2]	Potential Impact of Status/Quo/No Action Alternative			Discussion
	Injury or Mortality	Changes in Food Availability	Disturbance from Sound Sources	
ESA-Listed				
Southern Resident Killer Whale DPS	No effect	No effect	Minor *Adverse*	The status of this stock has not changed over the 2015-2018 period and remains of concern because the population is below 100 individuals. Disturbance takes occur but are well below MMPA-authorized levels.
Sperm Whale	No effect	No effect	Minor *Adverse*	Estimated abundance of this species doubled from 2015-2018. Disturbance takes occur, but are well below MMPA-authorized levels.
Humpback Whale Central America DPS Mexico DPS	No effect	No effect	Minor *Adverse*	The Central DPS population estimate of 411 is lower than previous estimates. The Mexico DPS estimate more than doubled from 2015-2018. This DPS is considered threatened rather than endangered. Disturbance takes occur but are well below MMPA-authorized levels.
Non Listed				
Humpback Whale[3] Brazil DPS Southeastern Pacific DPS Hawaii DPS	No effect	No effect	Minor *Adverse*	These ARA DPSs were delisted in 2016. Sightings of humpback whales are uncommon during ARA research activities. Disturbance takes occur but are well below MMPA-authorized levels.
Harbor Porpoise Morro Bay stock Monterey Bay stock	No effect	No effect	Minor *Adverse*	Morro Bay stock estimate increased by 1.5 times and a similar estimate of the Monterey Bay stock more than doubled from 2015-2018. Disturbance takes of harbor porpoise occur but are well below MMPA-authorized levels.
Dall's Porpoise	No effect	No effect	Minor *Adverse*	Abundance estimate of this stock decreased by over 16,000 from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels.

Marine Mammals[1,2]	Potential Impact of Status/Quo/No Action Alternative			Discussion
	Injury or Mortality	Changes in Food Availability	Disturbance from Sound Sources	
Bottlenose Dolphin Coastal Offshore	No effect	No effect	Minor *Adverse*	Abundance estimate of these stocks increased slightly from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels.
Striped Dolphin	No effect	No effect	Minor *Adverse*	Abundance estimate of this species almost tripled from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels.
Short-beaked Common Dolphin	No effect	No effect	Minor *Adverse*	Abundance estimate of this species more than doubled from 2015-2018. Disturbance takes occur, but are well below MMPA-authorized levels.
Long-beaked Common Dolphin	Minor *Adverse*	No effect	Minor *Adverse*	Abundance estimate of this species almost quadrupled from 2015-2018. An M/SI take of this species occurred in 2019. Disturbance takes occur but are well below MMPA-authorized levels.
Northern Right Whale Dolphin	No effect	No effect	Minor *Adverse*	Abundance estimate of this species tripled from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels.
Pacific white sided dolphin	Minor *Adverse*	No effect	Minor *Adverse*	No change to estimate of abundance. 18 MI/SI takes have occurred since the 2015 PEA. Level A and Level B take levels are below MMPA-authorized numbers.
Baird's Beaked Whale	No effect	No effect	Minor *Adverse*	Abundance estimate of this species more than doubled from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels.
Mesoplodon *spp.*	No effect	No effect	Minor *Adverse*	Abundance estimate of this species increased by almost 7 times from 2015-2018. Disturbance takes occur, but are well below MMPA-authorized levels
Cuvier's Beaked Whale	No effect	No effect	Minor *Adverse*	Abundance estimate of this species increased over 1,000 from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels.
Pygmy Sperm Whale	No effect	No effect	Minor *Adverse*	Abundance estimate of this species increased by over 7 times from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels.
California Sea Lion	Minor *Adverse*	No effect	Minor *Adverse*	Abundance estimate decreased by about 13% and an M/SI take occurred in 2018. Level A and Level B take levels are below MMPA-authorized numbers.

Marine Mammals[1,2]	Potential Impact of Status/Quo/No Action Alternative: Injury or Mortality	Changes in Food Availability	Disturbance from Sound Sources	Discussion
Crabeater Seal[4]	No effect	No effect	Minor *Adverse*	Abundance estimate is from 5-10,000,000, but authorized Level B takes were exceeded over 10 fold in 2015-2016. On ice disturbance takes exceeded allowed numbers, but due to the overall size of the population effects would be minor.

[1]All marine mammals in this table are from CCRA with the exception of for the three de-listed DPS of humpback whales and the crabeater seal as noted.
[2]Only marine mammals identified in Chapter 3 warranting re-analysis are shown in this table.
[3]These DPS may occur in the ARA during summer.
[4]Occurrs in the ARA.

<u>Effects on the Social and Economic Environment</u>

Through direct expenditures on fisheries and ecosystem research, SWFSC contributes to the communities and ports throughout the research areas located in the CCRA, ETPRA and ARA with the majority of influence likely occurring in the states of California, Oregon and Washington due to the number of communities in those states that could interact with research activities. While the contribution of research-related employment and purchased services is beneficial on an individual basis, the total contribution of research is minimal when compared to the value of commercial and recreational fisheries in the communities. Fisheries research is considered a minor beneficial effect to the economic status of communities within the research areas.

Effects of the Preferred Alternative

The assessment of impacts of this alternative retains all of the impacts described in Section 4.3.1 for the Status/Quo No Action Alternative, plus additional assessment of impacts due to the use of new technologies such as micro-trolling gear and unmanned systems, and the conducting of surveys in nearshore waters.

<u>Effects on the Physical Environment</u>

Impacts on EFH, closed areas, and the Cordell Banks and Gulf of Farallones NMSs for this alternative would be expected to be the same as for the Status Quo/No Action Alternative.

<u>Effects on ESA-Listed Fish</u>

Impacts on ESA-listed fish would be the same under the Preferred Alternative as those described for the Status Quo/No Action Alternative.

<u>Mitigation Measures for ESA-Listed Fish</u>

To better understand bycatch rates for ESA-listed salmon and steelhead, for SWFSC trawl surveys that catch more than 50 salmon, genetic subsampling will be undertaken to identify ESU to the extent possible. A description of the protocol used for genetic sampling is provided in C. For hauls less than 50 salmon, genetic sampling of all fish will be conducted. Genetic sampling, together with evaluating salmon bycatch relative to natal streams as described by Shelton *et al*. (2019), aims to address identifying fish to species and ESU.

Effects on Target Species

Table ES-7 summarizes the impacts of the Preferred Alternative on target fish that are different than those discussed in Section 4.3.1.2.1 and shown in Table 4-7. The targeting of additional *Sebastes* spp. under the Preferred Alternative and the use of unmanned systems would not be expected to affect target fish species differently from the Status Quo Alternative.

TABLE ES-7. SUMMARY OF POTENTIAL IMPACTS OF THE PREFERRED ALTERNATIVE ON CCRA TARGET FISH

Target Fish	Potential Impact of the Preferred Alternative		Description
	Mortality from Surveys	Disturbance Due to Sound Sources	
Pacific Sardine	Minor to Moderate *Adverse*	No Effect	Sardines are coastal epipelagic fish that migrate along the coast in large schools. The addition of nearshore sampling locations would collect data on nearshore abundance of sardines. Because the fishery is currently closed and biomass is at historically low levels, overall the removals may result in a minor adverse effect.

Effects on Marine Mammals

The impacts of the Preferred Alternative on marine mammals are not expected to be different from those discussed shown in Table ES-6. For the of the species in Table ES-6 including all ESA-listed marine mammals, no additional impacts from the nearshore surveys, the use of micro trolling in juvenile salmon surveys, and the targeting of additional *Sebastes* spp. are expected. Additional surveys in Monterey Bay would not be expected to impact the Monterey Bay stock of harbor porpoise. The use of hook and line gear in the HMS surveys would not impact cetaceans.

Effects on the Social and Economic Environment

The addition of inshore survey areas, targeting of new *Sebastes* spp., and the use of micro trolling and unmanned systems in surveys is not expected to have different effects on the social and economic environment as described for the Status/Quo/No action Alternative.

Cumulative Effects

Relevant past and present external actions and events that may interact with SWFSC fisheries and ecosystem research may include both human controlled activities (such as shipping or marine debris), and natural events, such as predation or climate change. Table 5-1 provides a list of past, present and RFFAs and natural events considered in the cumulative effects analysis in this SPEA.

Effects on the Physical Environment, Special Resource Areas, and EFH

The cumulative effects of proposed SWFSC fisheries and ecosystem research, when combined with other past, present and future actions, would likely result in negligible cumulative effects on the physical environment. Likewise, SWFSC research would not contribute to a cumulative effect on special resource areas or EFH within the research areas. While effects from actions external to SWFSC research could be long-term, the magnitude of SWFSC research is not expected to alter habitat function or cause wide-spread changes to the geologic structure of the research areas.

Effects on Fish

Fisheries research has documented multiple stressors from single fishing types. The spatial scale of the cumulative effects of a single activity can vary across local and regional scales, as well as their duration and frequency over time. The consequences of these cumulative effects also depend on the condition (i.e., health) of the resource exposed. For example, an ESA-listed species would be more vulnerable to long-term consequences of cumulative effects than a non-listed species.

Climate change may have effects on weather patterns and sea surface temperature, which may shift the distribution of fish populations. The potential far-reaching impacts of climate change on fish habitat due to warming ocean temperatures, decreased habitat for selected species, changing distributions and abundance, changes in productivity and subsequent production, far exceed the minor impacts of fish removal as a result of SWFSC fisheries research.

Overall, the contribution of SWFSC research on fish is negligible and could be considered positive when considering overall benefits from new information gained through research.

Effects on Marine Mammals

Numerous natural and anthropogenic threats to marine mammals in the SWFSC research areas may affect their continued existence. These threats include oceanic and climatic regime shifts, habitat degradation, fisheries interactions, vessel strikes, and disease and other disturbances associated with human activities. Fishery interactions with protected species are considered to have the most significant impact on marine mammal mortality worldwide, and are routinely evaluated by NMFS through the preparation and issuance of environmental impact analyses and biological opinions as well as Stock Assessment Reports (SARs).

The cumulative effects from past and present factors on ESA-listed and non-listed marine mammal species may result in minor to major impacts on these species. However, when considered in conjunction with other past, present, and reasonably foreseeable future activities affecting marine mammals in the CCE, ETP, and AMLR, the contribution of the Status Quo or Preferred Alternative to cumulative effects on ESA-listed and non-ESA-listed marine mammals would be minor and adverse through incidental take. However, fisheries and ecosystem research conducted by the SWFSC also provide valuable information for the conservation and management of ESA-listed and non-ESA-listed species and this contribution to cumulative effects would be beneficial for these species.

Effects on Seabirds

The combination of stressors such as sea-surface temperature changes, habitat modification or loss due to human activities (i.e., urbanization) or large storm events in addition to the effects of climate change can place additional stress on seabird reproduction or foraging. Disturbances from human activities or natural events can result in a reduction in seabird population health due to mortality, breeding failure or colony abandonment.

No seabirds have ever been caught incidentally in SWFSC fisheries surveys and changes in availability of seabird prey resulting from SWFSC research surveys are expected to be localized and insubstantial. The contribution of SWFSC research activities to seabird collisions with vessels and loss or injury of seabirds from interactions with marine debris are expected to be minor. Therefore, the contribution of SWFSC research on seabirds is negligible within the context of the past, present and reasonably foreseeable future actions (RFFAs).

Effects on Sea Turtles

Coastal development continues to remove habitat and increase artificial lighting along the coastline which can alter turtle behavior (NMFS and U.S. Fish and Wildlife Service [USFWS] 2013). Sea turtles are also threatened by global climate change (Hawkes *et al*. 2007; Fuentes *et al*. 2011). Sea turtles with high fecundity and low juvenile survival are the most vulnerable to climate change and elevated levels of environmental variability (Cavallo *et al.* 2015). Threats to sea turtles in the CCRA and ETPRA include incidental capture, injury, and mortality during commercial fishing operations.

One green sea turtle was taken by SWFSC research activities in 2016; the turtle was released alive[3]. There have been no reported interactions resulting in sea turtle mortality. Likewise, contributions of the research alternatives to ship strikes, changes in availability of prey for sea turtles, loss or injury due to ingestion of or entanglement in marine debris, and alterations to sea turtle habitat are expected to be minor. Within the context of global changes and stressors on sea turtles, the contribution of SWFSC research to cumulative effects on sea turtle populations and their habitat is negligible.

Effects on Invertebrates

Marine invertebrates are susceptible to natural and anthropogenic effects including exploitation through commercial and recreational fishing, habitat degradation and disturbance, pollution, competition with invasive species, and climate change. Degradation of invertebrate habitat can occur as a result of commercial and recreational fisheries that involve gear coming into contact with the sea floor. SWFSC research surveys remove small numbers of invertebrates from all three research areas, primarily plankton, pelagic jellyfish and squid. Mortality resulting from SWFSC fisheries research would be a minor contribution under each of the research alternatives to adverse cumulative effects on invertebrates of mortality from commercial fishing and dredging. Because the SWFSC does not use bottom-trawl gear in the CCE and ETP, SWFSC research would not contribute to benthic habitat disturbance in those areas.

Effects on the Social and Economic Environment

Activities external to SWFSC fisheries research that could potentially affect the social and economic environment in the CCRA, ETPRA, and ARA may include construction, commercial and recreational fisheries, shipping, coastal development, oil extraction, other scientific research, military operations, climate change, and ocean acidification. Overall, SWFSC research may contribute certain economic

[3]See 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

benefits to local communities through research-related expenditures; however, these effects are likely to be minor compared to other key factors that affect communities, economics and the global economy.

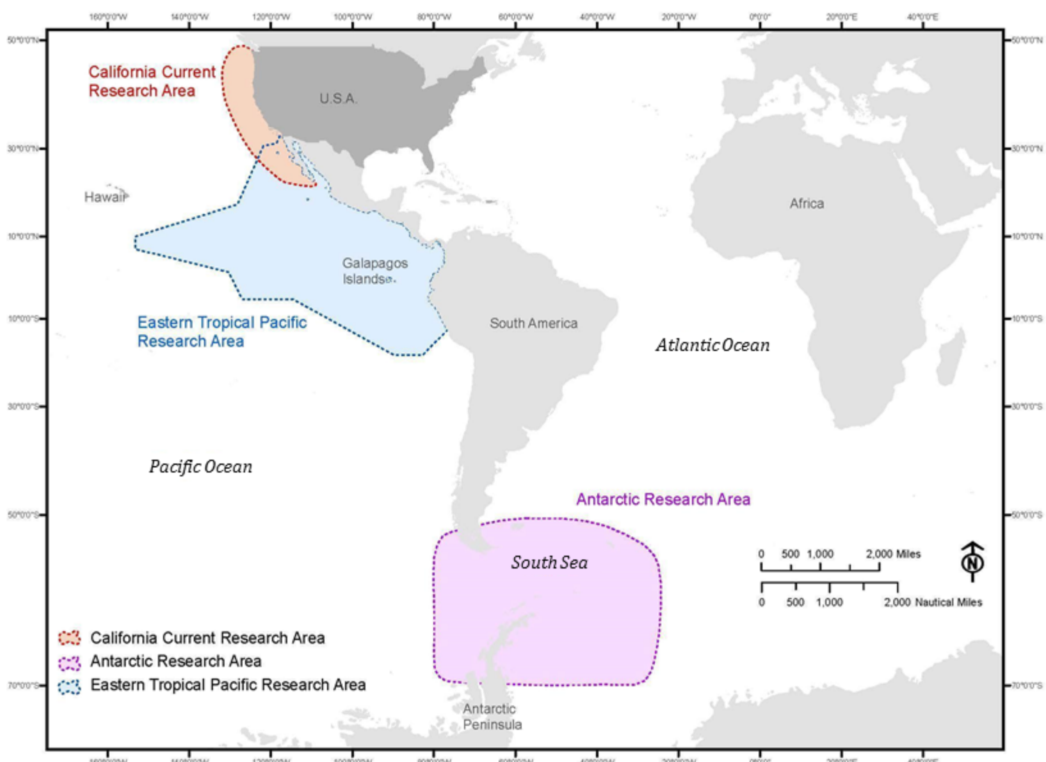
1 INTRODUCTION AND PURPOSE AND NEED

1.1 NOAA's Resource Responsibilities and Role in Fisheries Research

The United States (U.S.) government has jurisdiction over the living marine resources in waters of the Exclusive Economic Zone (EEZ), which lies 3 to 200 nautical miles (nm) from the U.S. shoreline. Congress has enacted several statutes authorizing federal agencies to manage and protect living marine resources. The National Oceanic and Atmospheric Administration (NOAA) is responsible for protecting marine finfish and shellfish species and their habitats. Within NOAA, the National Marine Fisheries Service (NMFS) is responsible for conducting science-based management, conservation, and protection of living marine resources within the U.S. EEZ.

The Southwest Fisheries Science Center (SWFSC) based in La Jolla, California and within NMFS' West Coast Region, is one of six Regional Fisheries Science Centers (Centers) that direct and coordinate the collection of scientific information needed to make fisheries management decisions and to protect fisheries resources. 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).

FIGURE 1-1. SOUTHWEST FISHERIES SCIENCE CENTER RESEARCH AREAS



Source: NMFS 2015a

SWFSC research efforts are divided among five research divisions, which have different roles in collecting scientific information. Additional details on these divisions and their associated research programs can be found in Section 1.2 of the PEA (NMFS 2015a).

Research divisions include:

- Fisheries Resources Division (FRD) develops the scientific foundation for the conservation and management of marine resources in the California Current and Pan-Pacific Pelagic Ecosystems. In addition, FRD scientists participate in international working groups.
- Fisheries Ecology Division (FED) conducts research on the ecology of groundfish, economic analysis of fishery data, Pacific salmon studies and coastal habitat issues affecting the San Francisco Bay and the Gulf of Farallones. FED also assesses the stocks of species targeted by various fisheries and assists in evaluating potential impacts of human activities on threatened or endangered species.
- Antarctic Ecosystem Research Division (AERD) manages the U.S. Arctic Marine Living Resources (AMLR) by providing information for U.S. policy on the management and conservation of Antarctic living resources and supports U.S. participation in international efforts to protect the Antarctic and its marine life.
- Environmental Research Division (ERD) conducts a flexible research program to assess, understand, and predict climate and environmental variability and its impacts on marine fish populations and ecosystems.

NMFS conducts primarily fisheries-independent research on the status of living marine resources and associated habitats. Fisheries-independent research is designed and conducted independent of commercial fishing activity to meet specific research goals, and includes research directed by SWFSC scientists and conducted on board NOAA-owned and operated vessels or NOAA-chartered vessels. SWFSC resource surveys collect the information needed to inform stock assessment models (abundance, demographics and life history) which form the basis for natural resource decisions. The AMLR surveys are designed to map krill distribution and abundance, to measure environmental variables influencing krill abundance and distribution, and to conduct bottom trawl surveys to characterize Antarctic finfish populations and their relationships to other components of the Antarctic ecosystem. The long time series and the extensive sample collections enable the SWFSC to study the impacts of climate variability and change on marine populations and trends in community composition.

The SWFSC also helps fund, staff, or analyze data from fishery-independent research directed by cooperating scientists (other agencies, academic institutions, and independent researchers) conducted on board non-NOAA vessels. SWFSC fisheries-dependent research is limited to collection of harvest data while fishing vessels are in port and does not involve research conducted in marine waters during commercial fishing operations. The fishery-independent research activities carried out by the SWFSC were programmatically evaluated in a 2015 Programmatic Environmental Assessment (PEA) and this SPEA serves to supplement that evaluation with new information on the surveys as well as the resources that may occur in the action area (see Section 1.2 regarding the 2015 PEA).

SWFSC research programs conducted by the divisions listed here must comply with several major statutes including: the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the Marine Mammal Protection Act (MMPA), the Endangered Species Act (ESA), among others. Table 1-1 briefly summarizes these and other key statutes and treaties applicable to this analysis, along with the actions taken to address their requirements.

Under Section 7 of the ESA, the SWFSC consulted over its 2016-2020 research program with the NMFS West Coast Regional Office and USFWS for species that are listed as threatened or endangered. These consultations resulted in the development of a NMFS Biological Opinion (BiOp) which was signed on August 31, 2015. Section 2.10.1 of the 2015 BiOp states that incidental takes of sea turtles (leatherback, North Pacific loggerhead, olive ridley and green) eulachon (Southern Pacific DPS), scalloped hammerhead sharks (Eastern Pacific DPS), and ESA-listed salmon and steelhead ESUs through capture or entanglement were likely to occur as a result of SWFSC research. Section 2.10.2 states: "In the biological opinion, we determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to any of these species or destruction or adverse modification of any designated critical habitats." A new BiOp will be available at: https://repository.library.noaa.gov/gsearch?terms=ESA Section 7&sm_localcorpname=WCRO (West Coast Region)

On April 23, 2015 and January 22, 2016, the SWFSC sent a concurrence request letter regarding the potential effects of its fisheries and ecosystem research activities and a not likely to adversely affect (NLAA) determination on ESA-listed species under the jurisdiction of USFWS. USFWS responded to the initial request letters from SWFSC and NWFSC on March 10 and 15, 2016, respectively. USFWS concurred with both the SWFSC and NWFSC on their respective NLAA determinations. SWFSC will continue to implement a suite of measures in their fisheries and ecosystem research activities to mitigate potential adverse impacts on ESA-listed and other protected species. Finally, on April 23, 2013 SWFSC sent a request to initiate consultation with the California State Historic Preservation Office (SHPO) under Section 106 of the National Historic Preservation Act. There was no response to the letter and SWFSC concluded that the California SHPO was in agreement with the proposed fisheries and ecosystem research activities. In 2020, NMFS published the SPEA and did not receive comments from the California SHPO.

TABLE 1-1. COMPLIANCE ACTIONS FOR APPLICABLE LAWS, REGULATIONS, AND TREATIES

Law	Description	PEA Action Taken	Date	SPEA Action
National Environmental Policy Act (NEPA)	Requires federal agencies to evaluate potential environmental effects of any major planned federal action and promotes public awareness of potential impacts by requiring federal agencies to prepare an environmental evaluation for any major federal action affecting the human environment.	1) Programmatic Environmental Assessment (PEA) 2) Finding of No Significant Impact (FONSI)	1) 08/31/2015 2) 09/28/2015	1) NMFS approval of Draft SPEA 2) 30-day comment period ends 3) Final SPEA 4) FONSI
Magnuson-Stevens Fishery Conservation and Management Act (MSA)	Authorizes the U.S. to manage fishery resources from a state's territorial sea or EEZ (3 nm to 200 nm from shore). Includes 10 national standards to promote domestic commercial and recreational fishing under sound conservation and management principles. Supports preparation and implementation of fishery management plans (FMPs).	Essential Fish Habitat (EFH) Request for concurrence from the NMFS West Coast Regional Office (WCRO). WCRO concurred with NMFS determination of minimal and temporary effects to EFH.	04/23/2013	No additional consultation required.
Marine Mammal Protection Act (MMPA)	Prohibits the take of marine mammals in U.S waters and by U.S. citizens on the high seas and the importation of marine mammals and marine mammal products into the U.S. with some exceptions and exemptions. Authorization may be granted for the "incidental," but not intentional, taking of small numbers of marine mammals.	1) Letter of Authorization (LOA) application 2) LOA-CCRA LOA-ETP LOA-AMLR 3) FONSI for LOA rule	1) 06/29/2012 2) 10/30/2015 3) 08/31/2015	1) LOA application 2) Notice of Receipt 3) Proposed rule 4) 30-day comment period ends 5) Final rule 6) 30 day wait period for final rule 7) LOA issued
Endangered Species Act (ESA)	Provides for the conservation and recovery of endangered and threatened species of fish, wildlife, and plants. Prohibits the take of endangered species and some threatened species with some exceptions and exemptions. Administered jointly by NMFS and the USFWS.	1) Request to Initiate Formal Consultation 2) NMFS Biological Opinion (BiOp) and Incidental Take Statement 3) U.S. Fish and Wildlife Service (USFWS) BiOp 4) Section 10 permit	1) 11/13/2014 2) 08/31/2015 3) 11/17/2017 4) 12/01/2015	1) Draft Biological Assessment (BA) 2) Final BA 3) Consultation with ESA Division 4) Draft BiOp and ITA 5) Final BiOp

Law	Description	PEA Action Taken	Date	SPEA Action
Migratory Bird Treaty Act (MBTA)	Protects approximately 836 species of migratory birds from any attempt at hunting, pursuing, wounding, killing, possessing, or transporting any migratory bird, nest, egg, or part thereof, unless permitted by regulations.	PEA sent to USFWS. No official response or documentation required.		SPEA published for comment. No additional documentation required.
Fish and Wildlife Coordination Act (FWCA)	Requires USFWS and NMFS to consult with other state and federal agencies in a broad range of situations to help conserve fish and wildlife populations and habitats in cases where federal actions affect natural water bodies.	PEA published, no official response or documentation required.		SPEA sent to appropriate state and federal cooperating agencies. No additional documentation required.
National Marine Sanctuaries Act (NMSA)	Authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities as national marine sanctuaries. Section 304(d) of the NMSA requires interagency consultation between the NOAA Office of National Marine Sanctuaries (ONMS) and federal agencies taking actions that are "likely to destroy, cause the loss of, or injure a sanctuary resource."	1) Request sent to ONMS for consultation 2) ONMS Recommended Alts. Memo 3) Recommended Alts. Response Memo SWFSC	1) 04/23/2013 2) 03/13/2015 3) 04/15/2015	SPEA sent to ONMS for comment. No additional consultation under Section 304(d) required.
National Historic Preservation Act (NHPA)	Section 106 requires review of any project funded, licensed, permitted, or assisted by the federal government for impact on significant historic properties.	Request sent to California (CA) State Office of Historic Preservation for consult. No response to letter. SWFSC concluded that the California State Office of Historic Preservation was in agreement with the proposed fisheries and ecosystem research activities.	04/23/2013	SPEA published for comment. No additional documentation required.

Law	Description	PEA Action Taken	Date	SPEA Action
Executive Order (EO) 12989, Environmental Justice	Directs federal agencies to identify and address disproportionately high and adverse effects of federal projects on the health or environment of minority and low-income populations to the greatest extent practicable and permitted by law.	No action taken		No action required.
Executive Order 12114, Environmental Effects Abroad of Major Federal Actions	Directs federal agencies to extend their compliance with NEPA and other specified laws to major federal actions outside of the U.S., its territories, and possessions. The purpose of the order is to establish internal procedures for federal agencies to consider the significant effects of their actions on the environment outside the U.S. but it does not require redress of those effects.	FONSI	09/28/2015	FONSI
Executive Order 13158, Marine Protected Areas (MPAs)	Strengthened and expanded the Nation's system of MPAs and encourages federal agencies to use science-based criteria and protocols to identify and prioritize natural and cultural resources in the marine environment that should be protected to secure valuable ecological services and to monitor and evaluate the effectiveness of MPAs. Each federal agency whose actions affect the natural or cultural resources that are protected by an MPA shall identify such actions. To the extent permitted by law and to the maximum extent practicable, each federal agency, in taking such actions, shall avoid harm to the natural and cultural resources that are protected by an MPA.	MPAs were evaluated in the PEA		MPAs are evaluated in the SPEA.
Coastal Zone Management Act (CZMA)	Encourages and assists states in developing coastal management programs. Requires any federal activity affecting the land or water use or natural resources of a state's coastal zone to be consistent with that state's approved coastal management program.	PEA provided to CA, OR, and WA coastal management agencies with a federally approved coastal management program.		SPEA sent to coastal management agencies. No additional documentation required.

Some SWFSC divisions also conduct directed research that may be covered under separate permits for work not evaluated in this SPEA. For example, under ESA Section 10(a)(1)(A), scientific research and enhancement permits are issued for certain salmon research conducted by FED. Similarly, AERD and the Marine Mammal and Turtle Division (MMTD) conduct directed marine mammal research which is covered under permit 19091-01 and authorized under the ESA and MMPA. MMTD research on marine mammals, sea turtles, and their designated critical habitats was previously included in the 2015 PEA. However, since 2015, MMTD directed research has been permitted under Permit 19091-01 and any required analyses for compliance have been considered separately from the analysis presented herein. For these reasons, MMTD and certain AERD or FED research activities are not included in this supplemental document. Additional information on regulatory requirements can be found in Chapter 6 of the PEA (NMFS 2015a).

The MSA established eight Regional Fishery Management Councils, consisting of fishing industry representatives, fishers, scientists, government agency representatives, federal appointees, and others. The Councils provide resource users and managers the ability to participate in the fisheries management process through the development of Fishery Management Plans (FMPs) and management measures for the fisheries occurring within the EEZ. The Pacific Fishery Management Council (Council) has jurisdiction over the EEZ off of the Washington, California and Oregon coasts, and is also active in international fisheries management for species that migrate through these waters[4]. The Council relies on data collected by the SWFSC to manage species in the California Current Research Area and to provide input on the management of species in the international waters of the Eastern Tropical Pacific and Antarctic Research areas (see Figure 1-1). The Council manages 119 species under four fishery management plans: Salmon, Groundfish, Coastal Pelagic Species (sardines, anchovies, and mackerel), and Highly Migratory Species (tuna, sharks, and swordfish).

Other entities that coordinate with SWFSC to meet MSA requirements and fishery management needs include: the Pacific States Marine Fisheries Commission; Western and Central Pacific Fisheries Commission; Pacific Salmon Commission; International Pacific Halibut Commission; International Scientific Committee for Tuna and Tuna-like Species; Inter-American Tropical Tuna Commission; International Whaling Commission; the Parties to the Agreement on the International Dolphin Conservation Program; the Convention for the Conservation of Antarctic Living Marine Resources; and federally recognized Native American tribes in California. For additional information on the interactions between SWFSC and these entities, please see Section 1.1 of the PEA (NMFS 2015a).

[4]See http://www.fisherycouncils.org/pacific for additional details.

1.2 Background and NEPA Analysis

The SWFSC previously analyzed the potential environmental effects of fisheries and ecosystem research and in June 2015 published a Final PEA for Fisheries Research Conducted and Funded by the Southwest Fisheries Science Center (NMFS 2015a). The 2015 PEA was determined to be sufficient and a Finding of No Significant Impact (FONSI) was signed on August 31, 2015. Concurrent with the 2015 PEA, SWFSC applied to NMFS for regulations and a five-year Letter of Authorization (LOA) for the incidental taking of marine mammals pursuant to Section 101(a)(5)(A) of the MMPA. NMFS published the final rule on September 30, 2019 (80 FR 58982) and issued the LOA authorizing the Taking Marine Mammals Incidental to Southwest Fisheries Science Center Fisheries Research on October 30, 2015.

The 2015 PEA provides baseline descriptions of the physical, biological and human environments and analyses of the potential consequences of alternative approaches to fisheries and ecosystem research. While the 2015 PEA and final rule provide the analytical framework to evaluate future research activities, the intent of this Supplemental PEA (SPEA) is to evaluate potential direct, indirect and cumulative effects of unforeseen changes in research that were not analyzed in the 2015 PEA, or new research activities. This final SPEA includes the latest available information on proposed research activities planned for the period 2020 – 2025 and tiers from the original 2015 PEA to focus "… on the issues which are ripe for decision…[excluding] from consideration issues already decided or not yet ripe" (40 Code of Federal Regulations [CFR] 15020.28). Where necessary, updates to certain information on species, stock status or other components of the affected environment that could result in different conclusions from the 2015 PEA are presented in this analysis.

This SPEA also provides information to support compliance with other statutes including the MMPA, ESA, National Marine Sanctuaries Act (NMSA), National Historic Preservation Act (NHPA), Coastal Zone Management Act, Executive Order 12114 (EO 12114), Migratory Bird Treaty Act (MBTA), and Essential Fish Habitat (EFH)/MSA, as well as to support consultation with native tribes within the Action Area, as previously discussed above.

This EA is being prepared using the 1978 CEQ NEPA Regulations. NEPA reviews initiated prior to the effective date of the 2020 CEQ regulations may be conducted using the 1978 version of the regulations. The effective date of the 2020 CEQ NEPA Regulations was September 14, 2020. This review began on March 15, 2019 and the agency has decided to proceed under the 1978 regulations.

1.3 Purpose and Need

The federal action to be analyzed under this SPEA is the proposed continuation of SWFSC fisheries research activities funded by NOAA. The purpose of SWFSC fisheries research is to produce scientific information necessary for the management and conservation of living marine resources in the NMFS West Coast Region. SWFSC's research is needed to promote both the long-term sustainability of the resource and the recovery of certain species, while generating social and economic opportunities and benefits from their use. Each of the research activities requires specific authorizations or permits including an authorization under the MMPA. Federal funding for research and the MMPA authorization for research activities described in Chapter 2 are components of the federal action covered under this supplemental NEPA review.

1.4 Project Area

For purposes of this SPEA, the Project Area is defined as the area within which all direct and indirect effects of the Project may occur. The SWFSC conducts research and provides scientific advice to manage fisheries and conserve protected species in three areas that comprise the Project Area: the California Current Research Area (CCRA) along the U.S. West Coast, throughout the ETP Ocean, and in the Southern Ocean off Antarctica (Antarctic Research Area or ARA)(Figure 1-1).

1.5 Public Review and Comment

Federal agencies are required to involve agencies, applicants, and the public in the NEPA process (40 CFR Sec. 1501.4 [b]). Guidance for the public review process for the 2015 PEA and this SPEA is found in Section 7B of *Policy and Procedures for Compliance with the National Environmental Policy Act - Companion Manual for NOAA Administrative Order (NAO) 216-6A*[5]. A notice of availability (NOA) for the Draft SPEA was published in the *Federal Register* on May 11, 2020 (85 FR 27719), and the documents were made available on the internet. The NOA of the proposed MMPA regulations was published in the *Federal Register* on May 8, 2020 (85 FR 27388).

There was only one public comment on the Draft SPEA during the comment period. Substantive comments requested NMFS to consider the impacts of fishing gear entanglements, potential acoustic disturbance from echosounders on killer whale prey and the potential for sea turtles to become entangled in research gear. These comments have resulted in revisions to the SPEA which are reflected in this Final version (see Sections 4.3.2 Effects of Future SWFSC Research and 5.2.3.2 Cumulative Effects).

[5] https://www.nepa.noaa.gov/docs/NOAA-NAO-216-6A-Companion-Manual-03012018.pdf

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2 DESCRIPTION OF ALTERNATIVES

The 2015 PEA (NMFS 2015a) evaluated four alternatives for fisheries research ranging from no action to a full suite of research activities and mitigation measures. The 2015 PEA Preferred Alternative (referred to in the 2015 PEA as Alternative 2) was chosen and provided the framework under which fisheries research has been conducted since 2015. In Section 2.6, the 2015 PEA describes three alternatives that were considered, but were determined to not meet the purpose and need and were not brought forward for analysis. This action is supplemental to the original evaluation in 2015; therefore, alternatives dismissed previously are not considered further for the same reasons explained in the 2015 PEA.

The range of alternatives evaluated in this SPEA present the status quo/no action (i.e., current research) as Alternative 1 while Alternative 2 presents modifications to current research or new research activities that are planned for the future (i.e., 2020 – 2025). New future research proposed under Alternative 2 was not previously analyzed in the 2015 PEA. Table 2-1 provides a brief summary of research surveys by type or gear for a simple comparison of alternatives. Table 2-2 provides a more detailed description of each survey proposed under the alternatives including survey description, area of operation, specific gears proposed, number of estimated Days At Sea (DAS), and number of sampling tows. Appendix A provides a detailed description of the types of gear and vessels that may be used during research. Appendix A is not intended to be a comprehensive or specific list, rather, the gear and vessels described would be the same or very similar to those used during research such that any potential effects of their use would be commensurate to the evaluation presented in this SPEA.

2.1 Alternative 1: Status Quo/No Action (2015-2018 Research)

The range of alternatives evaluated in this SPEA must achieve the objectives of the proposed action as described in Section 1.3, Purpose and Need. The alternative must not violate any of the minimum environmental standards listed in Chapter 1, Table 1-1. The purpose and need also helps determine which alternatives are carried forward for analysis in the SPEA. An alternative that does not satisfy the agency’s purpose and need objectives or does not meet minimum environmental standards is not considered reasonable and would not be carried forward for evaluation. An alternative cannot be arbitrarily dismissed from further analysis; justification must be provided for elimination of an alternative from further consideration. In this case, a No Action alternative that would mean no fisheries research, would not meet the agency’s purpose and need stated in Chapter 1. Therefore, the No Action considered in this SPEA is described as the Status Quo.

The No Action or Status Quo Alternative, which must be considered according to Council on Environmental Quality (CEQ) regulations, would allow only fisheries research activities that are currently conducted under existing permits valid through 2020. New permits issued in 2020 to replace the existing permits would mirror what was permitted for research conducted from 2015 through 2020 as described in the 2015 PEA (NMFS 2015a).

Research activities, equipment, gear, sample sizes, and objectives would not change for future research conducted between 2020 – 2025.

A summary of surveys under the Status Quo alternative are shown in Table 2-1. A detailed description of surveys under each alternative, as well as gear used and average range for DAS is provided in Table 2-2.

During the 2008-2009 field seasons, SWFSC research included mitigation measures which were developed in consultation with marine mammal scientists and other protected species experts to safeguard protected species. Mitigation measures implemented under the Status Quo are described in detail in Table 2-3 and summarized briefly below:

- Continued coordination and communication with NOAA's Office of Marine and Aviation Operations (OMAO) and other relevant parties to review the mitigation measures to be implemented;
- Pre-determined vessel speeds during activities;
- Marine mammal handling procedures and record-keeping requirements;
- Visual monitoring for protected species 30 minutes prior to the deployment of gear, during deployment of gear, active fishing and gear retrieval. Use of the "move-on" rule if marine mammals are sighted within 1 nautical mile (nm) from the vessel in the 30 minutes prior to setting trawl or pelagic longline gear, or during active fishing. If protected species are observed within 1 nm of the vessel, the most appropriate response to avoid interaction with the gear is determined through the use of professional judgment of the Chief Scientist or officer on watch;
- Use of a marine mammal excluder device (MMEDs) in the NETS Nordic 264 trawl gear;
- Use of 2-4 acoustic deterrent devices, or pingers, placed on the headrope or footrope of all trawl gear;
- Consider postponing haul-back during longline surveys, if risk of interaction with marine mammals exists (see exceptions listed in Table 2-3). Chumming is prohibited.
- Protected species incidentally captured in gear are prioritized and handled accordingly.
- Continue to review identify and review potential factors influencing incidental take of protected species; and
- Continue providing the mitigation and monitoring training program for Chief Scientists and crew responsible for implementing appropriate responses to protected species interactions.

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 Officer on Deck (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.

2.2 Alternative 2: Preferred Alternative (Future Fisheries Research Beginning 2020)

Generally, this alternative includes all of the studies described in Alternative 1 (Status Quo/No Action) plus additional technologies including unmanned systems and underwater acoustic monitoring devices. Unmanned Aerial Systems (UAS) are a new method of conducting aerial surveys and complement current research objectives. UAS may be fixed wing units, rotary with vertical take-off and landing (VTOL) capabilities or hybrid fixed-wing VTOL platforms. Payload components (cameras, other sensors, collection plates, etc.) mounted on the UAS platform vary based on research objectives. The use of UAS to conduct aerial surveys will decrease costs while increasing the number of aerial surveys, and, in turn, improve population assessments (i.e., census surveys). Many of the UAS that can be used are extraordinarily quiet with sound levels equivalent to a whisper (less than 5 decibels [dB]) at 30 meters (m); these UAS operate almost silently, resulting in minimal to no disturbance to animals. UAS units may be equipped with cameras and may be rotary, fixed wing or hybrid wing aircraft. UAS may be launched from survey vessels or from shore and fly at altitudes ranging from 60 - 400 ft[6] Above Sea Level (ASL) in order to assess and photograph marine mammals. As additional information becomes available on the potential effects of using UAS, the altitude authorized for marine research may continue to be adjusted on a case-by-case basis in close coordination with NMFS Office of Protected Resources (OPR).

Ecosystem Based Fisheries Management and Stock Assessment studies conducted by the ERD using unmanned systems and the Collaborative Optical Acoustical Survey Technology (COAST) Survey conducted by the FRD (see Table 2-1) are planned in future years under this alternative. The Antarctic Living Marine Resources glider program (FREEBYRD Program) also proposes to allow broader temporal and spatial coverage than has been previously possible using ship-based at-sea surveys (under Alternative 1 Status Quo/No Action). Under Alternative 2, gliders would "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. Gliders would also collect data using various attached sensors.

Alternative 2 also includes certain modifications to surveys conducted under Status Quo/No Action. For example, the Coastal Pelagic Species (CPS) sardine survey proposes to sample nearshore areas whereas under Alternative 1 (Status Quo/No Action), depths greater than 50 m have been surveyed. A commercial purse seine vessel (PSV) is also proposed to 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; validation of acoustic data and additional biological samples will enhance SWFSC's ability to improve its stock assessment for Pacific sardine and other CPS. Purse seines may also be used to conduct other surveys within the Action Area under Alternative 2. For example, when putative CPS schools are observed in the echogram along a transect, Lisa Marie will finish surveying the transect, then use a purse seine net to sample the sizes and species composition of the CPS in the area. Lisa Marie will set, on average, three times per day (excluding the first and last day), each time for ~60 minutes. This strategy should provide data from ~60 sets. In coordination with Lasker, some CPS schools will be sampled at night for comparative species composition between gears (trawl versus purse seine). For day-night comparisons, the Lisa Marie will set approximately four times per 24-hour period, each time for ~60 minutes to be repeated five days (a minimum of two sets before sunset and then after sunset). This strategy should provide data from at least 20 sets over the course of the study. A number of these sets will be done in the vicinity of the Lasker. The Highly Migratory Species (HMS) survey proposes to use hook and line gear rather than only longline gear (as under Status Quo/No Action) to target HMS species.

The Juvenile Salmon Survey conducted in the California Current Ecosystem may also include the use of micro-trolling (hook and line) sampling in combination with unmanned aircraft to collect hydro-acoustic and physical oceanographic data. Under Status Quo/No Action, SWFSC collected life history and reproductive data on sablefish whereas new research proposes to focus more on rockfish (*Sebastes*) species.

[6]Permit 19091 Modification 9 issued by NMFS OPR on March 27, 2018 permitted flying UAS at altitudes as low as 60 ft for cetacean research. On August 21, 2019, Permit 19091 Modification 25 issued by NMFS OPR authorizes flying a hybrid-wing UAS up to 400 ft ASL for cetacean research.

This alternative also includes additional U.S. participation in international Antarctic research. Research 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. Work in territorial waters does not require authorization under the MMPA or ESA. Instead, NMFS must follow the applicable laws of the lead country. For example, SWFSC's collaborative work undertaken with New Zealand in Antarctica is permitted by New Zealand authorities. 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. EO12114 also exempts activities that would not result in significant effects on the environment. Much of the fisheries and ecosystem research proposed under Alternative 2 are likely to be exempt under EO 12114 considering their negligible effect on the environment (see Chapter 4 Environmental Consequences).

As described in the 2015 MMPA final rule (80 Federal Register [FR] 58981), SWFSC may propose modifications to mitigation and monitoring measures implemented during research conducted between 2015 and 2019 "…if new data suggests that such modifications would have a reasonable likelihood of reducing adverse effects to marine mammals and if the measures are practicable." The following mitigation measures are proposed as modifications to measures currently implemented under Alternative 1 Status Quo. Mitigation measures by alternative and by gear type for Alternatives 1 and 2 are presented below in Table 2-3.

Trawl Surveys:

- Visual monitoring for protected species 15 minutes prior to the deployment of gear, during deployment of gear, active fishing and gear retrieval. Use of the "move-on" rule if marine mammals (with the exception of baleen whales) are sighted within 1 nautical mile (nm) from the vessel in the 15 minutes prior to setting trawl or pelagic longline gear, or during active fishing. If protected species are observed within 1 nm of the vessel, the most appropriate response to avoid interaction with the gear is determined through the use of professional judgment of the Chief Scientist or officer on watch;

Pelagic Longline Surveys:

- Visual monitoring pre-clearance period (15 minutes) same as for trawl surveys.

TABLE 2-1. SUMMARY OF RESEARCH BY ALTERNATIVE INCLUDING NEW PROPOSED ACTIVITIES UNDER ALTERNATIVE 2

Research Method	Alternative 1 No Action, Status Quo	Alternative 2 Future Research (Preferred Alternative)
Surveys Using Trawl Gear	● CPS Survey ● Pacific Coast Ocean Observing Program (Northern and Central California) ● Rockfish Recruitment and Ecosystem Assessment Survey -midwater trawls ● Juvenile Salmon Survey	● CPS Survey ***including nearshore*** ● All other surveys same as Alt 1
Purse Seine Surveys	● Purse Seine Survey	● Purse Seine Survey as described under Alternative 1 plus the addition of ***nearshore areas in conjunction with CPS Survey***
Longline Surveys	● HMS Surveys	● HMS Surveys ***including new gear (deep set buoy gear, troll and hook and line) for any HMS species***
Hook and Line and/or Rod and Reel Surveys	● Genetics Physiology and Aquaculture ● Life History and Reproductive Ecology Investigations of Rockfish	● Life History and Reproductive Ecology Investigations of Rockfish ***including new target species, such as Sebastes species, using hook and line or other gear (i.e., shrimp flies on 20-40-pound braided spectra line)*** ● Juvenile Salmon Survey ***including the use of micro-trolling (hook and line) and unmanned systems*** ● ***Opportunistically during CalCOFI and CPS surveys to target HMS species using angler hook and line gear (80+ pound line with barbed or unbarbed lures).*** ● All other surveys same as Alt 1
Unmanned Systems including Remotely Operated Vehicles (ROVs)	● California Current Ecosystem (CCE) spring and summer surveys conducted with available ship time ● White Abalone Study using ROV ● California Current Deep Sea Coral and Sponge Assessment ● Antarctic Living Marine Resources Program (FREEBYRD) ● Antarctic Living Marine Resources Program (Seabirds) - Land-based surveys using UAS and telemetry	● Antarctic Living Marine Resources Program (FREEBYRD) ***using various types of autonomous underwater vehicles, such as gliders, deployed for longer periods and greater depths*** ● **Juvenile Salmon Survey *including the use of unmanned systems*** ● COAST Survey *using unmanned systems* ● Ecosystem Based Fisheries Management and Stock Assessment ***including Monterey Bay or other regions within the California Current*** ● All other surveys same as Alt 1
Multi-gear Surveys	● California Cooperative Oceanic Fisheries Operations (CalCOFI) Winter, Spring, Summer and Fall Survey ● Humboldt State University Cooperative Fisheries Oceanography Research Team: Trinidad Headlines	● Same as Alt 1

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TABLE 2-2. DETAILED DESCRIPTION OF ALTERNATIVES BY SURVEY INCLUDING AREA OF OPERATION, FREQUENCY OR DAYS-AT-SEA, GEAR USED, AND NUMBER OF SAMPLES OR TOWS WITH *NEW PROPOSED RESEARCH INDICATED IN BOLD ITALICS*

Survey Name	Survey Description	Area of Operation	Season/Frequency/Days at Sea (DAS)	Gear Used	# Samples/Tows
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); and June-September; DAS: 80 (nearshore study using an industry fishing vessel)	NETS Nordic 264 Trawl two-warp rope trawl	50 tows, of which 3-4 tows occur 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 (i.e., 80-pound line with barbed or unbarbed hooks) and hand lines with tuna trolls.	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
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 (i.e., 80-pound line with barbed or unbarbed hooks) with tuna troll lures	100-500 casts per cruise
				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	# Samples/Tows
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
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 areas;*** 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
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	

Survey Name	Survey Description	Area of Operation	Season/Frequency/Days at Sea (DAS)	Gear Used	# Samples/Tows
Highly Migratory Species Surveys	Cooperative survey with Pfleger Institute of Environmental Research, CDFW, 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 Deep Set Buoy***	***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 leaders with a crimped 18/0 circle hook***	***Up to three hooks per gear with a max of 10 individual pieces deployed at one time***.
				Pelagic longline General: 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. Specific: Blue and mako sharks - Drift longline with vessel attached to one end of mainline or mainline suspended free between two radio buoys Swordfish and Opah: - 250 hooks baited with mackerel spread over 2-10 miles.	Soak time 2-4 hrs Blue and mako sharks: 2 sets/day; 200 hooks; soak time: 2-4 hours; < 30 sets. HMS: 100 hooks baited with mackerel. 2 sets/day; soak time: 2-4 hours; <30 sets; Swordfish and Opah: <100m depth sets will be conducted at night and >100m depth sets will be conducted during the day. Soak time: 4-6 hours; <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	# Samples/Tows
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
Juvenile Salmon Survey	Cooperative with Oregon State University, UC Santa Cruz, MBARI (Autonomous Underwater Vehicles [AUV] deployment), Moss Landing Marine Laboratory, UC Davis. 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)[1]	***50 tows (of micro-troll gear)***
				Multi-frequency single beam active acoustics	Continuous
				Unmanned system	Continuous
				Acoustic Tags	
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 status quo focuses on sablefish.***	California Current Ecosystem	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 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

Survey Name	Survey Description	Area of Operation	Season/Frequency/Days at Sea (DAS)	Gear Used	# Samples/Tows
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	
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. Note: the AZFP is considered a Category 1 source, indicating the lowest level of acoustical impact.	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 occupied from December - March each year, and Copacabana field camp occupied from January into early February each year	UAS, telemetry	
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.). This research is permitted by New Zealand authorities.	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	

[12]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

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TABLE 2-3. MITIGATION MEASURES BY ALTERNATIVE AND GEAR TYPE

Gear Type	Alternative 1 No Action, Status Quo	Alternative 2 Increased Research (Preferred Alternative)
General Measures Applicable to All Surveys	● Coordination and Communication: In advance of each survey, coordination with the NOAA 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. Chief scientist (CS) to coordinate with OOD or equivalent to ensure procedures are understood. ● Vessel speed: if vessel crew or dedicated 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; 2) take action to increase the animal's chance of survival; and 3) 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 30 minutes prior to arrival on station. Scan the surrounding waters with the naked eye and range-finding binoculars. ● "Move-on" rule. If any marine mammals (with the exception of baleen whales) are sighted within 1nm or sea turtles are sighted anywhere around the vessel in the 30 minutes before setting the gear, transit to a new location to maintain distance from sea turtles and a distance of 1 nm from the animal. If after moving, marine mammals remain within the 1nm exclusion zone or sea turtles are still at risk of interaction, the vessel may move on or skip the station. ● Conduct trawl operations upon arrival on station (after the 30-minute pre-watch) to the extent practicable. ● Continue visual monitoring while gear is deployed. If marine mammals or sea turtles 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.	● Initiate marine mammal and sea turtle watches no less than 15 minutes prior to arrival on station. ● Conduct standard tow durations of no more than 45 minutes at target depth for distances less than 3 nm. SWFSC will continue to investigate ways to better understand marine mammal-trawl gear interactions to the extent possible. ● All other mitigation measures same as Alt 1.

Gear Type	Alternative 1 No Action, Status Quo	Alternative 2 Increased Research (Preferred Alternative)
Surveys Using Trawl Gear, cont'd.	• Aside from the minimum 30-minute pre-trawl watch, the OOD/CS and crew standing watch will visually scan for marine mammals and sea turtles during all operations. • If trawling is suspended due to the presence of marine mammals or sea turtles, 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 30 minutes at target depth for distances less than 3 nm. • Empty gear as quickly as possible to ensure no marine mammals are entangled. • Standard tow durations have been reduced to 30 minutes or less at targeted depth, excluding deployment and retrieval time, to reduce the likelihood of attracting and incidentally taking protected species. These short tow durations decrease the opportunity for curious marine mammals to find the vessel and investigate. The resulting tow distances are typically 1 to 2 nautical miles, depending on the survey and trawl speed. • Nordic 264 trawl nets will be fitted with Marine Mammal Excluder Devices (MMEDs). Due to its similar configuration to turtle excluder devices, the excluder device may also be effective at reducing sea turtle capture and mortality in mid-water trawls. • Deploy 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 m, tones ranging from 100 milliseconds (ms) to seconds, variable frequency of 5 – 500 kHz, and maximum source level of 176 dB root mean square (rms) re 1 microPascal (μPa) at 30-80 kilohertz (kHz).	

Gear Type	Alternative 1 No Action, Status Quo	Alternative 2 Increased Research (Preferred Alternative)
Purse Seine Surveys	● During purse seine surveys, the crew keep watch for marine mammals and sea turtles before and during sets. If an observer is on board, the observer informs the chief scientist and captain of any marine mammals or sea turtles detected near or at the sampling station. ● 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 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 net may be set. ● If any dolphins or porpoises are observed within about 1 nm of the vessel, the net will not be set until the animals move further away. If any dolphins or porpoises are observed in the net, the net will be immediately opened to let the animals go. ● If killer whales are seen at any distance, the net will not be set and the move-on rule is applied.	● If any dolphins or porpoises are seen within 500 m of the vessel, the move-on rule is applied. If any cetaceans are seen within the net it is opened immediately.. ● All other measures same as Alternative 1
Longline Surveys, and Hook and Line and/or Rod and Reel Surveys	● Conduct visual monitoring as described for trawl surveys. ● With one exception, haul-back may be postponed if marine mammals or sea turtles are believed at risk for interaction. If five or fewer California sea lions are sighted within the 1 nm exclusion zone during the 30-minute pre-clearance period, longline gear may be deployed. ● If marine mammal or sea turtle interactions with longline gear increase possibly due to discarding bait, consider retaining spent bait until all gear is retrieved. Chumming is prohibited.	● Initiate marine mammal and sea turtle watches no less than 15 minutes prior to arrival on station. ● All other mitigation measures same as Alt 1.
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.	

Gear Type	Alternative 1 No Action, Status Quo	Alternative 2 Increased Research (Preferred Alternative)
Unmanned Aerial Systems (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 feet (ft)[1] above ground level 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 and in accordance with applicable sections of NOAA's UAS Policy 220-1-5 (NOAA 2019).	
Handling Procedures for Incidentally Captured Individuals	● Captured live or injured marine mammals are released from research gear and returned to the water as soon as possible with no gear or as little gear remaining on the animal as possible. Animals are released without removing them from the water if possible. Data collection is conducted in such a manner as not to delay release of the animal(s) and should include species identification, sex identification if genital region is visible, estimated length, disposition at release (e.g., live, dead, hooked, entangled, amount of gear remaining on the animal, etc.) and photographs. The Chief Scientist or crew should collect as much data as possible from hooked or entangled animals, considering the disposition of the animal; if it is in imminent danger of drowning, it should be released as quickly as possible. Biological samples could only be collected in accordance with section 109(h)(1) of the MMPA for live/dead marine mammals (non-listed) or under a directed scientific research and enhancement permit such as 19091-01 issued to AERD. ● If a large whale is alive and entangled in fishing gear, the vessel should immediately call the U.S. Coast Guard (USCG) at VHF Ch. 16 and/or the appropriate Marine Mammal Health and Stranding Response Network. Entangled whales may be reported to the NOAA Fisheries entanglement reporting hotline (1-877-767-9425). ● SWFSC will take appropriate measures to handle and release these individuals while minimizing injury to sea turtles and damage to their gear, consistent with the procedures set out in 50 CFR § 223.206(d)(1). If practicable, SWFSC crew will measure, photograph, and apply flipper and passive integrated transponder (PIT) tags to any live sea turtle, and salvage any carcass or parts or collect any other scientifically relevant data from dead sea turtles, per authorization in 50 CFR § 222.310 (endangered) and § 223.206 (threatened) regarding the handling of ESA-listed sea turtles by designated NMFS agents. For additional detail, please refer to Section 1.3.4.4.2 of the 2015 BiOp.	

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

3 AFFECTED ENVIRONMENT

Chapter 3 of the 2015 PEA provides a comprehensive summary of physical, biological and socioeconomic resources that characterize the affected environment within the Project Area. As a supplement to the 2015 PEA, this section describes updates to only those resources of the environment that have exhibited a change in status or condition, or that may be affected by the new proposed research activities that were not previously considered in the 2015 PEA. At the beginning of each resource category, a summary table provides references to the sections of the 2015 PEA where detailed information about resources is described. The summary tables also indicate whether any changes to resources since publication of the 2015 PEA are relevant for this evaluation of proposed fisheries and ecosystem research. In other words, if a change in the physical, biological or socioeconomic environment could result in conclusions different from those presented in the 2015 PEA, an update to those resources is presented in this chapter. A discussion of potential impacts of proposed research alternatives on the affected environment (i.e., resources) is presented in Chapter 4.

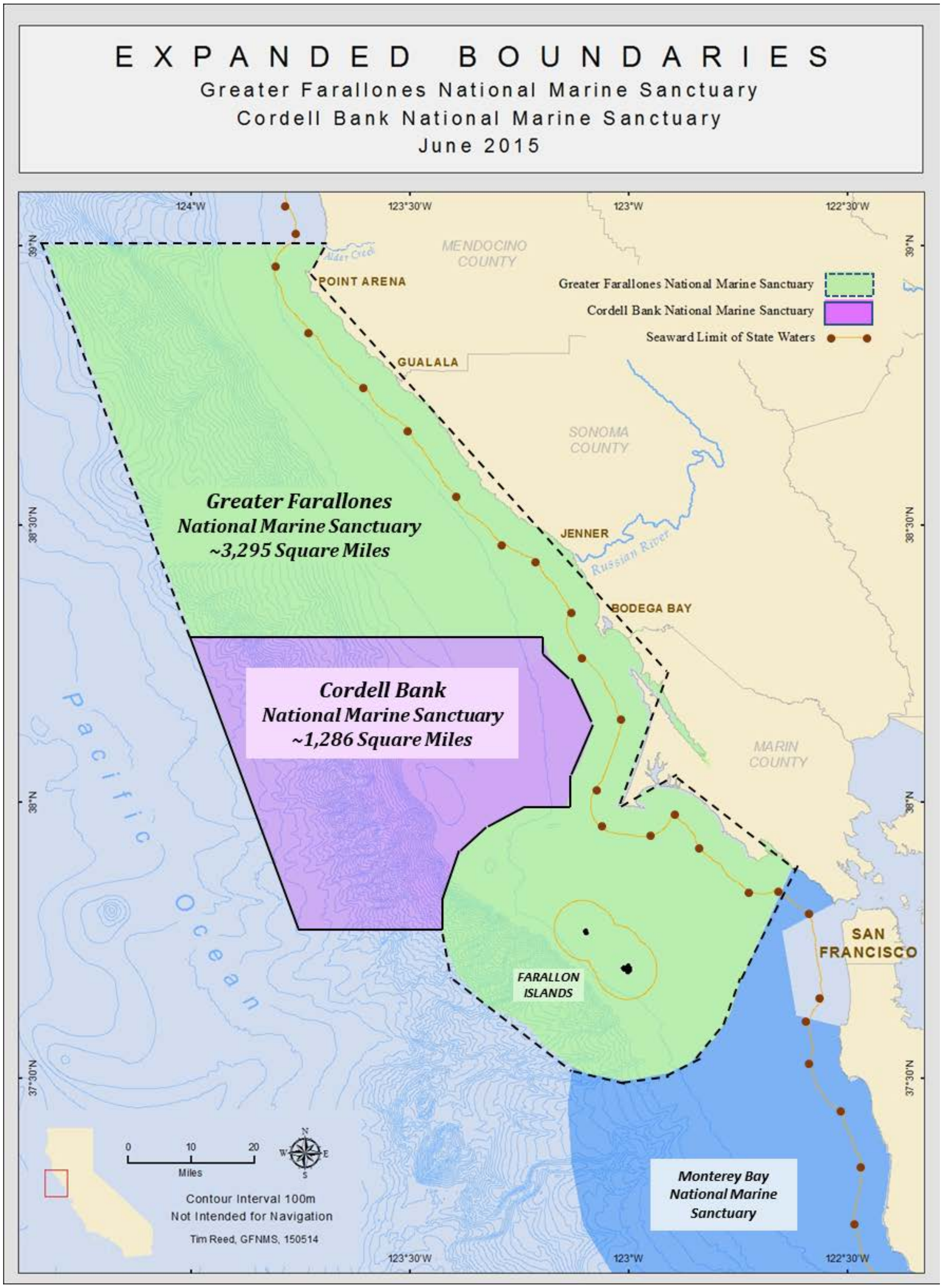
3.1 Physical Environment

The geographic areas and physical environments potentially affected by SWFSC research surveys are located throughout the Pacific Ocean and in the Southern Ocean off Antarctica. These areas are described in Section 3.1 of the 2015 PEA, and include the California Current, Eastern Tropical Pacific Ocean, and Antarctic ecosystems. SWFSC research surveys occur both inside and outside the U.S. EEZ and sometimes span across multiple ecological, physical, and political boundaries. Since 2015, there have been changes to a few special resource areas within the Project Area, which are summarized in Table 3-1 and briefly described in this section.

3.1.1 Sanctuary Boundary Expansion

In March 2015, NOAAs National Marine Sanctuary Program published a final rule that expanded the Greater Farallones National Marine Sanctuary (NMS) and Cordell Banks NMS from approximately 3,394 square kilometers (km^2) to approximately 8,544 km^2 (80 FR 13078) (see Figure 3-1). The final rule published on March 12, 2015 expanded the area for discharge requirements with regard to USCG activities, starting on the day when the remainder of the final rule became effective. The SWFSC fisheries research activities would have no substantial impact on these changes in sanctuary boundaries. As part of the permit, if the SWFSC intends to enter a sanctuary to conduct research they are/it is required to notify the Sanctuary Program. The greater extent of the Cordell Banks NMS and Greater Fallarones NMS boundaries increases the area that must be considered by SWFSC in terms of determining whether research would be located within or outside the sanctuaries (i.e., in terms of seeking permission to enter), but does not change the administrative or regulatory responsibilities of the SWFSC. Since this change is primarily administrative and relates to regulatory responsibilities of the SWFSC, this action is not discussed further.

FIGURE 3-1. 2015 NATIONAL MARINE SANCTUARY BOUNDARY EXPANSION: GREATER FARALLONES AND CORDELL BANK



3.1.2 Revision to Pacific Coast Groundfish EFH

On June 11, 2019, the PFMC proposed Amendment 28 to the Pacific Coast Groundfish FMP (84 FR 27072; August 10, 2019). Amendment 28 went into effect in January 2020 to re-open areas closed to bottom trawling to rebuild previously overfished groundfish stocks and would establish new and revised areas closed to bottom trawling to conserve and protect Pacific coast groundfish EFH. Together, these two changes are expected to increase protections for groundfish EFH and provide additional flexibility to participants fishing with bottom trawl gear in the Groundfish Trawl Rationalization Program. Deep-water areas (>3,500 m) off the California coast would also close to bottom contacting gear to protect deep-water habitats, including deep-sea corals (84 FR 27072). Little to no fishing with bottom gear occurs in this area at present; however, Amendment 28 prevents future fishing with bottom-contacting gear in sensitive deepwater areas.

TABLE 3-1. PHYSICAL ENVIRONMENT STATUS SUMMARY

Special Resource Area	2015 PEA Section Reference	SPEA Evaluation Required? (Yes/No)	Reference	Description
Essential Fish Habitat	3.1.2.1	Yes	84 FR 27072	NMFS proposed Amendment 28 to PFMC Groundfish FMP on June 11, 2019, to reconfigure closed areas to groundfish EFH conservation area boundaries. The combination of new and revised EFH conservation areas and the reopening of trawling in selected areas is anticipated to minimize adverse impacts to groundfish EFH from the effects of fishing. Any potential impacts due to this change are expected to be beneficial.
Habitat Areas of Particular Concern	3.1.2.4	No	n/a	n/a
Closed Areas	3.1.2.3	Yes	84 FR 27072	See EFH section above.
Marine Protected Areas	3.1.2.4	No	n/a	n/a
National Marine Sanctuaries				
Olympic Coast	3.1.2.4	No	n/a	n/a
Cordell Banks Greater Farallones	3.1.2.4	Yes	80 FR 13078	While on March 12, 2015, the boundaries of both sanctuaries were expanded, this change does not result in impacts due to proposed alternatives (see Section 3.1).
Monterey Bay	3.1.2.4	No	n/a	n/a
Channel Islands	3.1.2.4	No	n/a	n/a

NMFS previously conducted an extensive analysis of the impacts of SWFSC fisheries research activities in the 2015 PEA, which includes those research activities being considered under Alternatives 1 and 2 of this SPEA. The 2015 PEA addressed all physical environmental resources under the responsibility and jurisdiction of NMFS (as identified in Table 3-1) that had the potential to be affected by the proposed and alternative actions at that time. Chapter 4 of this SPEA will address any new or different issues that were not identified in the 2015 PEA.

3.2 Biological Environment

3.2.1 Fish

Finfish species that occur within the three SWFSC research areas are described in detail in Section 3.2.1 of the 2015 PEA. The following subsections focus only on species that have had changes since 2015 (i.e., biologically or in terms of management) and thus require evaluation in this SPEA given proposed research described in Chapter 2.

Since the potential effects of sound on fish species present in SWFSC research areas involve analysis of the manner in which sound interacts with the physiology of fish and their potential responses to sound, general information about sound and fish is provided in this subsection. Potential effects of sound on marine mammal species is provided in Chapter 4, Sections 4.3.1.2, 4.3.2.2. 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” (Discovery of Sound in the Sea [DOSITS] 2019).

The sound level of a region is defined by the total acoustical energy being generated by known and unknown sources. In general, ambient sound levels tend to increase with increasing wind speed and wave height. Precipitation can be an important component of total sound at frequencies above 500 Hertz (Hz) and possibly down to 100 Hz during quiet times. Some fish and snapping shrimp can contribute significantly to ambient sound levels, as can marine mammals. The frequency band for biological contributions is from approximately 12 Hz to over 100 kHz. In deep water, low-frequency ambient sound from 1-10 Hz mainly comprises turbulent pressure fluctuations from surface waves and the motion of water at the air-water interface. At these frequencies, sound levels depend only slightly on wind speed. Between 20-300 Hz, distant ships transiting dominates wind-related sounds. Above 300 Hz, the ambient sound level depends on weather conditions, with wind- and wave-related effects mostly dominating the soundscape. Vessel noise typically dominates the total ambient sound for frequencies between 20 and 300 Hz. In general, the frequencies of anthropogenic sounds are below 1 kHz and, if higher frequency sound levels are created, they attenuate rapidly.

Physiological effects of noise on fish includes potential auditory distortion however, this type of effect has been associated with underwater sound sources not used during SWFSC surveys such as seismic air guns or pile driving (Lokkeborg *et al*. 2012). Schools of sprat and Atlantic mackerel have been shown to response to sound pressure levels 163.2 and 163.3 dB peak-to-peak, respectively, approximately 50% of the time when exposed. Daytime exposure when fish were aggregated into schools initiated a response to sound, but these fish did not respond at night, when fish schools were broken up and individual fish were dispersed (DOSITS 2019).

High frequency scientific echosounders such as the EK60 or EK80 used during SWFSC research are increasingly being used to measure top predator habitat and predator-prey relationships (Risch *et al*. 2017). Echosounders have variable source levels typically ranging between 185 dB to 230 dB re 1µPa at 1m. Most fishes do not hear in the frequencies used by echosounders with the exception, possibly, of some species in the herring family which have been shown to respond to frequencies up to 200 kHz (DOSITS 2019). Changes in fish behavior due to sounds might range from momentary awareness of the sound, to small movements, or escape responses. The degree of behavioral response would indicate how significant it may be on a particular fish species or individual and may not be biologically significant (DOSITS 2019).

Fish may also respond to approaching vessels by diving towards the seafloor or moving horizontally out of the vessel’s path; however, the variable stimuli these fish may react to are not always clear (Kaplan and Mooney 2015; as cited in Popper *et al*. 2019). There may be some frequency overlap between vessel noise and fish hearing, resulting in masking sounds vital to important biological functions such as feeding or territorial defense. Many studies on vessel noise and fish behavior reported in Popper *et al.* (2019) reported some evidence of changes in behavior however, these studies were of areas where vessel traffic was likely more frequent than SWFSC surveys would occur (i.e., in areas where regular recreational or commercial traffic occurs). Kaplan *et al*. (2016 as cited in Popper *et al*. 2019) emphasized the need for both targeted and long-term acoustic monitoring studies to evaluate the potential for effects of noise on aquatic organisms, including fish.

3.2.1.1 Fish Species Listed Under the Endangered Species Act

The 2015 PEA describes six non-salmonid fish species listed under the ESA that occur within the Project Area (Table 3-2). In addition, the eastern Pacific DPS of scalloped hammerhead shark was listed under the ESA in 2014 and was not discussed in the 2015 PEA. Twenty-eight species of salmon and steelhead trout listed under the ESA are also found largely in the Project Area of the CCRA. Table 3-2 and the species descriptions that follow summarize recent status reviews and regulatory actions for ESA-listed species that have occurred since publication of the 2015 PEA and the BiOp for SWFSC fisheries research[7]. As required for compliance with the ESA, all species listed as threatened or endangered that occur within the Project Area are evaluated for potential effects as presented in the Biological Opinion that accompanies the SPEA. However, this does not mean all ESA-listed species require evaluation under the SPEA proposed alternatives; they will only be evaluated if the scope of activities has the potential to affect those species (as indicated in Table 3-2 *Description* column).

[7]The list of ESA-listed Pacific salmonids taken from NMFS (2015) and the ESA Section 7(a)(2) Biological Opinion on the Prosecution of Fisheries Research Conducted and Funded by the Southwest Fisheries Science Center; Issuance of a Letter of Authorization under the Marine Mammal Protect Act for the Incidental Take of Marine Mammals Pursuant to those Research Activities; and Issuance of a Scientific Research Permit under the Endangered Species Act for Directed Take of ESA-Listed Salmonids, NMFS Consultation Number: 2015-2455. Dated August 31, 2015.

3.2.1.1.1 ESA-listed Fish Species With Changes in Status Since the 2015 PEA

The following information provides additional detail on the changes in status for three species of Puget Sound rockfish, the eastern Pacific DPS of scalloped hammerhead shark, and ESA-listed salmonids and steelhead trout listed in Table 3-2. With the exception of Chinook salmon, the changes in status described below do not require additional evaluation under the SPEA alternatives as the scope of research is not expected to result in different conclusions from those that were presented in the 2015 PEA.

For the 28 ESA-listed Pacific salmon and steelhead trout species, NMFS completed five-year status reviews in 2016. The reviews found that no species warranted a change in listing status at this time. However, considering that anticipated levels of take for several ESUs and DPSs of ESA-listed salmon and steelhead were exceeded during SWFSC research surveys conducted 2015 - 2018, the proposed research alternatives in this SPEA will evaluate potential impacts to specific ESUs of salmon and DPSs of steelhead that may be incidentally caught as bycatch. Chapter 4 of this SPEA presents the analysis used to determine which salmon ESUs may have been incidentally caught during surveys 2015 - 2018.

<u>Pacific eulachon, Southern DPS</u>: The southern DPS of eulachon occurs in Puget Sound, Willamette and Lower Columbia rivers, and along the Oregon and Southern Oregon/Northern California Coasts. The ESA-listed population of eulachon includes all naturally-spawned populations that occur in rivers south of the Nass River in British Columbia to the Mad River in California. In late winter and early summer, eulachon migrate from the ocean to spawn in their natal streams. Spawning usually occurs at night in lower reaches of large rivers such as the Fraser and Columbia rivers, and historically, the Klamath River. While movements of eulachon in the ocean are poorly known, the amount of eulachon bycatch in the pink shrimp fishery may indicate an overlap in the distribution of the fishery with eulachon in the ocean. In 2011, monitoring programs for eulachon were undertaken to gather better information on species abundance which is currently data poor. Anecdotal information indicates that compared to historical eulachon runs which were quite large, current numbers have severely declined with an estimated 19 million fish returning to spawn in the lower Columbia and Fraser rivers in 2011 (NMFS 2012b as cited in NMFS 2015b). A Recovery Plan for the southern DPS of Pacific eulachon was completed in 2017.

<u>Scalloped Hammerhead Shark, Eastern Pacific DPS</u>: The eastern Pacific DPS of scalloped hammerhead shark was listed as endangered in November 2015. This determination was based on the best scientific information available including the following information from the *Scalloped Hammerhead Shark Status Report* (Miller *et al*. 2014). The core range of this DPS generally occurs off the coasts of Mexico and within the Gulf of California, an area entirely outside of U.S. jurisdiction. However, a few individuals have been observed north of this area following strong El Nino events. In southern California waters 26 scalloped hammerhead sharks have been caught since 1977 (Miller *et al*. 2014). Therefore, individuals in U.S. waters are considered rare vagrants outside their normal range (Miller *et al*. 2014). Given these findings, Miller *et al*. (2014) and the NMFS final ruling (80 FR 71774, November 17, 2015) concluded that there are no geographical areas occupied by the eastern Pacific DPS that were within the jurisdiction of the U.S. at the time of the listing.

TABLE 3-2. SUMMARY OF CHANGES TO ESA-LISTED FISH SPECIES WITHIN THE PROJECT AREA SINCE THE 2015 PEA AND BIOLOGICAL OPINION

ESA-listed Fish[1]	2015 PEA Section Reference	SPEA Evaluation Required? (Yes/No)	References	Description
Green Sturgeon, southern DPS (Threatened [T])	3.2.1.1	No	NMFS 2018a Moser *et al.* 2016	No change in ESA-listed status or critical habitat. Recovery Plan completed 2018 and publication of species information in. No changes to species' status that require further evaluation under SPEA alternatives.
Pacific Eulachon, southern DPS (T)	3.2.1.1	Yes	NMFS 2016b NMFS 2017b	No change in ESA status or critical habitat recommended. Recovery Plan completed September 2017. In 2019, for the first time, SWFSC research incidentally caught 58 Pacific eulachon. The estimated take limit for eulachon was 25 individuals or 1 kg. Therefore, the potential effects of research are considered further under the SPEA alternatives.
Totoaba (Endangered [E])	3.2.1.1	No	n/a	No change in ESA-listed status. Critical habitat not designated. No changes to species' status that require further evaluation under SPEA alternatives.
Boccaccio (E), Puget Sound DPS Yelloweye Rockfish (T), Puget Sound DPS Canary Rockfish (T)	3.2.1.1	No	NMFS 2017c 79 FR 68041 NMFS 2016c 82 FR 7711	No change in ESA-listed status for boccaccio or yellow-eye rockfish. Recovery plan for Puget Sound DPSs of these species completed October 13, 2017. Critical habitat was designated for the three species on February 11, 2015. Five-year ESA status review and final rule that the Puget Sound/Georgia Basin canary rockfish no longer meets the definition of a distinct DPS and should be de-listed. The Puget Sound DPS was de-listed on January 23, 2017. Canary rockfish are still listed as threatened range wide. These changes do not warrant additional evaluation under the SPEA alternatives.
Scalloped Hammerhead Shark, Eastern Pacific DPS (E)	n/a	No	79 FR 38213 80 FR 71774	Eastern Pacific DPS was listed as endangered on July 3, 2014. Despite this change in status, additional evaluation under the SPEA alternatives is not necessary given the scope of proposed research. Critical habitat has not been designated (November 17, 2015).
Gulf Grouper (E)	n/a	Yes	81 FR 75545	Due largely to overfishing and overall reduction in numbers and range, a final rule listing the grouper as endangered was published on October 20, 2016. This species was not analyzed in the 2015 PEA therefore, analysis under proposed SPEA alternatives is warranted.
Giant Manta Ray (T)	n/a	Yes	83 FR 2916	NMFS received a petition to list the giant manta ray (*Manta birostris*) under the ESA (Nov. 10, 2015). Petitioners also requested that critical habitat be designated. The main threat to the giant manta ray is overutilization from commercial fishing. NMFS published a final rule to list the giant manta ray as threatened on Jan 22, 2018. Based on the best available information, NMFS also concluded that critical habitat was not determinable. This species was not analyzed in the 2015 PEA therefore, analysis under proposed SPEA alternatives is warranted.

ESA-listed Fish[1]	2015 PEA Section Reference	SPEA Evaluation Required? (Yes/No)	References	Description
Pacific Salmonid ESUs/DPSs[2,3]	3.2.1.1	Yes	81 FR 33468	ESA status reviews were announced for 17 ESUs of Pacific Salmon and 11 DPSs of Steelhead Trout (May 26, 2016). NMFS fisheries research exceeded expected take levels for one or more ESUs of listed salmon including Chinook since the 2015 PEA and Biological Opinion. Therefore, bycatch of salmon during fisheries and ecosystem research and proposed mitigation and monitoring measures are evaluated in Chapter 4 of this SPEA.
Chinook Salmon Sacramento River, winter run Central Valley, spring run California Coastal	3.2.2.1	No	NMFS 2016n NMFS 2016m NMFS 2016r	No change in ESA-listed status; additional analysis under SPEA alternatives is not warranted.
Snake River, fall spring, summer run Lower Columbia River Upper Willamette River Upper Columbia, spring run Puget Sound		Yes	NMFS 2016g NMFS 2016j NMFS 2016i NMFS 2016f NMFS 2016d	No change in ESA-listed status; however. given recent bycatch events (2016 – 2018) additional analysis under SPEA alternatives is warranted.
Chum Salmon Hood Canal, summer run Columbia River	3.2.2.1	Yes	NMFS 2016d NMFS 2016j	No change in ESA-listed status; however, given recent bycatch events (2016 – 2018) additional analysis under SPEA alternatives is warranted.
Coho Salmon Central California Coast S. Oregon/N. California Coast Oregon Coast	3.2.2.1	No	NMFS 2016p NMFS 2016l NMFS 2016k	No change in ESA-listed status; additional analysis under SPEA alternatives is not warranted.
Lower Columbia River	3.2.2.1	Yes	NMFS 2016j	No change in ESA-listed status; however. given recent bycatch events (2016 – 2018) additional analysis under SPEA alternatives warranted.
Sockeye Salmon ESUs Snake River Lake Ozette	3.2.2.1	Yes	NMFS 2016g NMFS 2016e	No change in ESA-listed status; however, given recent bycatch events (2016 – 2018) additional analysis under SPEA alternatives warranted.

ESA-listed Fish[1]	2015 PEA Section Reference	SPEA Evaluation Required? (Yes/No)	References	Description
Steelhead Trout				
South California Coast			NMFS 2016s	
South-central California Coast			NMFS 2016t	
Central California Coast			NMFS 2016q	
California Central Valley			NMFS 2016o	
North California			NMFS 2016r	
Upper Columbia River	3.2.2.1	Yes	NMFS 2016f	No change in ESA-listed status; however due to exceeding anticipated level of take in 2018, steelhead are evaluated further under the SPEA alternatives.
Snake River Basin			NMFS 2016g	
Lower Columbia River			NMFS 2016j	
Upper Willamette River			NMFS 2016i	
Middle Columbia River			NMFS 2016h	
Puget Sound			NMFS 2016d	

[1]ESA-listing Status includes Endangered (E), Threatened (T) or Candidate Species. The List of Endangered and Threatened Wildlife is found at 50 CFR 17.11
[2]Evolutionarily Significant Unit (ESU). Please also see the discussion on salmon and steelhead below.
[3]Critical habitat has been designated for all ESA-listed Pacific salmon in freshwater rivers, streams and lakes used for spawning and early life-stages and potential impacts to those habitats occurs in other ESA consultations. The Proposed Action under consideration does not occur in those freshwater areas. Therefore, freshwater habitat is not considered further in this document

Gulf Grouper: Gulf grouper live in shallow, coastal areas during their first 2 years of life, before moving on to rocky reefs and kelp beds. They are late-maturing, long-lived, top-level predators found in the Gulf of California and the eastern Pacific Ocean. Gulf grouper used to be very common in the eastern Pacific Ocean, representing approximately 45 percent of the artisanal fishery landings in 1960. However, their abundance has severely declined since the mid-20th century, primarily due to direct harvest by commercial and artisanal (i.e., small-scale, traditional) fisheries. Gulf grouper landings declined to 10 percent of the artisanal fishery landings by the 1970s, and gulf grouper now make up less than 1 percent of the fishery, and they are now considered rare in U.S. waters. The biggest threat to the species is direct harvest especially at spawning aggregation sites in the Gulf of California.

Commercial landings of gulf grouper from the Pacific Ocean (U.S. vessels fishing in Mexican waters) peaked in the early 1950s, before the population declined to near commercial extinction by 1970. Based on recent fishery independent surveys and fisheries data, the gulf grouper has not recovered and is still considered very rare in the Pacific Ocean portion of its range. All harvest of gulf grouper is currently prohibited in in U.S. waters. On July 15, 2013, NMFS received a petition to list 81 marine species or populations under the ESA, including gulf grouper. On September 23, 2015, NMFs proposed to list the gulf grouper as an endangered species (80 FR 57314). A final rule listing the grouper as endangered was published on October 20, 2016 (81 FR 72545).

Critical habitat will not be designated for gulf grouper because the geographical area occupied by the species is entirely outside U.S. jurisdiction and unoccupied areas within the U.S. jurisdiction that are essential to the conservation of the species have not been identified. Outside of a known population in Bahía Magdalena, Mexico, there is no published evidence of gulf grouper along the Pacific coast of the Baja California peninsula. Current gulf grouper distribution appears to be much more limited than their historical range.

Giant Manta Ray: On November 10, 2015, NMFS received a petition to list the giant manta ray, as threatened or endangered under the ESA throughout its range. The petitioners also requested that critical habitat be designated with the ESA listing. The main threat to the giant manta ray is commercial fishing; the species is both targeted and caught as bycatch in a number of global fisheries throughout its range. Manta rays are particularly valued for their gill rakers, which are traded internationally. Demand for the gills of manta and other *Mobula* rays has risen dramatically in Asian markets. With this expansion of the international gill raker market and increasing demand for manta ray products, estimated harvest of giant manta rays, particularly in many portions of the Indo-Pacific, frequently exceed numbers of identified individuals in those areas and is accompanied by observed declines of up to 95 percent in sightings and landings of the species.

NMFS announced a final rule to list the giant manta ray as threatened on January 22, 2018 (83 FR 2916). Based on best available information, NMFS also concluded that critical habitat was not determinable.

Pacific Salmonids: While there are no current changes in the ESA-status of Pacific salmon or steelhead trout, on October 4, 2019, NMFS announced initiation of a 5-year review of 28 ESA-listed species. The listed species comprise 17 evolutionarily significant units (ESUs) of Pacific salmon and 11 DPSs of steelhead. The purpose of these reviews is to ensure the accuracy of their listing classifications based on the best scientific and commercial data available.

During trawl surveys in 2016, 2017 and 2018, salmon and steelhead were taken incidental to fisheries research. During the CCE trawl survey off Vancouver Island on June 28, 2017 an unexpectedly large number of salmon (1,866 fish), were taken via trawl net[8] relative to the number of takes estimated in the August 31, 2015 Incidental Take Statement (ITS) (NMFS 2015c). A subsample of salmon caught as bycatch were measured and set aside for deoxyribonucleic acid (DNA) sampling. All takes occurred during nighttime trawls and consisted of a combination of juvenile and adult salmon. Based on genetic sampling, an assessment of whether these salmon were from ESA-listed populations is provided in Chapter 4. The SWFSC (NMFS unpublished) reported that 2,590 salmon were taken during trawl (CPS) surveys and another 54 salmon were taken during Rockfish Recruitment and Ecosystem Assessment Surveys between August 31, 2015 and December 31, 2018. In 2018, twelve steelhead trout were incidentally caught during trawl surveys in the CCE. Based on the assumptions described by Shelton *et al*. 2019, steelhead were determined to likely be associated with the Northern California stock based on the location of catch in proximity to natal streams. According to the 2015 Biological Opinion for the 2015 PEA, sockeye and chum stocks are generally understood to travel north in marine waters, as encounters with those species are more common in marine fisheries (both incidental or directed salmon fisheries) in areas further north.

For the purposes of assessing potential effects of SWFSC fisheries research on ESA-listed salmon, the terms species, DPS, and ESU are used in the discussion to describe specific species that may interact with research. Under the ESA, "any subspecies of fish or wildlife or plants, and any DPS of any species of vertebrate fish or wildlife that interbreeds when mature" is a species. To clarify the definition of species for Pacific salmon (*Oncorhynchus sp*.), Waples (1991) proposed a more precise definition called the evolutionarily significant unit (ESU).

3.2.1.2 Target Species

Following the definition of target species that was used in the 2015 PEA, this group includes fish which are commercially or recreationally fished, are managed under a FMP, and for which stock assessments are conducted using SWFSC-affiliated fisheries research. The 2015 PEA identified and described 13 target species encountered in the CCRA with an average research catch of over 100 kilograms per year. For the purposes of analyzing potential effects of SWFSC research on target species, this same approach is followed. Thus Table 3-3 provides information on target species for which catch exceeded 100 kilograms per year for the 2008-2012 period. For information on life history traits and habitat for each of the species please refer to the Pacific Fishery Management Council's website: https://www.pcouncil.org/.

Sampling fish species in the ETPRA is limited and has not been conducted to support stock assessments of any target species (NMFS 2015a). Marine mammal studies conducted in the ETPRA have identified some common prey species, including lanternfish, flying fish, anchovies, sardines, and herring.

Most research surveys in the ARA focus on krill. However, periodic bottom-trawl surveys have been conducted to monitor the recovery of several finfish species that had been subject to severe overfishing in the past (NMFS 2015a). Several stocks of Antarctic finfish in the Southern Scotia Arc region were decimated in the 1970s and 1980s due to unmanaged commercial harvest. The rapid declines of catch lead Convention on the Conservation of Antarctic Living Marine Resources to impose a moratorium on all finfish fishing in 1990 in order to protect the remaining fish stocks (NOAA 2011). The 2015 PEA identified the primary species caught in the SWFSC bottom trawl surveys which are presented in Table 3-3. For detailed information including life history and distribution information for these species, please refer to Van Cise (2009).

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[8] NMFS, SWFSC, 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. LaJolla, California. 19 pp.

The target species identified in NMFS (2015) and subsequent changes in status, abundance, or population trends between 2015 and 2019 (if data are available) are provided in Table 3-3. The best scientific information available is for those species collected in the CCRA. Target species have been reviewed to identify changes in stock status, abundance, or other trends that may require further discussion in this SPEA (Table 3-3). Updated information was obtained where available from NOAA stock assessment, Stock Assessment Fishery Evaluation (SAFE) reports and other commercial fishery reports, fishery management council reviews, reports of international working groups, assessments from international fishery organizations, and other scientific literature as cited. Species requiring additional evaluation under the SPEA alternatives due to status change or new technologies are proposed for use in fisheries and ecosystem research are indicated in Table 3-3.

TABLE 3-3. COMPARISON OF ASSESSMENT STATUS BETWEEN 2015 PEA AND THE SUPPLEMENTAL PEA FOR SWFSC TARGET SPECIES OF FISH

Target Fish	2015 PEA Section Reference	SPEA Evaluation Required? (Yes/No)	References	Description
California Current Ecosystem				
Chinook Salmon		Yes	ESA-listed Species Status Table 3-2 and Section 3.2.1.1.	No change in ESA-listed status; however, given recent bycatch events (2016 – 2018), additional analysis under SPEA alternatives is warranted.
Blue Shark	3.2.1.2	No	ISC 2017a	No change in status. Additional analysis under SPEA alternatives is not warranted.
Common Thresher Shark	3.2.1.2	No	Teo *et al*. 2018	No change in status. Additional analysis under SPEA alternatives is not warranted
Jack Mackerel	3.2.1.2	No	PFMC 2019	No change in status. Additional analysis under SPEA alternatives is not warranted
North Pacific Albacore	3.2.1.2	No	WCPFC 2017b	No change in status. Additional analysis under SPEA alternatives is not warranted
Northern Anchovy	3.2.1.2	No	PFMC 2019	No change in status. Additional analysis under SPEA alternatives is not warranted
Pacific Mackerel	3.2.1.2	No	Crone and Hill 2015, 2017	No change in status. Additional analysis under SPEA alternatives is not warranted
Shortfin Mako	3.2.1.2	No	ISC 2018b	No change in status. Additional analysis under SPEA alternatives is not warranted
Yelloweye Rockfish	3.2.1.2	No	ESA-listed Fish, Table 3-2	No change in status. Additional analysis under SPEA alternatives is not warranted
Pacific Swordfish, central North Pacific DPS	3.2.1.2	No	ISC 2018a	No change in status. Based on recent trend in fishing mortality, overfishing is not occurring, the stock is not in an overfished state. There are no impacts to species status that would result from impacts due to proposed alternatives.
Pacific Swordfish, eastern Pacific DPS	3.2.1.2	No	ISC 2018a	Assessment not available. Additional analysis under SPEA alternatives is not warranted.

Target Fish	2015 PEA Section Reference	SPEA Evaluation Required? (Yes/No)	References	Description
Pacific Hake	3.2.1.2	No	Berger *et al.* 2019	No change in status at this time. Recent biomass assessment indicates there is an estimated 68% chance of the spawning biomass declining from 2019 to 2020, and an 84% chance of it declining from 2020 to 2021 under current level of catch. Given the potential decline in biomass, additional evaluation of proposed SPEA alternatives is warranted.
Pacific Sardine	3.2.1.2	No	Hill *et al.* 2017	The fishery is closed due to precautionary measures built into sardine management to stop directed fishing when the population falls below 150,000 metric tons. The latest population estimate is below that level due to environmental conditions, and managers have closed the fishery. Given the decline in biomass, additional evaluation of proposed SPEA alternatives is warranted.
Eastern Tropical Pacific /Antarctic Ecosystem				
Blackfin Icefish Mackerel Icefish Humped Rockcod Grey Rockcod South Georgia Icefish Patagonia Toothfish	3.2.1.2	No	Australian Bureau of Agricultural and Resource Economics (ABARES) 2018	No change in status or status unknown. Additional analysis under SPEA alternatives is not warranted.

3.2.1.3 Prohibited and Highly Migratory Species

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

HMS are those fish species which migrate variable distances across oceans for feeding or reproduction and have wide geographic distributions. These species are pelagic and are typically found both within the 200-mile EEZ and in open oceans, although some life history stages may occur in nearshore waters. SWFSC-affiliated HMS research focuses on tunas. For additional details on HMS see the references provided in Table 3-4.

As shown in Table 3-4 there are no prohibited or HMS species identified in the PEA (NMFS 2015a) for which there have been subsequent changes in status, abundance, or population trends that warrant additional analysis beyond what was provided in the 2015 PEA considering the scope of fisheries and ecosystem research. As indicated in Table 3-4, while there is some evidence of overfishing of species, the scope of proposed fisheries and ecosystem research by SWFSC (see Chapter 2) does not warrant additional analysis of potential effects on these species beyond what is described in the 2015 PEA. Research-related impacts have not occurred to these species since the 2015 PEA; therefore, the conclusions presented in the original impact assessment in the 2015 PEA are still valid. For these reasons, these species are not discussed further in this SPEA.

TABLE 3-4. COMPARISON OF ASSESSMENT STATUS BETWEEN 2015 PEA AND THE SUPPLEMENTAL PEA FOR SWFSC PROHIBITED AND HIGHLY MIGRATORY SPECIES

Prohibited and Highly Migratory Species (HMS)	2015 PEA Section Reference	SPEA Evaluation Required? (Yes/No)	References	Description
Prohibited Species	3.2.1.3	No		
Great White Shark			NMFS 2015a	No change in status. Additional analysis under SPEA alternatives is not warranted.
Basking Shark			NMFS 2019a	No change in status. ESA Species of Concern; Endangered in Canada. Additional analysis under SPEA alternatives is not warranted.
Megamouth Shark			Kyne *et al.* 2019	No change in status or unknown. Additional analysis under SPEA alternatives is not warranted.
Pacific Halibut			Stewart and Hicks 2018	No change in status. Estimates of spawning biomass from 2018 remain consistent with those from 2012-17. Additional analysis under SPEA alternatives is not warranted.
Pacific salmon *spp*.				See also ESA-listed Fish, Table 3-2.
HMS Pacific Tunas	3.2.1.3	No		
North Pacific Albacore			ISC 2017b	No change in status. The stock is likely not overfished. Additional analysis under SPEA alternatives is not warranted.
Eastern Pacific Ocean Bigeye			Xu *et al.* 2018	No change in status - The results of the 2017 assessment indicate a recovering trend for bigeye during 2005-2009, subsequent to Inter-American Tropical Tuna Commission (IATTC) tuna conservation resolutions initiated in 2004, that was not sustained during 2010-2013 period. The most recent estimate from the 2017 assessment indicates that the bigeye stock in the Eastern Pacific Ocean is not overfished and overfishing is not occurring. Additional analysis under SPEA alternatives is not warranted.
North Pacific Bluefin			ISC 2018c	No change in status – Stock is considered to be rebuilding. Additional analysis under SPEA alternatives is not warranted.
Skipjack Western central N. Pacific stock Eastern N. Pacific stock			McKechnie *et al.* 2016; Maunder 2018	No change in status of either stock. Stocks are not overfished. Additional analysis under SPEA alternatives is not warranted.
Yellowfin, western Central N. Pacific stock			Tremblay-Boyer *et al.* 2017	No change in status. Additional analysis under SPEA alternatives is not warranted.
Yellowfin, eastern N. Pacific stock			Minte-Vera *et al.* 2018	No change in status. Fishing mortality has been increasing in recent years however, additional analysis under SPEA alternatives is not warranted.

Prohibited and Highly Migratory Species (HMS)	2015 PEA Section Reference	SPEA Evaluation Required? (Yes/No)	References	Description
Other HMS Species	3.2.1.3	No		
Pacific swordfish				See *Target Species*, Table 3-3.
Striped Marlin, western central N. Pacific stock			ISC 2019	No change in status. Overfishing is occurring and the Western Central North Pacific striped marlin stock remains overfished however, additional analysis under SPEA alternatives is not warranted.
Striped Marlin, eastern N. Pacific stock			IATTC 2014	Status unknown. Additional analysis under SPEA alternatives is not warranted.
Dorado			Aires-da-Silva *et al.* 2016	No change in status. Additional analysis under SPEA alternatives is not warranted.
Blue Shark			ISC 2017a	No change in status. Additional analysis under SPEA alternatives is not warranted.

3.2.2 Marine Mammals

The marine mammal species listed in Tables 3-5 through 3-7 were discussed in the 2015 PEA in Section 3.2.2, Table 3.2-4 and Appendix B Section 4. These species occur in SWFSC research areas including the CCRA, ETPRA and ARA. Marine mammal species encountered during transit between Antarctic study sites are included with Antarctic species. As described in Section 1.2, concurrent with the development of this SPEA, SWFSC has applied for regulations and a new five-year LOA for the incidental taking of marine mammals pursuant to Section 101(a)(5)(A) of the MMPA. In 2015, NMFS issued a 5-year LOA for fisheries and ecosystem research conducted by SWFSC. The new LOA would cover SWFSC's proposed research beginning in 2020 as described in Chapter 2 of this SPEA. For this reason, it is important to provide the most recent abundance estimates for marine mammals that may occur within the Project Area. Appendix B provides the new LOA application for the future period 2020-2025.

Seven species of whales listed as endangered under the ESA occur in one or more of the SWFSC research areas. Also, two pinnipeds and one sea otter DPS are listed as threatened under the ESA, and two dolphin species in the ETPRA are considered depleted under the MMPA. The survey areas also overlap with designated critical habitat for several species as described in Chapter 3 of the 2015 PEA. Information provided here is based on published literature, reports or observer data and summarizes recent data on stock status, abundance or density, distribution and habitat. Table 3-5 provides abundance estimates for species that may occur in the CCRA. Information on marine mammal abundance or density in the other two research areas (ETPRA and ARA) is more difficult to obtain given their remote locations. For this reason, no new information is available for species that occur in those research areas. Table 3-6 provides a summary of the abundance estimates for marine mammals that may occur in the ETPRA which are the same as those reported in the 2015 PEA. Density estimates of marine mammal species are provided for ARA based on observer data during AMLR surveys and are also the same as reported in the 2015 PEA.

Based on the 2018 Pacific stock assessment reports (SAR) (Carretta *et al*. 2019), abundance estimates for some marine mammal stocks have changed since the 2015 PEA as shown in Table 3-5. For most species, changes in abundance are relatively small and for that reason, proposed fisheries and ecosystem research-related impacts are not expected to result in a different conclusion than was described in the 2015 PEA. In many cases, adjustments to species' abundance as reported in the recent SAR are not the result of biologically significant changes associated with population demographics (reproduction rate, mortality, emigration or immigration, etc.). Rather, the differences between the more recent abundance estimates from those in 2015 are more likely the result of new or different datasets or assessment methods used. NMFS attempts to update the status of each marine mammal stock at least every three years and annually for ESA-listed species or species considered 'strategic' under the MMPA. As stock assessments are revised, abundance estimates change. Generally, the Guidelines for Assessing Marine Mammal Stocks (GAMMS) II Workshop Report 2016 guidelines for preparing SARs (Wade and Angliss 1997; NMFS 2016u) requires that survey results older than eight years are deemed unreliable.

TABLE 3-5. ABUNDANCE ESTIMATES OF MARINE MAMMALS IN THE SWFSC CALIFORNIA CURRENT RESEARCH AREA AS REPORTED IN THE 2015 PEA AND THE 2018 STOCK ASSESSMENT REPORTS

Marine Mammals	2015 PEA Section Reference	Abundance and Status from 2015 PEA[1]	Abundance and ESA Status from 2018 SAR[2]	SPEA Evaluation Required? (Yes/No)
Cetaceans				
Harbor Porpoise	2015 Appendix B, 4.1.1			
Morro Bay stock		2,048	2,917	Yes
Monterey Bay stock		1,494	3,715	Yes
San Francisco- Russian River stock		9,189	9,886	No
Northern CA-Southern OR stock		39,581	35,769	No
Dall's Porpoise	2015 Appendix B, 4.1.2	42,000	25,750	Yes
Pacific White-sided Dolphin	2015 Appendix B, 4.1.3	26,930	26,814	Yes
Risso's Dolphin	2015 Appendix B, 4.1.4	6,272	6,336	No
Bottlenose Dolphin	2015 Appendix B, 4.1.5			
Coastal		323	453	Yes
Offshore		1,006	1,924	Yes
Striped Dolphin	2015 Appendix B, 4.1.6	10,908	29,211	Yes
Short-beaked Common Dolphin	2015 Appendix B, 4.1.7	411,211	969,861	Yes
Long-beaked Common Dolphin	2015 Appendix B, 4.1.8	27,046	101,305	Yes
Northern Right Whale Dolphin	2015 Appendix B, 4.1.9	8,334	26,556	Yes
Killer Whale	2015 Appendix B, 4.1.10			
Southern Resident		89 (E,D)	77 (E,D)	Yes
Transient		354	354	No
Eastern North Pacific Offshore		162	300	No
Short-finned Pilot Whale	2015 Appendix B, 4.1.11	760	836	No
Baird's Beaked Whale	2015 Appendix B, 4.1.12	907	2,697	Yes
Mesoplodon *spp.*	2015 Appendix B, 4.1.13	421	3,044	Yes
Cuvier's Beaked Whale	2015 Appendix B, 4.1.14	2,143[3]	3,274	Yes
Pygmy Sperm Whale	2015 Appendix B, 4.1.15	579	4,111	Yes
Sperm Whale	2015 Appendix B, 4.1.16	971(E,D)	1,997 (E,D)	Yes
Humpback Whale[3]	2015 Appendix B, 4.1.17	1,389 (E,D)		
Central America DPS	Appendix B, 4.1.17		411 (E)	Yes
Mexico DPS	Appendix B, 4.1.17		3,264 (T)	Yes
Brazil DPS	Appendix B, 4.1.17		6,400	Yes
Southeastern Pacific DPS	Appendix B, 4.1.17		6,504	Yes

Marine Mammals	2015 PEA Section Reference	Abundance and Status from 2015 PEA[1]	Abundance and ESA Status from 2018 SAR[2]	SPEA Evaluation Required? (Yes/No)
Blue Whale	2015 Appendix B, 4.1.18	2,497 (E,D)	1,647 (E,D)	No
Fin Whale	2015 Appendix B, 4.1.19	3,044 (E,D)	9,029 (E,D)	No
Sei Whale	2015 Appendix B, 4.1.20	126 (E,D)	519 (E,D)	No
Minke Whale	2015 Appendix B, 4.1.21	478	636	No
Gray Whale Eastern Pacific stock	2015 Appendix B, 4.1.22	18,017	26,960	No
Pinnipeds				
California Sea Lion	2015 Appendix B, 4.1.23	296,750	257,606	Yes
Steller Sea Lion, eastern DPS[4]	2015 Appendix B, 4.1.24	58,334 (T,D)	71,562	No
Guadalupe Fur Seal	2015 Appendix B, 4.1.25	15,830[5] (T)	3,025	No
Northern Fur Seal	2015 Appendix B, 4.1.26			
California stock[6]		9,968	14,052	No
Pribilof Island or Eastern Pacific stock[7]		687,902 (D)	637,561[8]	No
Harbor Seal	2015 Appendix B, 4.1.27	26,667	30,968	No
Northern Elephant Seal	2015 Appendix B, 4.1.28	124,000	179,000	No
Southern Sea Otter[9]	PEA Section 4.2.2.1	3,272 (T,D,S)	3,128[10]	No

[1]Estimates are N_{best} unless otherwise stated; E – endangered, T – threatened, D – depleted. If there is no E, T or D, the species is not listed.
[2]Carretta *et al.* 2019.
[3]Change in ESA-listing status (81 FR 62259, September 8, 2016). The first Two DPSs occur in the CCRA; the other two may occur in the ARA during summer. The current revised estimates by DPS come from the Final Rule (at 81 *FR* 62260) reclassifying humpback whale DPSs, not Carretta *et al.* 2019.
[4]De-listed since the 2015 PEA (81 FR 62259, September 8, 2016).
[5]Guadalupe fur seals also occur in portions of the ETPRA but for the purposes of this application, are considered here under CCRA.
[6] Formerly the San Miguel Stock.
[7]Declining trend continues
[8] Muto *et al.* 2018
[9]Southern sea otters are under the jurisdiction of the USFWS and therefore are not included in the LOA request to NMFS (Appendix B of the 2015 PEA). USFWS Stock Assessment Report revised May 2017
[10]USFWS most current estimate revised 2018

TABLE 3-6. ABUNDANCE ESTIMATES FOR MARINE MAMMALS IN THE SWFSC EASTERN TROPICAL PACIFIC RESEARCH AREA[1,2]

Marine Mammals	2015 PEA Section Reference	Abundance and Status from 2015 PEA[3]	Current Estimated Abundance	SPEA Evaluation Required? (Yes/No)
Cetaceans				
Risso's Dolphin	2015 Appendix B, 4.2.1	110,457	No change	No
Short-beaked Common Dolphin	2015 Appendix B, 4.2.2	3,127,203	No change	No
Long-beaked Common Dolphin	2015 Appendix B, 4.2.3	372,429	No change	No
Roughed-tooth Dolphin	2015 Appendix B, 4.2.4	107,633	No change	No
Striped Dolphin	2015 Appendix B, 4.2.5	964,362	No change	No
Spinner Dolphin	2015 Appendix B, 4.2.6			
Eastern stock		1,062,879 (D)	No change	No
White-bellied stock		734,837 (D)	No change	No
Pantropical Spotted Dolphin	2015 Appendix B, 4.2.7			
Western/southern offshore stock		439,208	No change	No
Northeastern offshore stock		857,884 (D)	No change	No
Coastal stock		278,155 (D)	No change	No
Dusky Dolphin	2015 Appendix B, 4.2.8	40,211	No change	No
Fraser's Dolphin	2015 Appendix B, 4.2.9	289,300	No change	No
Melon-headed whale	2015 Appendix B, 4.2.10	45,400	No change	No
Bottlenose Dolphin	2015 Appendix B, 4.2.11	335,834	No change	No
Killer Whale	2015 Appendix B, 4.2.12	8,500	No change	No
False Killer Whale	2015 Appendix B, 4.2.13	39,808	No change	No
Pygmy Killer Whale	2015 Appendix B, 4.2.14	38,900	No change	No
Short-finned Pilot whale	2015 Appendix B, 4.2.15	589,315	No change	No
Cuvier's Beaked Whale	2015 Appendix B, 4.2.16	29,000	No change	No
Longman's Beaked Whale	2015 Appendix B, 4.2.17	1,007	No change	No
Mesoplodon *spp.*	2015 Appendix B, 4.2.18	25,300	No change	No
Sperm Whale	2015 Appendix B, 4.2.19	4,145 (E,D)	No change	No
Dwarf Sperm Whale	2015 Appendix B, 4.2.20	11,200	No change	No

Marine Mammals	2015 PEA Section Reference	Abundance and Status from 2015 PEA[3]	Current Estimated Abundance	SPEA Evaluation Required? (Yes/No)
Humpback Whale Coastal-Peru DPS[4]	2015 Appendix B, 4.2.21	2,566 (E)	No change	No
Blue Whale	2015 Appendix B, 4.2.22	1,415 (E,D)	No change	No
Sei Whale	2015 Appendix B, 4.2.23	None Observed	No change	No
Minke Whale	2015 Appendix B, 4.2.25	115	No change	No
Bryde's Whale	2015 Appendix B, 4.2.26	10,411	No change	No
Fin Whale	2015 Appendix B, 4.2.26	574	No change	No
Pinnipeds				
South American Sea Lion	2015 Appendix B, 4.2.27	No Estimate	No estimate	No
California Sea Lion	2015 Appendix B, 4.2.28	105,000	No estimate	No
Guadalupe Fur Seal[5]	2015 Appendix B, 4.2.28	See Table 3-5		No
Northern Elephant Seal	2015 Appendix B, 4.2.28	No estimate	No estimate	No

[1]The most recent abundance estimates for ETP species are from surveys conducted in 2003 or 2006. There is nothing more recent since the 2015 PEA
[2]Abundance estimates for ETP species are not discussed in Carretta *et al.* (2018 or 2019).
[3]All estimates are Nbest unless otherwise stated; E – endangered, T – threatened, D – depleted.
[4]ESA-listing was revised since 2015 PEA (81 FR 62259, September 8, 2016).
5Guadalupe fur seals occur in portions of the ETPRA but for the purposes of this application, are considered here under CCRA.

TABLE 3-7. DENSITY ESTIMATES / ESTIMATED NUMBER OF MARINE MAMMALS IN THE SWFSC ARA AS REPORTED IN THE 2015 PEA

Marine Mammals	2015 PEA Section Reference	Estimated Density/km^2 (2015 PEA[1])	Estimated Number in ARA	Current Estimated Density/km^2	SPEA Evaluation Required? (Yes/No)
Cetaceans					
Spectacled Porpoise	2015 Appendix B, 4.3.1	No Estimate	No Estimate	No estimate	No
Hourglass Dolphin	2015 Appendix B, 4.3.2	0.00151	n/a	No change	No
Killer Whale	2015 Appendix B, 4.3.3	0.00151	25,000	No change	No
Sperm Whale	2015 Appendix B, 4.3.4	0.0065 (E,D)	n/a	No change	No
Arnoux’s Beaked Whale	2015 Appendix B, 4.3.5	0.0006	n/a	No change	No
Southern Bottlenose Whale	2015 Appendix B, 4.3.6	0.0006	n/a	No change	No
Long-finned Pilot whale	2015 Appendix B, 4.3.7	0.00757	n/a	No change	No
Antarctic Minke Whale	2015 Appendix B, 4.3.8	0.00182	1,544	No change	No
Southern Right Whale	2015 Appendix B, 4.3.9	0.001 (E,D)	1,755[2]	No change	No
Fin Whale	2015 Appendix B, 4.3.10	0.08391[3] (E,D)	n/a	No change	No
Blue Whale	2015 Appendix B, 4.3.11	0.00012 (E,D)	4,487[4]	No change	No
Humpback Whale[5]	2015 Appendix B, 4.3.12	0.03005	1,829[6]	No change	Yes
Pinnipeds					
Antarctic Fur Seal	2015 Appendix B, 4.3.13	0.0999	n/a	No change	No
Southern Elephant Seal	2015 Appendix B, 4.3.14	0.003	640,000	No change	No
Crabeater Seal	2015 Appendix B, 4.3.15	0.175	5-10,000,000	No change	Yes
Weddell Seal[7]	2015 Appendix B, 4.3.16	n/a	500-100,000	No change	No
Leopard Seal	2015 Appendix B, 4.3.17	0.0003	220,000	No change	No

[1]Estimated densities are based on observer data and represent the best available data for these species; E – endangered, T – threatened, D – depleted.
[2]Williams *et al*. (2006)
[3]Santora *et al.* (2009)
[4]Williams *et al*. (2006)
[5]Humpback whale DPSs that forage in Southern Hemisphere were delisted (81 *FR* 62259, September 8, 2016. Listing under the ESA for southern hemisphere humpback whale stocks that forage in unspecified Antarctic regions was found to be not warranted
[6]Williams *et al.* (2006)
[7]Not found at sea in SWFSC area, so no density estimate at sea.

3.2.2.1 Non-ESA Listed Marine Mammals With Change in Status Since the 2015 PEA

The following summary focuses on changes in abundance since the 2015 PEA and the most recent stock assessment (Carretta *et al.* 2019). More detailed information on life history and biology of species can be found in Chapter 3 and Appendix B of the 2015 PEA as well as Carretta *et al*. (2019).

Harbor Porpoise, *Monterey Bay and Morro Bay Stocks*: Harbor porpoise in the CCRA 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). 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 (Barlow and Forney 1994, Forney 1999). These estimates did not include an unknown number of animals 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. The 2015 PEA abundance estimate was based on 2002-2007 aerial surveys. The most recent assessment for the Monterey Bay stock based on 2011 aerial surveys is 3,715 (Coefficient of Variation [CV]=0.51) harbor porpoises (Forney *et al.* 2013 as cited in Carretta *et al*. 2019). Similarly, the most recent estimate of abundance for the Morro Bay stock, based on 2012 aerial surveys is 2,917 (CV=0.41) harbor porpoises (Forney *et al*. 2013 as cited in Carretta *et al*. 2019).

Dall's Porpoise, *California/Oregon-Washington stock*: Dall's porpoises are commonly seen in shelf, slope and offshore waters off California, Oregon and Washington (Barlow 2016, as reported 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. The southern end of this population's range is not well-documented but they are commonly seen off Southern California in winter (Carretta *et al*. 2019). 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 reported in Carretta *et al.* 2019). This is down from the estimate of 42,000 reported in the 2015 PEA, which was based on the geometric mean of estimates from 2005 (Forney 2007) and 2008 (Barlow 2010) summer/autumn vessel-based line transect surveys of California, Oregon, and Washington waters.

Bottlenose Dolphin, *California coastal stock and Offshore stock:* The California coastal stock of bottlenose dolphins is distinct from the offshore stock based on significant differences in genetics and cranial morphology (Lowther-Thielking *et al*. 2014). California coastal bottlenose dolphins are found within about one kilometer of shore (Carretta *et al*. 1998) from central California south into Mexican waters. The offshore stock of bottlenose dolphins have been found at distances greater than a few kilometers from the mainland and throughout the Southern California Bight.

Recent estimates of the coastal stock are the largest for this stock, dating back to the 1980s (Dudzik *et al.* 2006). Previously, the closed population estimate for this stock was 453 (CV=0.06) animals (Carretta *et al*. 2019). Another recent estimate of bottlenose 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, which estimated 1,924 (CV=0.54) animals (Barlow 2016, reported in Carretta *et al*. 2019). This estimate includes new correction factors for animals missed during the surveys.

Striped Dolphin: Striped dolphins are commonly encountered in warm offshore waters of California and a few sightings have been made off Oregon (Barlow 2016, reported in Carretta *et al.* 2019). 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. The abundance of striped dolphins in this region appears to be variable between years and because animals may spend time outside the U.S. EEZ, a multi-year average abundance estimate is considered the most appropriate for management within U.S. waters. The abundance reported in the 2015 PEA was based on two summer/fall shipboard surveys conducted within 556 km of the coastline in 2005 (Forney 2007) and 2008 (Barlow 2010). The most recent estimate of striped dolphin abundance (29,211 [CV=0.20]) is the 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).

Short-beaked Common Dolphin: 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) 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).

Long-beaked Common Dolphin: 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). 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 2015 PEA reported a mean abundance of 8,334 based on surveys conducted from 2005 through 2008. 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).

Northern Right Whale Dolphin, *California/Oregon and Washington stock*: Northern right-whale dolphins are endemic to temperate waters of the North Pacific Ocean. 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). Based on sighting patterns, Barlow (2016 as reported 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. 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 2015 PEA reported an abundance estimate of 8,334, the geometric mean abundance based on surveys conducted in 2005-2008. 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).

Pacific White-sided Dolphin: Pacific white-sided dolphins primarily occur on the shelf and slope waters along the U.S. west coast. During months where colder water occurs, Pacific white-sided dolphins can be found off the California coast while the species shifts northward to Oregon and Washington as water temperatures increase in spring and summer (Carretta *et al*. 2017). The distribution of Pacific white-sided dolphins along the coasts of California, Oregon and Washington changes seasonally and interannually likely in response to oceanographic changes (Carretta *et al*. 2017). Since this species may spend time outside the U.S. EEZ, a multi-year abundance estimate including California, Oregon and Washington is appropriate for managing the population. The most recent abundance estimate is 26,814 animals. No long-term population trends for this species are currently available. Potential Biological Removal for this stock is 191 Pacific white-sided dolphins per year (Carretta *et al*. 2017). The California drift gillnet fishery took an average of 1.1 animals per year during the period 2010 – 2014 and while the West Coast groundfish fishery has historically taken few of these dolphins, no takes were reported between 2009 and 2013 (Carretta *et al*. 2017).

Baird's Beaked Whale: 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). These numbers were based on newer (lower) *g(0)* estimates from earlier analyses but were not as low as those used by Barlow (2016), thus the abundance estimates are not as high (Moore and Barlow 2017). 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.

Mesoplodon Beaked Whales: *Mesoplodon* beaked whales are distributed throughout deep waters and along the continental slopes of the North Pacific Ocean. There are six species known to occur in the Pacific and until methods of distinguishing these six species at sea are developed, NMFS defines the management unit to include all *Mesoplodon* stocks in this region.

A trend-based analysis of line-transect data from surveys conducted between 1991 and 2014 provided new estimates of *Mesoplodon* species abundance (Moore and Barlow 2017 as cited in Carretta *et al.* 2019). The trend 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). This is a reversal of the population decline reported by Moore and Barlow 2013 (as cited in Carretta *et al.* 2019). The best estimate of *Mesoplodon* abundance in 2014 in waters off California, Oregon and Washington is 3,044 (CV=0.54) (Moore and Barlow 2017 as cited in Carretta *et al*. 2019).

Cuvier's Beaked Whale: 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, 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).

Pygmy Sperm Whale: Sightings within the CCRA are rare. 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).

California Sea Lion: California sea lions breed on islands in southern California, western Baja California and the Gulf of California. Based on genetic analysis, there are five distinct geographic populations including the Pacific Temperate, Pacific Subtropical, Southern Gulf of California, Central Gulf of California and the Northern Gulf of California (Carretta *et al*. 2019), each of which occur within SWFSC research areas. In 2014, the population size was estimated to be 257,606 with a corresponding pup count of 47,691 sea lions (Carretta *et al*. 2019). PBR for California sea lions is 14,011 sea lions per year. On average, between 2012 and 2016, 146 sea lions were killed or seriously injured by hook and line fisheries, an annual average of approximately 29 animals per year (Carretta *et al*. 2018b as cited in Carretta *et al*. 2019). Other sources of human-caused mortality may include intentional shootings, entrainment in power plant facilities, entanglement, vessel strikes, oil exposure and dog attacks. From 2012 – 2016, 485 sea lions were killed or seriously injured from these sources (Carretta *et al*. 2019). There have been an increasing number of sea lions entering rehabilitation programs emaciated in recent years. Emaciation is a contributing factor in stranding events and Unusual Mortality Events (UME) across the Pacific Basin. In 2015, a record 4,200 California sea lions stranded off California. From January - June 2016, the average number of stranded California sea lions (n=2,043) was two times higher than the same six-month period 2003 – 2012[9]. Stranded pups were emaciated and dehydrated due to apparent malnutrition. Changes in oceanographic temperatures and prey distribution are likely contributing to these events across the Pacific (see also cumulative effects Chapter 5).

Crabeater Seal: Millions of crabeater seals inhabit the pack ice surrounding Antarctica and are the most numerous seal in the world. While current population estimates are not available, there were previously thought to be over 15 million seals. Crabeater seals main food item, krill, is found in abundance around Antarctica. Female seals give birth to a single pup during spring (September – December) and are joined by the male seal which protects the pup from predators and other male crabeater seals. Pups are weaned in three weeks and as winter approaches, the mother and pup separate and head northward. Currently, an international effort is underway to estimate population of this species (https://www.afsc.noaa.gov/nmml/education/pinnipeds/crabeater.php).

3.2.2.2 ESA Listed Marine Mammal Species with Change in Abundance or Status Since the 2015 PEA

The following discussion focuses changes in abundance that have occurred since the 2015 PEA based on the most recent stock assessment (Carretta *et al.* 2019). More detailed information on life history and biology of species can be found in Chapter 3 and Appendix B of the 2015 PEA and Carretta *et al*. (2019).

Humpback Whale: There is only one stock of marine mammal species that forages in the Project Area within California/Oregon and Washington waters whose ESA listing status changed since the 2015 PEA. On September 8, 2016, NMFS issued a final rule that revised the global listing status of the humpback

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

whale by dividing the species into 14 distinct DPSs[10]. Of these 14 DPS, NMFS listed 4 DPSs as endangered and one DPS as threatened. The remaining nine DPSs were delisted, including the Hawaii DPS which forages in unspecified areas of the Antarctic Research Area.

Two of the DPSs occur within the CCRA and are considered discrete which include the endangered Central America DPS and the threatened Mexico DPS. Calambokidis *et al*. (2017) reported that approximately 70% of whales photographed in the breeding grounds of these two DPSs have been matched to California and Oregon waters.

Central America DPS – The Central America DPS consists of whales that breed along the Pacific coast of Central America. Whales from this breeding ground feed almost exclusively offshore of California and Oregon, with few individuals identified as far north as Washington (Wade *et al*. 2016). Considerable uncertainty exists about the abundance estimate for this DPS. Wade *et al.* (2016) used a spatial multi-strata mark-recapture model to estimate abundance for all winter and summer areas sampled during the SPLASH[11] project in the North Pacific. The multi-strata estimate for the Central America DPS is 411 (CV = 0.30), lower than previous estimates (Wade *et al*. 2016).

Mexico DPS – The Mexico DPS consists of whales that breed along the Pacific coastlines of Mexico and feed across a broad geographic range from California to the Aleutians, with concentrations in California-Oregon, northern Washington-British Columbia, north into the Gulf of Alaska. The abundance estimate used from Calambokidis *et al*. (2008) in the final rule was 6,000-7,000, although there was considerable uncertainty in these estimates[12]. More recently, Wade *et al.* (2016) produced a winter range estimate for the Mexico DPS of 3,264 (CV = 0.06). This is a significantly lower abundance estimate than previous number from Calambokidis *et al.* (2008) and is considered more reliable (Carretta *et al.* 2018).

Antarctic DPS – There are two DPSs that may occur in the ARA and forage off the Atlantic and Pacific coast off South America. These include the Brazil DPS, which forages in the area of South Georgia Island to the east side of the Antarctic Peninsula, and the southeastern Pacific DPS, which breeds on the western side of South America but could also forage in southern waters west of the Antarctic Peninsula. Humpback whales that form these DPSs were delisted in 2016. Sightings of humpback whales are uncommon during ARA research activities.

In addition, on October 9, 2019, NMFS published a proposed rule to designate humpback whale critical habitat (84 FR 54354). A final rule is anticipated by September 28, 2020. For the Central American DPS of humpback whales, NMFS proposed critical habitat in an area that extends from northern Washington/entrance to the Strait of Juan de Fuca south to/and including the Channel Islands Area (16 U.S.C. 1533, Part 226.227(g)(1)). NMFS excluded the California south coast area (corresponding to Unit 19) from the designation of critical habitat. This unit has the lowest predicted density of humpback whales across all U.S. West Coast units (NMFS 2019a). NMFS determined that the limited conservation benefits of designating Unit 19 - California South Coast Area were outweighed by the economic impact of designating this area as described in the proposed rule. NMFS also determined that exclusion of this area will not result in the extinction of this DPS (see map at 16 U.S.C. 1533, Part 226.227(g)(2)).

[10] 81 *FR* 62260
[11] SPLASH: Structure of Populations, Levels of Abundance and Status of Humpback Whales (Calambokidis *et al.* 2008)
[12] 81 *FR* 62260

Of the three DPSs addressed in the proposed rule, the Mexico DPS has the broadest distribution within the U.S. portion of their range. During the SPLASH study, Mexico DPS whales were photo-identified in all five of the major feeding areas in, or partially in, U.S. waters—i.e., California/Oregon (n=105 whales), northern Washington/southern British Columbia (n=27 whales), southeast Alaska/northern British Columbia (n=35 whales), the Gulf of Alaska (n=97 whales), and the Aleutian Islands/Bering Sea (n=27 whales, Calambokidis *et al*. 2008). In terms of their distribution across this range, Mexico DPS whales using different portions of their breeding area appear to target different feeding destinations. During SPLASH surveys whales that had been photo-identified along the Pacific coast of mainland Mexico were sighted in highest numbers off the coast of California and Oregon (97 of 164 total matches), suggesting that this is their primary foraging destination (Calambokidis *et al*. 2008, NMFS 2019a). Of those whales that feed off the west coast of the U.S. during the summer, Wade *et al*. (2016) estimated that 2.5 percent of the whales present in the southern British Columbia/Washington area are Mexico DPS whales and 73.6 percent present in the Oregon/California areas are Mexico DPS whales. The Mexico DPS whales sighted around the Revillagigedo Archipelago offshore of mainland Mexico had more matches overall to Alaska feeding areas and, in particular, higher match rates to the northern Gulf of Alaska feeding areas (44 of 87 matches; Calambokidis *et al.* 2008). As proposed, the geographical boundaries of critical habitat Units 1-6, 8, and 10-18 for the Mexico DPS constitute a patchy sequence of areas from the Channel Islands (Unit 18) along the U.S. west coast up to the Gulf of Alaska and into the Bering Sea (see map at 16 U.S.C. 1533, Part 226.227(g)(2)).

Killer Whale – Southern Resident DPS: 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.

3.2.3 Seabirds

3.2.3.1 Threatened and Endangered Species

Table 3-8 identifies the ESA-listed seabird species occurring within the SWFSC CCRA and ETPRA, their status and management actions taken to conserve the species since the 2015 PEA. Seabird species that may occur in the ARA were discussed in Section 3.2.3.1 of the PEA and since that time, the status of each of those species has not changed. No ESA-listed species are likely to be encountered by SWFSC research activities in the ARA. Considering that the populations of these seabird species have not significantly changed and that potential impacts from future fisheries and ecosystem research (see Chapter 2) is not expected to result in different conclusions from those presented in the original 2015 PEA impact assessment, ESA-listed seabird species are not discussed further in this SPEA. For more information on the current status of each species and references to individual status reviews, please see Table 3-8.

TABLE 3-8. ESA-LISTED BIRDS OCCURRING IN THE SWFSC RESEARCH AREAS

ESA-Listed Seabird	2015 PEA Section Reference	SPEA Evaluation Required? (Yes/No)	References	Description
Short-tailed albatross (E)	3.2.3.1	No	79 FR 25613 USFWS 2014a	No change in ESA-listed status. Management actions taken since 2015 PEA include initiation of a 5-Year ESA Status Review May 5, 2014 and completion of a 5-Year ESA Review Summary and Evaluation. Further evaluation under SPEA alternatives not warranted.
Hawaiian dark-rumped petrel (E)			81 FR 7571 84 FR 790	No change in ESA-listed Status. Management actions taken since 2015 PEA include initiation of a 5-Year ESA Status Review in HI, OR, WA, MT and ID February 12, 2016 and a Draft Recovery Plan Amendment January 21, 2019. Further evaluation under SPEA alternatives not warranted.
Newell's shearwater (T)			81 FR 7571 84 FR 790	No change in ESA-listed status. Management actions taken since 2015 PEA include initiation of a 5-Year ESA Status Review in HI, OR, WA, MT and ID February 12, 2016 and publication of a Draft Recovery Plan Amendment January 21, 2019. Further evaluation not warranted.
Humboldt penguin (T)			75 FR 45497	No change in ESA status. Further evaluation under SPEA alternatives not warranted.
Galapagos penguin (E)			USFWS ECOS: https://ecos.fws.gov/ecp0/profile/speciesProfile?spcode=B02M	
Galapagos petrel (T)			75 FR 235	
California least tern (E)			83 FR 28,251	No change in ESA-listed status. However, USFWS may consider downlisting from endangered to threatened. Management actions taken since the 2015 PEA include initiation of 5-Year Status Reviews of 50 Species in California, Nevada, and the Klamath Basin of Oregon including the least tern June 18, 2018. Further evaluation under SPEA alternatives not warranted.
Marbled Murrelet (T)			Desimone 2016) 79 *FR* 25613, USFWS 2014b	No change in ESA-listed Status. There has been a documented 4.4% decline between 2001-2015 in Washington (present abundance 7,494), further evaluation not warranted due to lack of interaction. Management Actions taken since 2015 PEA include initiation of a 5-Year ESA-status review May 5, 2014 and publication of a 5-Year ESA Review Summary and Evaluation.

3.2.3.2 Other Seabird Species

Seabirds have never been caught incidentally in SWFSC fisheries surveys. However, a thorough evaluation of the potential interactions between birds, SWFSC research vessels and gear was described in Chapter 4 of the 2015 PEA. Section 3.2.3.2 of the 2015 PEA provided a brief account of the marine bird communities in the three different research areas and included references to additional information on the natural history, habitats, and conservation status of marine birds in each area. There have been no changes in the status or overall population assessment of seabirds in SWFSC research areas since the 2015 PEA. Therefore, the analyses of fisheries and ecosystem research-related impacts on seabirds is not expected to differ from the original impact assessment, thus seabirds are not discussed further in this SPEA.

3.2.4 Sea Turtles

Five species of sea turtles can be found within the area of the proposed SWFSC research activities: leatherback, olive ridley, green, loggerhead, and hawksbill sea turtles (Table 3-9). As described in Section 3.2.4 of the 2015 PEA, all of the sea turtles found in the area of the SWFSC research activities were listed as endangered at the time the PEA was published. Following a range-wide ESA status review on the green turtle (Seminoff *et al.* 2015), that species was partitioned under the ESA into 11 DPSs (81 FR 20057, April 6, 2016). Two of those DPSs are found in SWFSC Research Areas including the east and central North Pacific DPSs. These DPSs were re-classified as threatened under the ESA; previously they were listed as endangered (see Table 3-9). Even with the change in status of the green turtle, current or proposed fisheries and ecosystem research-related impacts on sea turtles are not expected to differ from those presented in the original 2015 PEA impact assessment.

TABLE 3-9. ESA-LISTED SEA TURTLES FOUND WITHIN THE CCRA AND ETPRA

<table>
<tr><th>ESA-Listed Turtle Species</th><th>2015 PEA Section Reference</th><th>SPEA Evaluation Required? (Yes/No)</th><th>References</th><th>Description</th></tr>
<tr><td>Olive ridley sea turtle (E)</td><td rowspan="5">3.2.4.1</td><td rowspan="5">No</td><td>NMFS and USFWS 2014</td><td>No change in ESA status. Further evaluation under SPEA alternatives not warranted. Management actions taken since 2015 PEA include completion of an ESA 5-Year Status Review on June 18, 2014.</td></tr>
<tr><td>Green sea turtle (T)
East North Pacific DPS
Central North Pacific DPS</td><td>Seminoff et al. 2015;
81 FR 20057</td><td>Change in ESA listing status from endangered to threatened based on status review March 2015 and final ruling April 6, 2016. This change and the low level of interaction with proposed fisheries research do not warrant further evaluation under SPEA alternatives.</td></tr>
<tr><td>Loggerhead sea turtle (E)</td><td rowspan="3"></td><td rowspan="3">No change in ESA status. Further evaluation under SPEA alternatives not warranted.</td></tr>
<tr><td>Hawksbill sea turtle (E)</td></tr>
<tr><td>Leatherback sea turtle Western Pacific DPS (E)[1]</td></tr>
</table>

T – ESA threatened; E – ESA endangered

[1]There are two DPSs, Pacific and Eastern Pacific. Western leatherbacks nest in the western Pacific and migrate to foraging grounds off of the US North pacific coast. The Eastern Pacific DPs nest along the Pacific coast of the Americas in Mexico and Costa Rica and migrate to foraging grounds off of S. America. CH for the Western DPS was designated in 2012 off the US West coast (CA OR and WA) because the areas are key for foraging turtles.

3.2.4.1 Green Sea Turtle

On February 16, 2012, NMFS received a petition from the Association of Hawaiian Civic Clubs to identify the Hawaiian green turtle population as a DPS and ''delist'' it. On August 1, 2012, with USFWS concurrence, NMFS determined that the petition presented substantial information indicating that the petitioned action may be warranted (77 FR 45571). A comprehensive status review of the species was conducted and published as the ''Status Review of the Green Turtle (Chelonia mydas) under the Endangered Species Act'' (Seminoff *et al*. 2015). Based on the best scientific information presented in the status review, a final rule was published on March 23, 2015 (80 FR 15271) which removed the existing ESA listings, changing them to three endangered DPSs and eight threatened DPSs (including the Central North Pacific and East Pacific).

<u>Central North Pacific DPS</u>: The range of the Central North Pacific DPS includes the Hawaiian Archipelago and Johnston Atoll. The DPS exhibits low nesting abundance, with an estimated total nester abundance of 3,846 nesting females at 13 nesting sites (Balazs *et al*. 2015). The nesting trend is increasing. Nesting site diversity is extremely limited with 96 % of nesting at one low-lying atoll (i.e., French Frigate Shoals). NMFS and USFWS concluded that while the DPS is not presently in danger of extinction throughout all or a significant portion of its range, numerous continuing and increasing threats suggest that the DPS is likely to become endangered within the foreseeable future. Based on the review, the Central North Pacific DPS was listed as a threatened species.

<u>East Pacific DPS</u>: The range of the East Pacific DPS extends from 41° N. southward along the Pacific coast of the Americas to central Chile (40° S.) and westward to 142° W. and 96° W., respectively. The offshore boundary of this DPS is a straight line between these two coordinates (80 FR 15271). The East Pacific DPS includes the Mexican Pacific coast breeding population, which was originally listed as endangered (43 FR 32800, July 28, 1978). The DPS exhibits an estimated total nester abundance of 20,112 females at 39 nesting sites. Nesting data indicate increasing trends in recent decades (Seminoff *et al*. 2015). The DPS is threatened primarily by habitat loss and degradation, overexploitation, inadequate regulatory mechanisms, and fisheries bycatch. Based on the status review, NMFS and USFWS determined that the DPS is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Therefore, the East Pacific DPS was listed as a threatened species (80 FR 15271).

3.2.5 Invertebrates

3.2.5.1 Threatened and Endangered Species

Two invertebrate species found within the SWFSC region are listed as endangered under the ESA: the black abalone (*Haliotis cracherodii*), and the white abalone (*Haliotis sorenseni*). Brief descriptions are given for each of these species including habitat, distribution, and factors leading to population decline. The data have been reviewed to identify changes in status, abundance, or population trends that may require further discussion in this SPEA. However, the best available information indicates that there have been no changes in species status since the 2015 PEA, and fisheries research-related impacts from Alternatives 1 and 2 are not expected to be different from the original impact assessment (NMFS 2015a). Therefore, these species are not discussed further in this SPEA. Individual status and assessment reports for each species are shown in Table 3-10.

TABLE 3-10. INVERTEBRATES FOUND WITHIN THE SWFSC RESEARCH AREAS

Invertebrate Species	2015 PEA Section Reference	SPEA Evaluation Required? (Yes/No)	References	Description
ESA-listed Invertebrates				
Black Abalone	3.2.5.1	No	81 FR 93902	No change in ESA status. Management actions taken since 2015 PEA include the initiation of a 5-Year Status Review for both species of endangered abalone (December 22, 2016).
White Abalone	3.2.5.1	No	81 FR 93902 84 FR 9309	No change in ESA status. Management actions taken since 2015 PEA include the initiation of a 5-Year Status Review for both species of endangered abalone (December 22, 2016); On March 14, 2019, the SWFSC requested a 5-year recovery and enhancement permit for all live stages in California. Due to lack of interaction with SWFSC research, additional analysis under SPEA alternatives not warranted.
Coral *spp.*	3.2.5.3	No	79 FR 53852	Fifteen species of Indo-Pacific corals were listed as threatened on Sept 10, 2014. Generally, these species are not found in the Action Area. Therefore, additional analysis under SPEA alternatives not warranted.
Target Species of Invertebrates				
Market Squid	3.2.5.2	No	PFMC 2019	No change in status. Lowest recorded landings ever from 2014 to 2017 due to El Nino conditions[1]. However, due to a lack of interaction with proposed SWFSC research, additional analysis under SPEA alternatives not warranted.
Antarctic Krill	3.2.5.2	No	Klein *et al*. 2018 Santora *et al.* 2010, 2014	No change in status. While declining trends in total biomass continue, additional evaluation under SPEA alternatives not warranted due to lack of interaction.

Source: California Dept. Fish and Game, Pelagic Fisheries and Ecosystem Program at https://www.wildlife.ca.gov/Conservation/Marine/Pelagic

NMFS has listed 20 species of corals as threatened, including five in the Caribbean and 15 in the Indo-Pacific (79 FR 53852). These species are known to occur in the western or central portions of the Pacific, but not in the ETP. None of these species are known to occur within the SWFSC research areas and none would be expected to be affected by SWFSC research activities. Therefore, these species are not discussed further in this SPEA.

3.2.5.2 Target Species of Invertebrates

Market squid (*Doryteuthis opalescens*) and Antarctic krill (*Euphausia superba*) were described in Section 3.2.5.2 of the 2015 PEA and are the only invertebrate species within the SWFSC research areas that are considered target invertebrate species. The status of these species has not changed since 2015; therefore, analyses of fisheries and ecosystem-research related impacts are not expected to differ from those discussed in Chapter 4 of the 2015 PEA. Therefore, these species are not discussed further in this SPEA.

3.3 Economic and Social Environment

3.3.1 SWFSC Operations

The SWFSC fisheries and ecosystem research activities have direct and indirect influence on the economics of U.S. communities and ports in which they operate. As described in the 2015 PEA, SWFSC research funds are distributed among five research divisions and corporate services that support them. SWFSC facilities are located in California in the communities of La Jolla, Santa Cruz, Monterey, Arcata, Granite Canyon, and Piedras Blancas. The SWFSC's Antarctic Ecosystem Research Division maintains two field stations located at Cape Shirreff on Livingston Island and at Copacabana in Admiralty Bay on King George Island in Antarctica. The ETPRA includes waters extending from Mexico to Peru. As described in the 2015 PEA, in addition to these research divisions, SWFSC research is conducted in three oceanographic areas including CCRA, ETPRA and ARA, with most research occurring in the CCRA. Therefore, communities that may be affected by proposed SWFSC research are located in Washington, Oregon, and California. Research voyages and field stations in the Antarctic or Eastern Tropical Pacific ecosystems have limited interaction with foreign ports, and therefore have minor social and economic influence in those regions.

Through direct expenditures on fisheries and ecosystem research, SWFSC contributes to the communities and ports in these regions. While the contribution of research-related employment and purchased services is beneficial on an individual basis, the total contribution of research is very small when compared to the value of commercial and recreational fisheries in the communities. Fisheries research is considered beneficial to the economic status of fishing communities through contribution to sustainable fisheries management.

Approximately $17 million is spent annually on the collection of survey data in the SWFSC. Approximately 80 % of this is spent on surveys in the CCRA to meet management and science-based information needs for both the NMFS Regional Office and the Pacific Fisheries Management Council. To support this effort, the SWFSC developed a California Current Integrated Ecosystem Assessment program to advance the implementation of ecosystem-based fishery management in the CCE program. The program was reviewed in April 2016[13] and found to provide the best available scientific information for management of marine living resources in the CCE. Substantial long-term data collection programs such as the California Cooperative Oceanic Fisheries Investigations (CalCOFI)[14], fish surveys, and pinniped surveys are also critical components of resources management in these regions. For additional details on these programs, please see Section 3.3.4 of the 2015 PEA.

[13]NMFS, SWFSC, Program Review of Ecosystem Science Southwest Fisheries Science Center, Chair's Summary and Panelists' Comments. La Jolla, California April 2016. 61 pp.
[14]At https://www.fisheries.noaa.gov/region/west-coast#southwest-science

Other cooperative research partners, including state agencies, universities, and commercial fishing associations, receive funding through SWFSC. SWFSC also provides contracts and grants to individual social science researchers as well as to other institutions throughout the Pacific region. Research-related spending directly generates jobs and income and benefits private businesses through purchases of research-related equipment.

For the purposes of assessing the potential influence of SWFSC research on the communities described above, the 2015 PEA and this SPEA rely on information from the commercial and recreational fisheries to provide a general sense of revenues and economic impact. Every year, NMFS publishes a report titled *'The Fisheries Economics of the United States'*. This report includes commercial market conditions, total tonnage of commercial fish landed and revenue by region and state, recreational fishing expenditures and levels of participation by region and state, key species, and community profiles. The 2018 report covers the period 2007-2016 (NMFS 2018b). To assess socio-economic impacts in this SPEA, information from 2015-2016 (NMFS 2018b) is compared to data reported in the 2015 PEA[15] for the period 2010-2012. For more detailed information on the entire time-series presented in the annual report, refer to NMFS (2018b).

NMFS (2018b) identifies four different measures commonly used to show how commercial fisheries landings/revenue affect the economy in a region (state or nationwide) which include: sales, income, value-added, and employment. Economic impact modeling assumes that every dollar spent in a regional economy (direct impact) is either saved or re-spent on additional goods or services. Dollars that are re-spent on other goods and services in the regional economy generate additional economic activity in the region (NMFS 2018b).

For both commercial fisheries, *sales* include direct sales of landed fish; secondary sales made between businesses and households resulting from the original sale. *Income* includes: wages, salaries, and proprietors' income (income from self-employment). *Value-added* is the contribution of fisheries to the gross domestic product in a region. *Employment* is specified on the basis of full-time and part-time jobs supported directly or indirectly by the sales of seafood, purchases by recreational anglers, or items purchased to support commercial and recreational fishing (NMFS 2018b).

3.3.2 Commercial Fisheries

Table 3-11 summarizes the economic significance of commercial fishing to each state for the year 2016. Table 3-12 shows commercial landings, revenue, and top species (by revenue) for west coast states over the periods of 2010-2012 and 2015-2016. Commercial fisheries refer to fishing operations that sell their catch for profit. The term does not include subsistence fishermen or saltwater anglers who fish for sport. It also excludes the for-hire sector, which earns its revenue from selling recreational fishing trips to saltwater anglers. As shown in Table 3-11, California generated the largest employment impacts in the region.

The inflation adjusted (2018 $) ex-value of CPS fisheries to the West Coast (California, Oregon, Washington) ranged from a high of $101 million in 2013 to a low of almost $28 million in 1993 between 1981 and 2018 and was $42 million in 2018; for groundfish ex-vessel value ranged from $158 million in 1982 to a low of $60 million in 2002 and was almost $82 million in 2018; for salmon it ranged from a high of $290 million in 1933 to a low of $21 million 1999 and was $46 million in 2018 (see Figures 3-1

[15]Note the draft and final PEA used fisheries datasets up to 2012, so information from 2010-2012 is representative of that described in the 2015 PEA.

through 3-4). These values only represent ex-vessel value, not the full value or impact of the fisheries to the West Coast.

TABLE 3-11. 2016 ECONOMIC IMPACTS OF THE PACIFIC SEAFOOD INDUSTRY

State	Jobs	Sales	Income	Value Added
California	124,803	$22,776,152	$4,911,619	$8,141,191
Oregon	16,162	$1,190,017	$415,939	$583,687
Washington	55,325	$7,463,634	$2,003,817	$3,047,760

Source: NMFS 2018b

Landings revenue increased by $131.2 million in California, Oregon and Washington (referred to as the Pacific Region in the NMFS FEUS) from 2015 to 2016, mostly due to an increase in revenue from crab landings (NMFS 2018b). This number represented a 79% (56% when accounting for inflation) increase in revenue from 2007 and a 24% increase from 2015. A fishery disaster had been declared for the Dungeness crab fishery in California and for the Quileute tribe in Washington State for the 2015-2016 season because of closures implemented due to high levels of the neurotoxin, domoic acid. As these fisheries re-opened, landings returned to their highest level since 2013 (NMFS 2018b).

In 2016, revenue from whiting increased by 93% from 2015 due to higher utilization rate of the total allowable catch (TAC). Poor performance in 2015 was associated with the anomalously warm ocean conditions and poor market conditions. Revenue from squid landings also rebounded in 2016; global supply shortages of squid due to the strong *El Niño* event from 2015-2016 caused prices to surge 60% in California (NMFS 2018b). Squid landings were essentially flat in 2016 relative to 2015 (46.3% compared to 43.4% of total landings in California, Table 3-12). Prior to the most recent *El Niño* event, squid had been California's largest fishery by value and volume, and represented 80% of U.S. squid landings as well as 64% of U.S. squid revenues in recent years. In 2016, California represented only 58% and 40% of U.S. squid landings and landings revenue, respectively (Table 3-12).

Revenue from landings in the Pacific Region (California, Oregon and Washington) totaled $688.9 million in 2016, with the highest revenue in Washington ($287.5 million), followed by California ($216.1 million) (Table 3-12). Crab had the highest landings revenue in the Pacific region in 2016 and dominated landings revenue for California throughout the period 2010-2016. The largest revenue increases occurred in 2016 when landings increased by nearly 400% and revenue was up nearly 160% from the previous year. In California, crab and shellfish accounted for 54% of total landings revenue in 2016, while over the period 2015-2016, shrimp had the largest revenue decrease (-45%). From 2010-2016, shellfish (clams) in Washington received the highest price per pound (Table 3-12). Clams and crab accounted for 50% of the total landings revenue in Washington throughout the period.

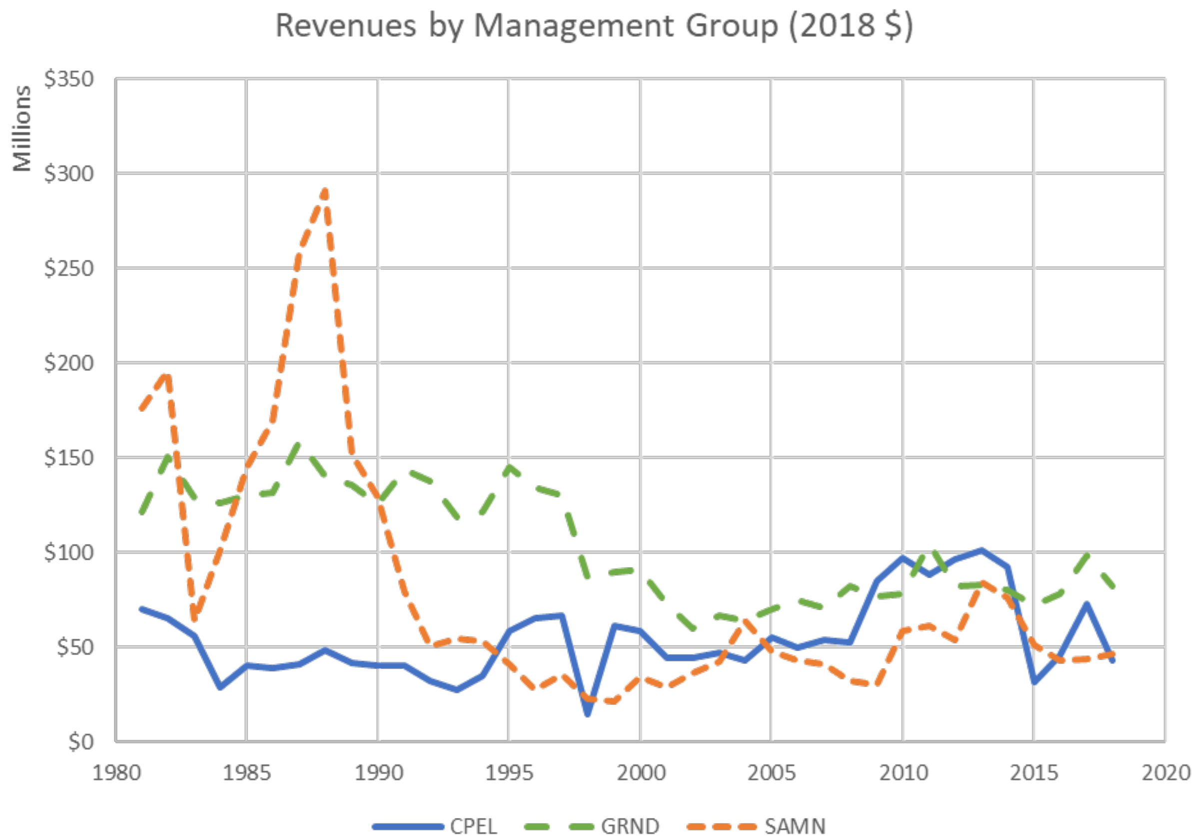
TABLE 3-12. TOTAL LANDINGS, TOTAL LANDINGS REVENUE, AND LANDINGS REVENUE OF TOP TWO SPECIES FOR CALIFORNIA, OREGON, WASHINGTON 2010-2012 AND 2015-2016 (REVENUE IN THOUSANDS OF DOLLARS)

	All Species (Total)		Top Species/Species Groups Revenue				Top Species Percent of All Species	
Year	Pounds	Revenue	Pounds	Revenue	Price per Pound	Top Two Species	Pounds	Revenue
California								
2010	439,440	$187,263	23,352	$43,016	$1.84	Crab	5.31%	22.97%
			288,497	$71,165	$0.25	Squid	65.65%	38.00%
2011	409,837	$222,160	22,206	$53,762	$2.42	Crab	5.42%	24.20%
			267,890	$66,546	$0.25	Squid	65.37%	29.95%
2012	353,875	$243,963	27,589	$88,207	$3.20	Crab	7.80%	36.16%
			214,867	$63,886	$0.30	Squid	60.72%	26.19%
2015	186,418	$129,143	5,412	$20,467	$3.78	Crab	2.90%	15.85%
			80,968	$24,458	$0.30	Squid	43.43%	18.94%
2016	176,403	$216,139	28,135	$85,620	$3.04	Crab	15.95%	39.61%
			81,751	$39,194	$0.48	Squid	46.34%	18.13%
Oregon								
2010	201,974	$106,378	15,817	$32,757	$2.07	Crab	7.83%	30.79%
			31,516	$11,313	$0.36	Shrimp	15.60%	10.63%
2011	274,533	$148,354	17,240	$44,696	$2.59	Crab	6.28%	30.13%
			48,276	$24,901	$0.52	Shrimp	17.58%	16.78%
2012	296,091	$128,222	8,681	$29,189	$3.36	Crab	2.93%	22.76%
			49,054	$24,884	$0.51	Shrimp	16.57%	19.41%
2015	194,575	$113,990	2,284	$11,935	$5.22	Crab	1.17%	10.47%
			53,457	$40,634	$0.76	Shrimp	27.47%	35.65%
2016	209,486	$151,707	15,702	$55,737	$3.55	Crab	7.50%	36.74%
			35,344	25,245	$0.71	Shrimp	16.87%	16.64%

Year	All Species (Total)		Top Species/Species Groups Revenue				Top Species Percent of All Species	
	Pounds	Revenue	Pounds	Revenue	Price per Pound	Top Two Species	Pounds	Revenue
Washington								
2010	189,486	$255,332	3,876	$73,625	$18.99	Clams	2.05%	28.84%
			22,500	$57,070	$2.54	Crab	11.87%	22.35%
2011	210,282	$329,785	4,038	$88,774	$21.98	Clams	1.92%	26.92%
			27,072	$83,627	$3.09	Crab	12.87%	25.36%
2012	213,578	$275,585	3,677	$69,445	$18.89	Clams	1.72%	25.20%
			16,590	$59,485	$3.59	Crab	7.77%	21.58%
2015	153,568	$299,952	4,262	$75,342	$17.68	Clams	2.78%	25.12%
			15,048	$72,651	$4.83	Crab	9.8%	24.22%
2016	168,136	$287,543	3,355	$82,882	$24.70	Clams	2.0%	28.82%
			19,109	$75,376	$3.94	Crab	11.37%	26.21%

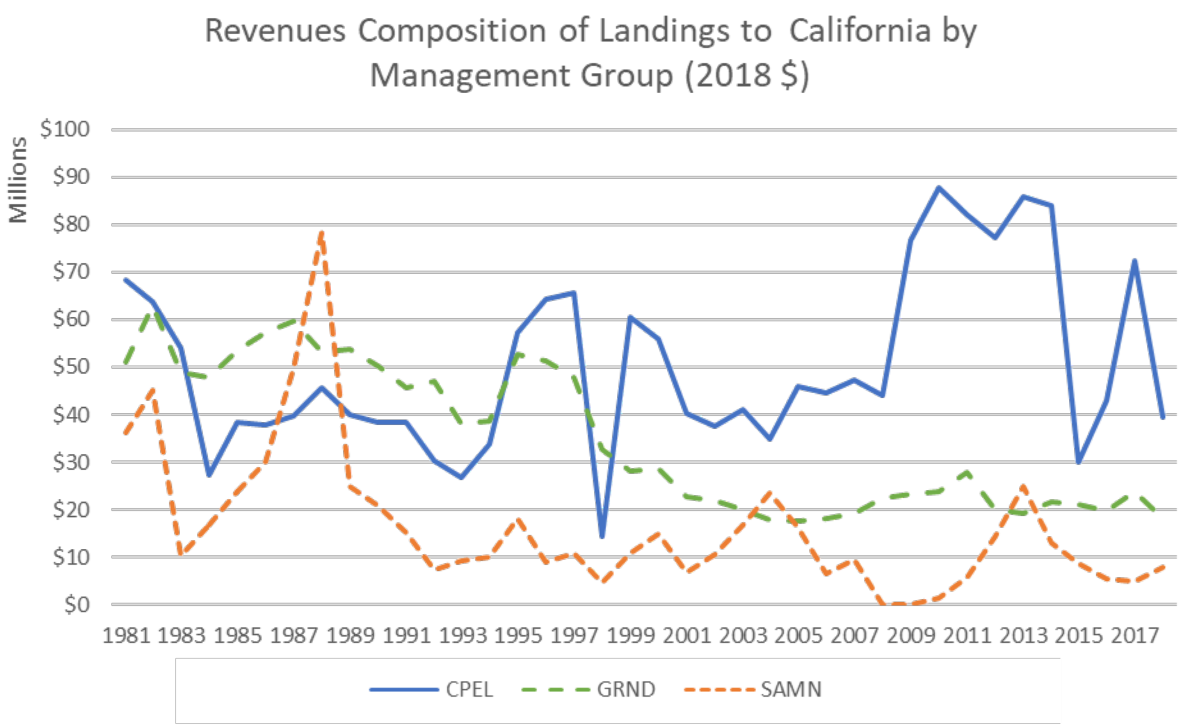
Source: NMFS 2018b

FIGURE 3-2. EX-VESSEL REVENUE FOR THE COASTAL PELAGIC (CPS), GROUNDFISH AND SALMON FISHERIES ON THE WEST COAST IN INFLATION ADJUSTED 2018 DOLLARS FOR 1981-2018



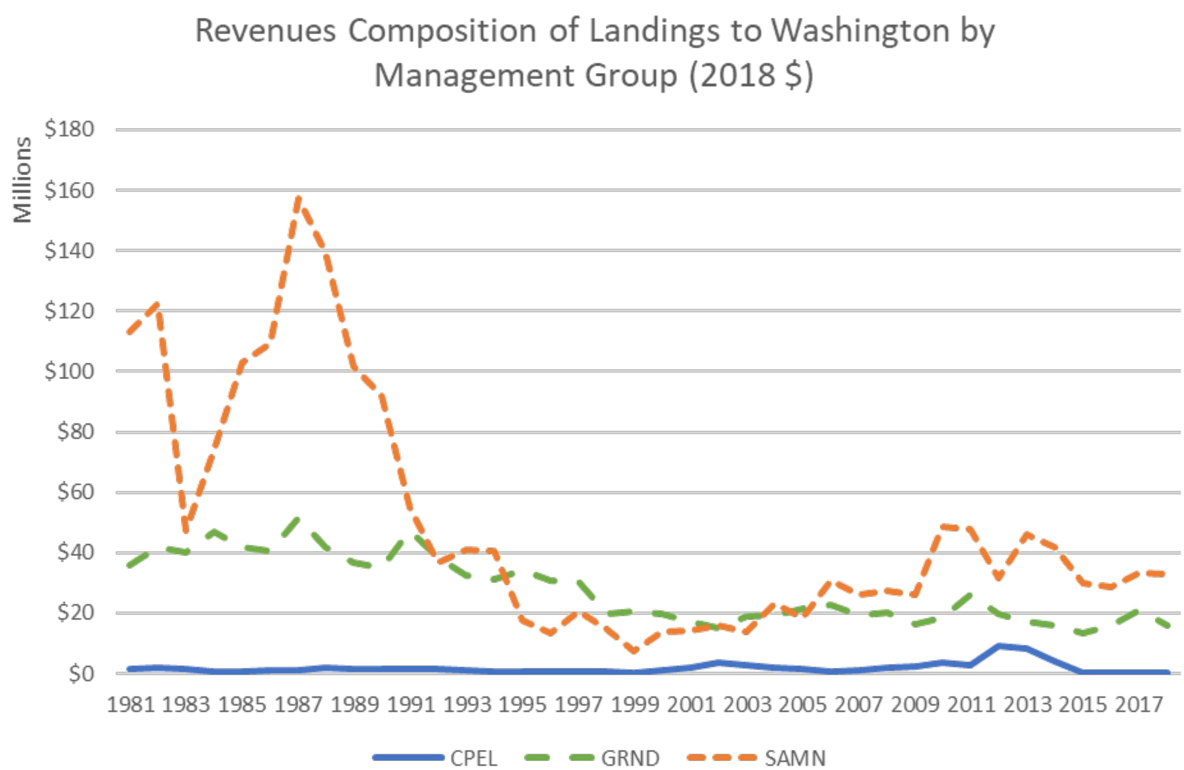
Source: PacFIN
Key:
CPEL – In this figure CPEL means coastal pelagic species
GRND – groundfish species
SAMN – salmon

FIGURE 3-3. EX-VESSEL REVENUE FOR THE COASTAL PELAGIC (CPS), GROUNDFISH AND SALMON FISHERIES TO CALIFORNIA IN INFLATION ADJUSTED 2018 DOLLARS FOR 1981-2018



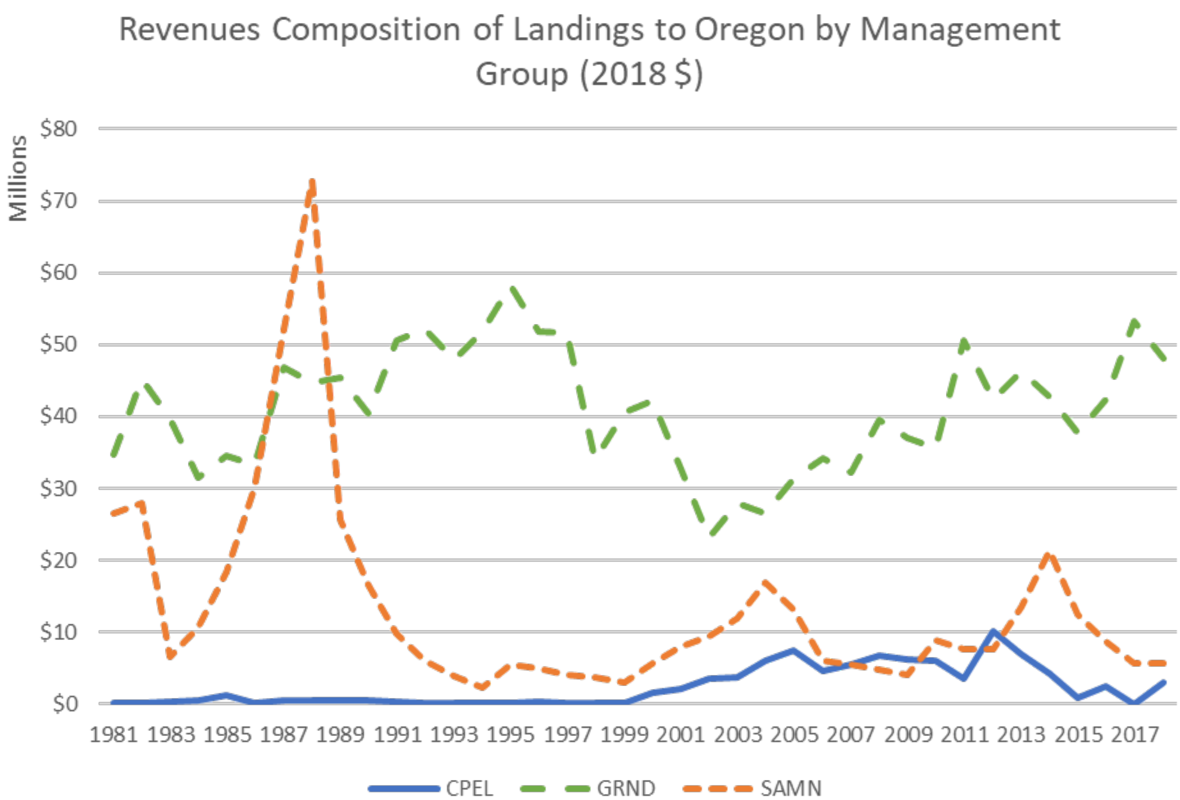
Source: PacFIN
Key:
CPEL – In this figure CPEL means coastal pelagic species
GRND – groundfish species
SAMN – salmon

FIGURE 3-4. EX-VESSEL REVENUE FOR THE COASTAL PELAGIC (CPS), GROUNDFISH AND SALMON FISHERIES TO WASHINGTON IN INFLATION ADJUSTED 2018 DOLLARS FOR 1981-2018.



Source: PacFIN
Key:
CPEL – In this figure CPEL means coastal pelagic species
GRND – groundfish species
SAMN – salmon

FIGURE 3-5. EX-VESSEL REVENUE FOR THE COASTAL PELAGIC (CPS), GROUNDFISH AND SALMON FISHERIES TO OREGON IN INFLATION ADJUSTED 2018 DOLLARS FOR 1981-2018.



Source: PacFIN
Key:
CPEL – In this figure CPEL means coastal pelagic species
GRND – groundfish species
SAMN – salmon

3.3.3 Recreational Fisheries and Fishing

The contribution of recreational fishing activities in the U.S. is reported in terms of economic impacts from angler expenditures. Economic impacts from recreational fishing activities were generated using the NMFS Recreational Economic Impact Model (2011) available at https://www.fisheries.noaa.gov/inport/item/25239.

Total annual trip expenditures are estimated by multiplying mean trip expenditures by the estimated number of adult trips in each trip mode (for-hire, private boat, and shore). Total annual durable expenditures were estimated by multiplying mean durable expenditures by the estimated annual number of adult participants in a given state.

The greatest employment impacts from expenditures on saltwater recreational fishing in the Pacific region were generated in California (17,100 jobs), followed by Washington (4,600 jobs). The largest sales in the nation were observed in California ($2.1 billion), followed by Washington ($542.1 million). Recreational fishing also generated $24.3 billion in income and $38.7 billion in value-added revenue. Durable equipment expenditures (e.g., rods and reels, fishing-related equipment, boats, vehicles, and second homes) accounted for 86% of total employment, 85% of sales, 87% of income, and 87% of value-added revenue (NMFS 2018b). The highest income in the Pacific region was generated in California ($819.4 million), followed by Washington ($209.4 million). Recreational fishing expenditures (on both fishing trips and durable equipment purchases) across the Pacific region in 2016 totaled about $2.3 billion (NMFS 2018b).

3.3.3.1 Fishing Trips

In 2016, 1.2 million recreational anglers took 5.2 million fishing trips in the Pacific region. This is an 8% decrease from 2015 and a 26% decrease from 2007. States with the highest number of recorded trips in the Pacific Region were California and Washington (Table 3-13). Regional trip expenditures totaled more than $526 million in revenue (NMFS 2018b).

TABLE 3-13. ECONOMIC IMPACTS OF THE PACIFIC RECREATIONAL FISHERIES 2016

State	Trips	No. of Jobs	Income (Thousands of Dollars)	Value Added
California	3,532	17,050	$819,382	$1,305,411
Oregon	684	3,048	$131,937	$192,078
Washington	1,008	4,597	$209,416	$339,605

Source: NMFS 2018b

3.3.4 Fishing Communities

NMFS has identified 30 major fishing ports on the U.S. west coast that significantly engage in commercial or recreational fisheries (84 FR 22051). They were primarily selected because of vessel statistics, along with pounds and value of commercial fish landed in those ports. The 30 top leading fishing ports by revenue and state for 2016 and 2017 include thirteen communities in California, four in Oregon, and thirteen in Washington as shown in the Table 3-14. As described in the 2015 PEA, many of these communities are home ports for fishing vessels that hold permits in both the Pacific and North Pacific Oceans so they spend part of the year fishing in Alaska (84 FR 22051). The top ranked port by revenue was Westport, Washington. Three of the top six revenue producing ports were in Oregon (Table 3-13).

TABLE 3-14. 2016 AND 2017 COMMERCIAL FISHERY LANDINGS BY TOP 30 PORTS IN CALIFORNIA, WASHINGTON, AND OREGON RANKED IN DOLLARS

Port by State	Rank 2017	Millions of Dollars	Rank 2016	Millions of Dollars
California				
Port Hueneme-Oxnard-Ventura	2	$52.6	6	$26.0
Los Angeles	7	$26.1	14	$18.6
San Francisco Area	13	$14.5	8	$23.2
Bodega Bay	14	$13.0	17	$13.8
Santa Barbara	15	$12.8	18	$13.6
Princeton/Half Moon Bay	16	$11.0	15	$16.6
Eureka	17	$10.4	19	$12.7
Fort Bragg	19	$9.2	23	$7.3
San Diego	22	$7.8	21	$8.3
Crescent City	23	$7.4	9	$22.9
Monterey	24	$6.9	28	$5.8
Morro Bay	26	$6.5	24	$7.1
Moss Landing	28	$4.5	26	$6.0
Oregon				
Newport	3	$52.6	2	$47.8
Astoria	4	$40.0	3	$42.3
Coos Bay - Charleston	6	$27.5	5	$27.9
Brookings	21	$8.4	16	$14.7
Washington				
Westport	1	$63.9	1	$59.2
Seattle	5	$29.0	7	$25.6
Bellingham	8	$22.7	12	$20.5
Ilwaco-Chinook	9	$22.0	10	$22.1
Anacortes-LaConner	10	$21.3	13	$19.0
Shelton	11	$15.5	4	$36.4
Olympic	12	$15.1	11	$20.6
Willapa Bay	18	$9.9	20	$10.8
Neah Bay	20	$8.7	25	$7.0
Blaire	25	$6.8	27	$5.9
Tacoma	27	$5.4	22	$7.8
Everitt	29	$2.9	29	$2.3
La Push	30	$2.6	30	$1.2

Source: 84 FR 22051

4 ENVIRONMENTAL EFFECTS

Chapter 4 describes the potential environmental consequences of the Status Quo/No Action alternative (Alternative 1) and the proposed SWFSC fisheries and ecosystem research activities for the period 2020 – 2025 (Alternative 2) as described in Chapter 2. As a supplement to the original PEA published by NMFS in 2015, which analyzed a full suite of fisheries and ecosystem research, this SPEA focuses only on those new or modified research activities that were not previously evaluated in the 2015 PEA. This SPEA also summarizes potential impacts of fisheries and ecosystems research due to recent (2015-2019) changes in resources within the research areas described in Chapter 1 (see Figure 1-1). As described in Chapter 3, if changes to physical, biological or socioeconomic resources do not alter the conclusions from the 2015 PEA, those resources are not discussed further in this SPEA. Resources described in Tables 3-1 through 3-10 were evaluated in terms of whether: 1) proposed future SWFSC research would result in a different conclusion presented in the 2015 PEA; and 2) whether any recent changes such as species status (i.e., ESA status or whether a target species is considered overfished), changes in environmental conditions, or socioeconomic conditions warrant additional evaluation under the proposed SPEA alternatives. Cumulative effects, including but not limited to the influence of climate changes on resources within the Action Area, are discussed in Chapter 5. This chapter focuses only on those resources listed in Chapter 3 that require additional evaluation. For an evaluation of potential effects of research on all other resources please see the 2015 PEA (NMFS 2015a).

4.1 Methodology and Impact Criteria

Section 4.1 of the 2015 PEA describes the methodology used to evaluate potential direct, indirect and cumulative effects of fisheries and ecosystem research. Consistent with the approach used in the 2015 PEA, the following criteria (Table 4-1) are used to evaluate SPEA Alternatives 1 and 2 for those resources identified in Chapter 3 needing additional evaluation considering new information and/or the proposed scope of new research proposed 2020–2025.

For example, in the 2015 PEA, potential effects of contamination due to discharges from vessels, whether accidental or intentional, were evaluated. Discharges may include sewage, ballast water, fuel, oil, miscellaneous chemicals, garbage, and/or plastics. During SWFSC research activities from 2015 – 2018, there were no measurable discharges from any vessels. While discharges could still occur during future research (2020-2025), this type of event is expected to be rare. The potential effects of such discharge would be the same as described in the 2015 PEA and is therefore, not evaluated further in this SPEA.

TABLE 4-1. CRITERIA FOR DETERMINING EFFECT LEVELS

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

[1]Potential Biological Removal (PBR).

4.1.1 Impact Criteria for Marine Mammals

Following the approach used in the 2015 PEA to analyze potential effects of fisheries and ecosystem research on marine mammals, SPEA Alternatives 1 and 2 are evaluated using two factors, PBR and the categorization of commercial fisheries with respect to their adverse interactions with marine mammals.

Regarding the first factor, PBR is defined in the MMPA (16 U.S.C. § 1362(20)) as, "the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population." PBR is intended to serve as an upper limit guideline for fishery-related mortality for each species. Calculations of PBR are stock-specific and calculated as the product of the estimate of the minimum population size, reproductive potential of the species, and a recovery factor related to the conservation status of the stock (e.g., whether the stock is listed under the ESA or depleted under the MMPA). NMFS is required to calculate PBR (if possible) for each marine mammal stock under their jurisdiction and report PBR in the annual marine mammal SARs mandated by the MMPA. The PBR metric has been used extensively to assess human impacts on marine mammals in many situations involving mortality and serious injury (M&SI) and is recognized as an acceptable metric used by NMFS Office of Protected Resources in the evaluation incidental takes of marine mammals from commercial fisheries in U.S. waters.

Regarding the second factor, NMFS classifies all U.S. commercial fisheries into one of three categories based on the level of marine mammal M&SI that occurs incidental to each fishery, as published in the annual List of Fisheries (LOF). Category III fisheries are considered to have a remote likelihood of or no known incidental M&SI of marine mammals. Category II fisheries are those that have occasional incidental M&SI of marine mammals. Category I fisheries are those that have frequent incidental M&SI of marine mammals. These commercial fisheries categories are used as proxies for SWFSC fisheries and ecosystem research as a way to evaluate potential interactions with marine mammals during surveys.

As shown in Table 4-1, if projected annual M&SI of a marine mammal stock from SWFSC research is less than or equal to 10 percent of PBR for that stock, the effect would be minor in magnitude (similar to the LOF’s Category III fisheries that have a remote likelihood of measurable population change). Estimated annual M&SI from SWFSC research between 10 and 50 percent of PBR for that stock would be moderate in magnitude, similar to the LOF’s Category II fisheries where population effects may be measurable. Similar to LOF Category I fisheries that have frequent M&SI of marine mammals, SWFSC research that could result in annual M&SI greater than 50 percent of PBR would be considered a major effect due to potential impacts on a stock’s population. Note that NEPA requires several other components to be considered for impact assessments (see Table 4-1); the magnitude of impact is not necessarily the same as the overall impact assessment in a NEPA context.

In addition to projecting possible M&SI using the commercial fisheries classifications as a proxy for SWFSC research takes, this assessment of SPEA Alternatives 1 and 2 also provides a comparison of actual marine mammal takes during the period 2015 – 2018. Actual takes that occurred during this period represent the Status Quo/No Action (Alternative 1). This information, together with the fisheries classifications used to project takes during future SWFSC research (2020-2025) represent Alternative 2.

Concurrent with this SPEA, an application for potential incidental harassment of marine mammals associated with future SWFSC research (2020-2025) has been prepared pursuant to Section 101(a)(5)(A) of the MMPA (see Section 1.2). The MMPA LOA application is provided as Appendix B and estimates takes for each marine mammal stock that may occur due to SWFSC research. In the SPEA assessment as well as the MMPA LOA application, SWFSC research is grouped by gear type (i.e., trawl gear and longline gear), not by individual research activities (e.g., by survey). This precludes impact analysis of each individual survey or project and instead provides a basis for understanding interactions between specific gear used and marine mammals that may occur in a designated research area.

To evaluate potential cumulative effects on marine mammals, the contribution of SWFSC research is evaluated in combination with past, present, and reasonably foreseeable actions and events that may impact marine mammals (i.e., commercial fisheries and climate change). Potential cumulative effects presented in Chapter 5 have been analyzed using the same impact assessment criteria and thresholds as described in Table 4-1, only they consider the collective sources of M&SI and other types of impacts on marine mammals.

4.1.1.1 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 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 shift result in permanent threshold shift (PTS), where loss of hearing sensitivity is unrecoverable, or 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). While the 2019 publication considers more recent studies conducted since 2007 to better understand marine mammal hearing, the 2018 revised NMFS Technical guidance continues to be used for defining regulatory thresholds for calculating incidental takes of marine mammals under the MMPA. For this reason, the thresholds used in this SPEA and the MMPA LOA application are based on the 2018 revised NMFS guidance (NMFS 2018c).

The *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing* (NMFS 2018c) 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 4-2. As shown on 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 4-3).

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 4-2. 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. Dall’s porpoise)	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 2018c

TABLE 4-3. 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 2018c

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 120 dB rms for continuous noise sources (i.e., echosounder EK60/80 used in fisheries surveys) and 160 dB rms for impulsive noise sources. These interim behavioral effect thresholds 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 shown in Table 4-4 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. Temporary threshold shift (TTS) is by definition recoverable rather than permanent and is treated as ‘‘Level B harassment’’ under the MMPA.

TABLE 4-4. ACOUSTIC THRESHOLDS FOR LEVEL A INJURY

	Permanent Threshold Shift (PTS) Onset Acoustic Thresholds (Received Level)		
	Impulsive Sources		Non-impulsive Sources
Hearing Group	**Peak, L_{pk}, flat** ***(dB re 1 μPa)***	**Cumulative weighted SEL_{24h}** ***(dB re 1 μPa²·s)***	**Cumulative weighted SEL_{24h}** ***(dB re 1 μPa²·s)***
Low-frequency cetaceans	219	183	199
Mid-frequency cetaceans	230	185	198
High-frequency cetaceans	202	155	173
Phocid pinnipeds in water	218	185	201
Otariid pinnipeds in water	232	203	219

Source: NMFS 2018c
Notes: Peak sound pressure is "flat" or unweighted. Cumulative sound exposure level has a reference value of 1μPa2s. Cumulative levels should be appropriately weighted for the hearing group for assessment to the threshold.
SEL – Sound Exposure Level

4.1.2 Impact Criteria for ESA-Listed Salmon

As described in Section 3.2.1.1, SWFSC research has incidentally taken salmon and steelhead trout during trawl surveys, which use a Nordic 264 or Modified Cobb net[16]. To estimate the number of potential ESA-listed salmon associated with a particular ESU from the juvenile and adult salmon incidentally captured in the 2017 surveys, a two-step process was applied based on genetic sampling that was conducted on a proportion of salmon incidentally caught that year. For details on the analytical approach as well as the results, please see Section 4.3.1.2.1 for ESA-listed fish.

4.2 Mitigation Measures

By definition, mitigation means to "make less severe or intense; moderate or alleviate." The U.S. CEQ provided guidance in 1981 stating:

Mitigation measures discussed in an EIS must cover the range of impacts of the proposal. The measures must include such things as design alternatives that would decrease pollution emissions, construction impacts, esthetic intrusion, as well as relocation assistance, possible land use controls that could be enacted, and other possible efforts. Mitigation measures must be considered even for impacts that by themselves would not be considered "significant." Once the proposal itself is considered as a whole to have significant effects, all of its effects on the environment (whether or not "significant") must be considered, and mitigation measures must be developed where it is feasible to do so (CEQ, 1981).

Proposed mitigation measures organized by gear type for SPEA alternatives are listed in Table 2-3. Specific measures to reduce potential interaction with resources evaluated in detail in this chapter are discussed in the following sections where applicable.

[16]See Annual Reports under Section 7(a)(2) of the ESA for Fisheries and Ecosystem Research Conducted by Southwest Fisheries Science Center for reporting periods during 2016 – 2018.

4.3 Direct and Indirect Effects of the Alternatives

Chapter 2 provides a detailed description of Alternatives 1 and 2 (Status Quo/No Action and Future Proposed Research, respectively). The following sections present the results of the evaluation for resources identified in Chapter 3 as requiring additional consideration based on the activities described under each of the alternatives.

4.3.1 Direct and Indirect Effects of the Status Quo No Action Alternative

This section describes the results of a focused assessment on the research that occurred between 2015 and 2018 (i.e., Status Quo) on those resources identified in Chapter 3 as stated above. For example, the assessment of potential effects of SWFSC fisheries and ecosystem research on ESA-listed salmon during fisheries surveys for the period 2016 – 2018 are presented herein. This section also presents a comparison of the number of marine mammal incidental takes that occurred 2016 – 2018 to what was requested in the 2015 LOA.

4.3.1.1 Effects on the Physical Environment

Table 4-5 summarizes the potential effects of the Status Quo/No Action Alternative on elements of the physical environment that have been added or updated since the 2015 PEA. Potential environmental consequences on these elements are described in Table 4-1 and have been updated based on actions described for the new Status Quo/No Action alternative and newly available information presented in Table 3-1. Overall, SWFSC research would be expected to contribute to a better understanding of physical resources within research areas and the effects of recent conservation and management regimes as well as the expansion of sanctuary boundaries are expected to be beneficial.

TABLE 4-5. SUMMARY OF POTENTIAL IMPACTS OF THE STATUS QUO/NO ACTION ALTERNATIVE ON THE PHYSICAL ENVIRONMENT

Physical Environment	Potential Impact of Status Quo/ No Action Alternative	Description
Essential Fish Habitat	Minor *Beneficial*	The combination of new and revised EFH conservation areas and the reopening of trawling in selected areas is anticipated to minimize adverse impacts to groundfish EFH from the effects of fishing. Any potential impacts due to this change are expected to be ***beneficial.***
Closed Areas	Minor *Beneficial*	See EFH above.
National Marine Sanctuaries *Cordell Banks* *Gulf of Farallones*	Minor *Beneficial*	On March 12, 2015, the boundaries of both sanctuaries were expanded.

Overall, the effects of recent changes to regulatory regimes in the SWFSC research areas are expected to result in minor beneficial effects on physical resources. These changes do not alter the conclusions of the original analyses of fisheries research-related impacts on the physical environment presented in the 2015 PEA which were considered minor adverse.

4.3.1.2 Effects on the Biological Environment

Only certain ESA-listed fish, target fish, ESA-listed marine mammals, and non-listed marine mammals are considered in the following subsections. As described in Sections 3.2.3, 3.2.4 and 3.2.5, seabirds, sea turtles and invertebrates did not change sufficiently to warrant detailed re-analysis in this SPEA.

4.3.1.2.1 Effects on Fish

Section 3.2.1 describes ESA-listed fish species, target species, prohibited species and HMS species in the CCRA, ETPRA, and ARA. As shown in Section 3.2.1, not all fish species require evaluation under the SPEA proposed alternatives; only those species potentially affected by the changed scope of activities, or species with a change in status are evaluated in the following subsections. Section 3.2.1 and Tables 3-2, 3-3, and 3-4 show that only ESA-listed and target species in the CCRA warrant further analysis. The status and expected impacts from Status Quo/No Action alternative components on prohibited or HMS species have not changed (see Table 3-4), and these species are not discussed further.

<u>ESA Listed-Fish Species</u>

Table 4-6 brings forward CCRA ESA-listed fish species identified in Table 3-2 as requiring further evaluation, and it summarizes the potential effects of the Status Quo/No Action Alternative on these species. There are no ESA-listed fish species potentially impacted in the ETPRA and ARA.

TABLE 4-6. SUMMARY OF POTENTIAL IMPACTS OF THE STATUS QUO/NO ACTION ALTERNATIVE ON ESA-LISTED FISH

ESA-listed Fish	Potential Impact of Status Quo/No Action Alternative: Mortality from Surveys	Potential Impact of Status Quo/No Action Alternative: Disturbance Due to Sound Sources	Description
Pacific eulachon Southern DPS (T)	Minor *Adverse*	No Effect	Pacific eulachon have been incidentally captured during surveys 2016-2017 and 2019, mostly during CPS surveys (see text). No eulachon were caught in 2018.
Gulf Grouper (E)	No Effect	No Effect	Due to overfishing and reduction in numbers and range, NMFS listed the grouper as endangered in 2016. Gulf grouper are not likely to be caught incidentally by SWFSC due to their close proximity to shore.
Giant Manta Ray (T)	No Effect	No Effect	Giant manta rays are targeted and caught as bycatch, with high rates of removal from industrial purse-seine and artisanal gillnet fisheries (83 FR 2916). SWFSC is not likely to incidentally catch Giant manta rays during research.
Oceanic Whitetip Shark (T)	No Effect	No Effect	On January 30, 2018, NMFS listed the oceanic whitetip shark as threatened throughout its range (83 FR 4153). Bycatch in commercial fisheries combined with the rise in demand for shark fins is threatening oceanic whitetip sharks in the Pacific and Atlantic Oceans (Young *et al*. 2018). Oceanic whitetip sharks are targeted and caught as bycatch in commercial fisheries, SWFSC is not likely to incidentally catch these sharks during research.
Scalloped Hammerhead Shark (E)	No Effect	No Effect	Scalloped hammerhead sharks are targeted and caught as bycatch in commercial fisheries throughout their range. SWFSC is not likely to incidentally catch scalloped hammerhead sharks during research.
Chinook Salmon[1] Snake River, fall spring, and summer run Lower Columbia River Upper Willamette River Upper Columbia, spring run Puget Sound	Minor *Adverse*	No Effect	SWFSC research exceeded authorized take for one or more ESUs of ESA-listed Chinook salmon during surveys conducted between 2016 – 2018. These recent bycatch events (2016 – 2018) likely resulted in a moderate adverse effect on these populations in terms of magnitude (see Table 4-1). However, the limited extent of research in terms of geographic area and frequency results in a minor adverse effect overall..
Chum Salmon Hood Canal, summer run Columbia River	Minor *Adverse*	No Effect	In 2017, SWFSC research incidentally caught 46 chum identified from these ESA-listed populations based on natal stream proximity.
Coho Salmon S. Oregon/N. California Coast Oregon Coast Lower Columbia River	Minor *Adverse* No Effect	No Effect	SWFSC research exceeded anticipated take for ESA-listed salmon from S. Oregon/N. California in 2018 and therefore may have had a moderate adverse effect on the population in terms of magnitude (see Table 4-1). However, the limited extent of research in terms of geographic area and frequency results in a minor adverse effect overall.

ESA-listed Fish	Potential Impact of Status Quo/No Action Alternative		Description
	Mortality from Surveys	Disturbance Due to Sound Sources	
Sockeye Salmon ESUs Snake River Lake Ozette	Minor *Adverse*	No Effect	SWFSC research did not exceed expected take levels for sockeye salmon. Takes that did occur are considered to have had a minor adverse effect on the population.
Steelhead Trout South California Coast South-central California Coast Central California Coast California Central Valley Northern California Upper Columbia River Snake River Basin Lower Columbia River Upper Willamette River Middle Columbia River Puget Sound	Minor *Adverse*	No Effect	SWFSC research did not exceed anticipated take levels for steelhead trout. In 2018, there were 12 takes of the Northern California DPS. Takes that did occur in 2018 were more than the level identified in the ITS but did not occur again and would be considered to have had a minor adverse effect on the population.

[1]Please see Table 4-7 for reported incidental take during SWFSC research conducted 2016 – 2018.

Disturbance and Changes in Behavior due to Sound Sources

An analysis was conducted to evaluate potential acoustic impacts to fish species present in SWFSC research. Fish may exhibit behavioral changes such as diving towards the seafloor or relocated from the area where vessels are approaching as a result of underwater sound or the presence of vessels. While these effects may occur due to SWFSC research, the low frequency of SWFSC surveys, as compared to regular shipping or commercial and recreational fishing, would not indicate that population level effects due to behavioral changes are likely. The use of underwater equipment that may produce noise such as EK60/80 echosounders, are also not likely to cause biologically significant behavioral changes in fish, given that most fish species have hearing ranges outside of the frequencies used by echosounders. One possible exception to this are few species in the herring family, which have been demonstrated to respond to frequencies up to 200 kHz (DOSITS 2019). Overall, disturbance and changes in fish behavior are expected to be short-term and not result in biologically significant changes to fish populations. Therefore, SWFSC research is expected to have no effect on fish behavior.

Mortality from Surveys

On August 31, 2015 the SWFSC received a BiOp and ITS under section 7(a)(2) of the ESA, valid through August 30, 2020, to take ESA-listed species including Pacific eulachon (Southern DPS), Eastern Pacific DPS of scalloped hammerhead shark, Pacific salmon and steelhead trout incidental to SWFSC fishery and ecosystem research activities in the CCRA and the ETPRA (NMFS 2015b).

The current ITS estimated that SWFSC's research would take 25 eulachon (or up to 1 kilogram) over the period 2015 – 2020 (NMFS 2015b). The Southern DPS of Pacific eulachon have been incidentally caught during CPS surveys in 2016, 2017 and 2019 with SWFSC reporting 4, 28[17] and 58[18] takes, respectively. The juvenile rockfish survey in 2017 also incidentally caught one Pacific eulachon. A majority of eulachon bycatch occurs during commercial offshore shrimp trawl fisheries (Gustafson *et al*. 2019) and additional sampling in nearshore areas are likely to adversely affect eulachon.

Gulf grouper are typically found in reefs and seamounts where water depth ranges from 30-45m. Direct harvest of Gulf grouper and bycatch during shrimp trawls has been a primary reason for their decline (NMFS 2015d). Gulf grouper observations in the Gulf of California have been reported in a few, scattered locations and are still generally rare. Directed fisheries for Gulf grouper occurred off California, with high catch rates in the early 1950s. Overharvest of the species led to no-take prohibitions adopted by the California Department of Fish and Game in 1976. Shrimp aquaculture has also been introduced along the coast of Mexico where tens of thousands of acres have been converted for shrimp farming which has likely altered grouper habitat (NMFS 2015d). Considering how rare the species is within the CCRA research area, the shallow depth where they are known to occur and the small amount of SWFSC research surveys that occur as compared to commercial fishing, SWFSC is not expected to result in any incidental take of Gulf grouper.

Demand for manta ray gills and other manta ray products parts in Asian markets is the most significant threat for this species. Available data reviewed by Oliver *et al*. (2015 as cited in NMFS 2016a) revealed that manta rays comprised the highest proportion of ray bycatch (specifically Giant manta rays) in the purse-seine fisheries in Indian Ocean (especially the Eastern Pacific Ocean). Bycatch in longline, trawl or gillnet fisheries was not large in any ocean basin (NMFS 2016a). U.S. bycatch of manta rays from fisheries operating primarily in the Central and Western Pacific Ocean, includes the U.S. tuna purse seine fisheries, Hawaii-based deep-set longline fisheries for tuna, and American Samoa pelagic longline fisheries. Estimates of *M. birostris* (i.e., Giant manta rays) bycatch in the U.S. tuna purse seine fishery (1.69 mt in 2015) (Secretariat of the Pacific Community, unpublished data, 2016), Hawaii-based deep-set longline fisheries (0.20 mt in 2013) (NMFS 2016a), and American Samoa pelagic longline fisheries (0.32 mt in 2013) (NMFS 2016a), are low and therefore impacts on the giant manta ray are likely to be minimal (NMFS 2016a). Considering the distribution and volume of SWFSC research is much lower than commercial fisheries, Giant manta rays are not likely to be caught incidentally as bycatch during SWFSC surveys. For this reason, no effects on this species from SWFSC research are anticipated.

There are limited data on global population size of the oceanic whitetip shark, however, available data suggest that the species has experienced a potentially significant decline due to fishing pressure. Bycatch in commercial fisheries combined with the rise in demand for shark fins is threatening oceanic whitetip sharks (Young *et al*. 2018). For example, the oceanic whitetip has declined by approximately 80 to 95 percent across the Pacific Ocean since the mid-1990s. Substantial abundance declines have also been estimated for the Atlantic Ocean, including an 88 percent decline in the Gulf of Mexico due to commercial fishing.

[17]Weight of one fish is missing – total weight of remaining 27fish = 0.43 kg
[18]Total weight of 58 fish = 1.455 kg

On September 21, 2015 NMFS received a petition to list the oceanic whitetip shark as threatened under the ESA throughout its range and to designate critical habitat. NMFS found the action may be warranted[19] and announced the initiation of a status review of the species. The review, published on December 1, 2017 (Young *et al*. 2018), summarized the best available data on the species and presented an evaluation of its status and extinction risk. On December 29, 2016, NMFS published a proposed rule to list the oceanic whitetip shark as threatened[20]. Based on the status review and proposed rule, NMFS determined that the oceanic whitetip shark was not presently in danger of extinction but is likely to become so in the foreseeable future. As such, NMFS listed the species as threatened under the ESA throughout its range[21]. NMFS also determined that critical habitat was not determinable at that time due to insufficient information regarding the physical and biological features essential to its conservation and recovery. While oceanic whitetip sharks are targeted in commercial fisheries and caught as bycatch, the limited research proposed by SWFSC is not likely to incidentally capture oceanic whitetip sharks.

Bycatch of Pacific Salmonids During SWFSC Trawl Surveys 2015-2019

The SWFSC CPS trawl surveys generally occurred June-August of each year 2015-2019. Several trawl types were used including a Nordic 264, a surface trawl, and a Modified Cobb, a mid-water trawl which was during the Rockfish Recruitment and Ecosystem Assessment Surveys. The location of incidental take occurred in higher quantities from Oregon to Canada, with a smaller number of incidental takes occurring in off the California coast. Further, Shelton *et al*. (2019) stated that the abundance of spring Chinook runs increase markedly during the summer and reflects a northerly shift in distributions of most Chinook salmon stocks during this period. This explains the higher biomass of Chinook salmon in the bycatch relative to other stocks.

Table 4-7 shows the total incidental take of all salmonids (ESA-listed and non-listed) by capture in SWFSC trawl gear during each reporting period since June 2015[22]. The general location of each survey during which salmonids were incidentally captured can be determined by the latitude recorded in PSIT reports for each bycatch event. Generally, as shown in Table 4-7, most salmon (94%) caught incidental to SWFSC surveys 2015-2019 were caught north of the Oregon/California border, and 50% of all salmon (ESA-listed and non-listed) were caught in Canada (702 out of 1,389). The largest number of salmonids caught in California occurred in 2018 when 51 salmonids were caught including 30 coho salmon, three Chinook salmon and 12 steelhead trout; the remaining six fish were not positively identified.

Salmon caught in 2017 and 2018 were genetically identified to stock where possible. Approximately 55-60% of the salmon caught between Oregon north into Canada in 2017 (167 out of 308) and 2018 (231 out of 385) were from non-ESA-listed stocks (PSIT Reports, 2015-2019). In 2018, 118 or 51% of the genetically identified salmon caught in Canada (north of 48.45 degrees N Latitude) (N = 230) were not, or not likely, from a listed ESU. The bottom row of Table 4-7 also shows the number of salmon caught incidentally during SWFSC surveys that occurred south of the Oregon – California border. As the origin of some salmon samples during the 2018 surveys are unknown, it is possible this percentage may be greater.

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[19] 81 *FR* 1376
[20] 81 *FR* 96304
[21] 83 *FR* 4153, January 30, 2018
[22] Source: Protected Species Incidental Take (PSIT) Reports, 2015-2019, NMFS, SWFSC, La Jolla, California

TABLE 4-7. INCIDENTAL TAKE OF ALL PACIFIC SALMONIDS (ESA-LISTED AND NON-LISTED) CAPTURED IN SWFSC TRAWL GEAR 2015-2019 BY REGION OF CAPTURE[1]

Location of Capture	Proportion of Total Salmon Bycatch in Number of Fish and Percentage (%)			
	2015-2016	**2017**	**2018[2]**	**2019**
Canada	156 (93%)	153 (48%)	230 (49%)	149 (47%)
Washington	5 (3%)	142 (45%)	90 (19%)	126 (39%)
Oregon	6 (4%)	13 (4%)	100 (21%)	31 (10%)
California	1 (1%)	8 (3%)	51 (11%)	14 (4%)
Total Salmonids Caught Incidental to SWFSC Surveys (ESA-listed and non-listed)	**168**	**316**	**471**	**320[3]**
Number of Chinook Salmon Caught below Oregon/California from listed ESUs	0	7 Total 1 Klamath River, 6 North California ESU	4 Total 1 Klamath River 3 North California ESU	11 Total 1 Central Valley Spring ESU

[1]These reported takes do not include fish captured in a single haul off Vancouver Island June 28, 2017, when 17.76 kg of juvenile salmon were incidentally caught as bycatch (representing 1,866 salmon). This event is discussed separately in a following section of this assessment
[2]The SWFSC incidentally caught 610 salmon as bycatch during the CPS surveys (591 fish) and Rockfish Recruitment and Ecosystem Assessment Survey (19 fish) during 2018. Four hundred seventy-one salmon were identified to an ESU using genetics and these are reported in this table. The rest were discarded.
[3]Due to subsampling, 311 are currently undergoing genetic analysis.

Incidental Take of ESA-Listed Salmonids, 2015-2019

The number of genetically identified ESA-listed salmon by ESU taken in SWFSC trawl gear during each reporting period since July 2015[23] are shown in Table 4-8. The far right column shows the total take expected each year over the authorization period (August 2015 – August 2020). All takes are assumed to lead to mortality. The numbers reflect the total number of genetically-identified species taken.

Based on Protected Species Incidental Take (PSIT) data, the majority of salmon incidentally caught as bycatch during the period 2015 – 2019 were identified as juveniles. Table 4-9 provides a summary of the number of juveniles versus adult salmon as reported in PSIT 2015 – 2019. Please note, the results in Table 4-9 do not report ESA-listed versus non-ESA-listed salmon, rather all salmon as a total in terms of adults versus juveniles.

[23]These reported takes of ESA-listed salmon do not include fish captured in the June 28, 2017, sample. These are discussed separately in a following section of this assessment.

TABLE 4-8. INCIDENTAL TAKE OF ESA-LISTED SALMON CAPTURED IN SWFSC TRAWL GEAR 2015-2018[1]

Species[2]	Aug 31, 2015-Dec. 31, 2016[3]	Jan. 1-Dec. 31, 2017[4]	Jan 1 - Dec 31, 2018[5]	2015 -2020 Anticipated Annual Take
Chinook Salmon				
Snake River fall run	3	24	40	2
Snake River spring, summer run	0	0	1	2
Lower Columbia River	2	10	39	5
Upper Willamette River	0	10	3	3
Upper Columbia, spring run	0	1	0	2
Puget Sound	0	8	36	3
Chum Salmon				
Hood Canal, summer run	0	0	0	5
Columbia River	2	0	0	5
unknown population	-	46	87	-
Coho Salmon				
S. Oregon/N. California Coast	3	0	36	29
Oregon Coast	1	0	6	30
Lower Columbia River	2	0	6	25
Sockeye Salmon ESUs				
Snake River	0	0	0	4
Lake Ozette	0	0	0	4
Steelhead Trout				
South California Coast	0	0	0	4
South-central California Coast	0	0	0	4
Central California Coast	0	0	0	4
California Central Valley	0	0	0	4
North California	0	0	12	4
Upper Columbia River	0	0	0	4
Snake River Basin	0	0	0	4
Lower Columbia River	0	0	0	4
Upper Willamette River	0	0	0	4
Middle Columbia River	0	0	0	4
Puget Sound	0	0	0	4

[1]Juveniles and sub-adults or some combination of both.
[2]Only species considered are those identified in Table 3-2 as warranting re-analysis.
[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 August 31, 2015 – December 31, 2016.
[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 January 1, 2017 – December 31, 2017
[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, 2018 – December 31, 2018. Take numbers in the 2018 Annual Report were extrapolated based on field data.

TABLE 4-9. NUMBER OF ADULT VERSUS JUVENILE SALMON[1] TAKEN[2] DURING SWFSC RESEARCH 2015 - 2019

Survey Year	Subadult/ Adult	Juvenile	Unidentified
2015	7	20	22
2016	9	106	4
2017	38	278	34
2018	186	302	0
2019	40	271	0
TOTAL	302	1,091	38

[1]Species not identified as ESA or non-ESA listed.
[2]Note some fish were released alive

A description summarizing bycatch events since 2015 is based on PSIT Reports and the 2016-2018 Annual Reports[24] as required under Section 7 (a)(2) of the ESA, and a subsequent analysis to determine whether the salmon caught as bycatch were from ESA-listed ESUs in the following sections (as summarized in Tables 4-10 and 4-11).

Reporting Period August 31, 2015 – December 31, 2016

The SWFSC incidentally caught 168 juvenile and adult salmon as bycatch in trawl nets between August 31, 2015 and December 31, 2016. The spring and summer CPS survey nighttime trawls using the Nordic 264 net caught 167 salmon while the Rockfish Recruitment and Ecosystem Assessment Survey using a modified Cobb net caught one salmon as bycatch. These takes were a combination of juvenile and adult salmon[25].

Based on genetic analyses of the salmon bycatch 37 Chinook salmon were identified as captured during this period, five of which were associated with two ESA-listed ESUs (three individuals from the Snake River fall run and two from the Lower Columbia River). A total of 44 coho were also part of the bycatch, six of which were from ESA-listed ESUs (two from Lower Columbia River, one from Oregon Coast, and three from S. Oregon/N. California Coastal ESU). Fifty-eight percent (97 fish) of the bycatch during this period were chum salmon. One Chinook salmon from an unidentified ESU was caught in California during this period and was assumed to be ESA-listed (Table 4-8).

Reporting Period January 1 – December 31, 2017

No salmon were caught during the spring CPS survey. As presented in Table 8 of the 2017 ESA Annual Report, the results of 173 DNA subsamples from Chinook salmon incidentally caught, confirmed that at least 53 Chinook salmon were from ESA-listed ESUs and the remaining 120 fish were not listed under the ESA.

In a single haul off Vancouver Island June 28, 2017, 17.76 kg of juvenile salmon were incidentally caught as bycatch (representing a total of 1,866 ESA-listed and non-listed salmon). The salmon were incidentally

[24]Source: PSIT. Salmon not always identified to species; therefore, age-class data are presented for all salmon as a total.
[25]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

captured during nighttime trawl surveys. The majority of the salmon were caught during the CPS survey (1,832 fish). Saved samples were not analyzed for DNA analysis. Therefore, no definitive ESU or stock identification is available for this event for most of these fish. The following analyses is based on information from the total sample and the available NA analyses.

Analysis of Salmon Bycatch to Determine the Species and Proportion of Discarded Salmon in the 2017 Survey Season from ESA-Listed ESUs

The following two-step process was used to estimate the number of ESA-listed salmon associated with a particular ESU from the aforementioned 1,866 juvenile and adult salmon incidentally captured on June 28, 2017.

Step 1: Of the 1,866 total salmon caught as bycatch in the 2017 surveys, the SWFSC was able to genetically identify a subsample of 316 to species (see Table 4-10, row 1). The proportion of each salmon species (shown as a percentage) is also represented in row 2 of Table 4-10. Based on these proportions, the total number of each species caught as bycatch was estimated from the total 1,866 fish caught (Table 4-10, row 3). This assumes that the percentages in the 316 salmon that were identified to a species is representative of the entire bycatch of 1,866 fish. This also assumes any of the 316 genetically sampled fish identified to a species but of “unknown” origin are from ESA-listed ESUs. Using this approach, it is clear that the majority of salmon incidentally caught (94.3%) were likely Chinook salmon (1,022 fish) and chum salmon (737 fish). Notably, the genetic analysis further determined that a large percentage of the Chinook and chum bycatch was from non-ESA-listed populations or stocks. Of the genetically identified sample of 316 salmonids, 120 were Chinook, 79 chum, 15 coho and 2 steelhead trout (Table 4-10, row 7).

TABLE 4-10. PROPORTION OF ESA-LISTED AND NON-ESA-LISTED PACIFIC SALMON AND STEELHEAD TROUT INCIDENTALLY CAUGHT AS BYCATCH DURING SWFSC RESEARCH IN 2017

Grouping	Chinook	Chum	Coho	Sockeye	Steelhead	TOTAL
Total Number Genetically Identified By Species	173	125	15	0	3	316
Proportion of Species Within the Total Identified Genetically	54.7%	39.6%	4.7%	0.0%	0.9%	100%
Total Number Caught by Species (based on proportion above)	1,022	738	89	0	18	1,866
Number of ESA-Listed Salmon Out of the 316 Genetically Identified Fish	53	46	0	0	1	100
Percentage of Salmon Assumed to be Non-ESA-Listed	69%	63%	0%	0%	66%	68.5%
Percentage of Genetically Identified Salmon Assumed to be ESA-Listed	31%	37%	0%	0%	33%	31.5%
Estimated Number of ESA-Listed Salmon (as a proportion of total take)	**313**	**272**	**0**	**0**	**6**	**591**

Source: 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

Non-listed salmon represented approximately 69.5% of the 316 fish that were genetically identified (Table 4-10, row 5). With the non-listed Chinook and chum salmon removed from the bycatch estimates, the number of ESA-listed salmon caught in 2017 is significantly reduced to approximately 31.5% of the bycatch (see Table 4-10, row 6). Two of the three steelhead trout captured were from a non-listed population and none of the coho salmon captured were from a listed population.

The number of ESA-listed salmonids that were part of the bycatch and that could be identified to an ESU or DPS was 100 (Table 4-10, row 4) and the resulting extrapolated total estimated number of listed salmon taken in the 2017 surveys was 591 fish (Table 4-10, row 7). Therefore, approximately 591 out of the 1,866 salmon caught were estimated to be from ESA-listed salmonids (Table 4-10, row 5). The estimated bycatch of Chinook and chum salmon from ESA-listed ESUs is relatively low (31 and 37%, respectively) when compared to the total number of fish assumed to be from non-ESA-listed stocks (68.5%).

Step 2: Based on the results of genetic sampling summarized in Table 4-10 to determine what proportion of the bycatch were ESA-listed salmon, SWFSC conducted additional analyses to identify specific ESUs for that subset of fish. The results of this analysis are summarized in the 2017 Annual Report for the period January 1 – December 31. Based on genetic sampling, five Chinook salmon ESUs were identified (Table 4-11). The known bycatch of Chinook salmon came from following ESUs: Snake River fall-run, Lower Columbia River, Upper Columbia River spring-run, Upper Willamette River, and Puget Sound. The SWFSC does not currently have the capability to perform stock ID on chum salmon or steelhead. However, the SWFSC evaluated the location of capture and proximity to natal streams (based on Shelton *et al*. 2019) to estimate that 21 chum were likely associated with ESA-listed stocks.

The hypothesized ESA-listed chum salmon were likely from the Hood Canal summer run or Columbia River as they are the only two ESA-listed ESUs of chum salmon in the CCRA. Based on the 2016 abundance estimates of juvenile and sub-adult salmon from NMFS (2016a), estimated chum salmon bycatch shown in Table 4-11 (6,980,712) can be further partitioned into the Columbia River ESU (3,462,120) and Hood Canal ESU (3,518,592), which includes 150,000 hatchery fish (Table 86, NMFS 2016a). Based on these abundance estimates, it could be assumed that approximately 50% of each ESU could be represented in the bycatch. Using this assumption, approximately 50% of the estimated bycatch of listed chum salmon in the 2017 bycatch (or 133 salmon) would come from each ESU. This would reduce the estimate of the 2017 bycatch as a percentage of each ESU to 0.0019%, rather than the 0.0038% estimated for the combined chum salmon catch. There were no ESA-listed coho or sockeye salmon taken during the 2017 surveys.

TABLE 4-11. ESTIMATES OF PACIFIC SALMON AND STEELHEAD TROUT CAUGHT IN JUNE 2017 BYCATCH SAMPLE BY ESU INCLUDING ESTIMATES FROM UNKNOWN AND NON-LISTED ESU

Grouping	Chinook					Chum	Coho	Sockeye	Steelhead	TOTAL
	Snake River Fall	*Lower Columbia River*	*Upper Willamette River*	*Upper Columbia River Spring*	*Puget Sound*	*Unknown*	*n/a*	*n/a*	*Unknown*	
Total Number of Genetically Identified Fish By Species[1]	**173**					**125**	**15**	**0**	**3**	**316**
Number of ESA-Listed Fish By Species (Table 4-8)	53					21	0	0	0	100
Number (%) Genetically Identified Salmon by ESU	24 (45%)	10 (19%)	10 (19%)	1 (2%)	8 (15%)	0 (0%)	0	0	0 (0%)	100
Estimated Number of ESA-listed Salmon taken as Bycatch by ESU	143	60	60	6	48	266	0	0	6	589
2016 Abundance[2]	8,491,288	48,165,567	7,092,097	1,000,558	41,809,650	6,980,712[2]	9,175,905	551,481	9,610,849	132,878,107
2017 Bycatch as % of 2016 Abundance	0.001684%	0.000124%	0.000846%	0.000599%	0.000114%	0.003810%	0%	0%	0.000062%	0.000443%

[1] See Table 4-10
[2]2016 abundance for chum salmon was estimated as 3,462,120 Columbia River ESU and 3,518,592 from Hood Canal ESU including150,000 hatchery fish) (NMFS 2016a).

The high percentage of non-listed Chinook salmon in the bycatch from the June 28, 2017, trawl survey may be related to the northern location of the haul near Vancouver Island. According to Shelton *et al.* (2019) the likelihood of catching ESA-listed Chinook salmon diminishes as the survey location moves further north away from their rivers of origin. Under this assumption, the location of the June 2017 trawl survey was sufficiently far enough away from Washington/Oregon rivers of origin that a large percentage of the bycatch may have come from Canadian or southeast Alaska stocks which are not ESA-listed. For example, in British Columbia the average return from 2010 - 2015 was 10.2 million sockeye per year (range 2-28.2 million, DFO 2016a). In 2012, the total abundance of Fraser River sockeye was 2,219,200 fish (PSC 2017). In 2015, the Fraser River sockeye forecast was the third highest in average adult return abundance of Fraser River sockeye salmon with an average return (1951-2011) of 5,300,000 fish (DFO 2016a, 2016b). Therefore, the likelihood of a listed sockeye being captured in a SWFSC fishery survey significantly decreases as the survey moves north based simply on the overwhelming abundance of non-listed stocks originating in British Columbia and southeast Alaska as compared to the abundance of listed salmon ESUs from the northwest United States.

Also, as surveys move north, enhanced stocks of hatchery-raised juvenile salmonids from southeast Alaska become more prevalent during these surveys (NMFS 2017a). For example, hundreds of thousands of hatchery-produced non-listed chum, coho and sockeye salmon are released in southeast Alaska each year. As a result, the percentage of Alaska-enhanced stocks of salmon caught in AFSC southeast Alaska surveys is very high and the percentage from Pacific northwest listed DPSs is low each year (Wertheimer *et al*. 2016; NMFS 2017a, 2019). Ninety-seven percent of the salmon catch in AFSC's Southeast Alaska coastal monitoring surveys during 2011-2016 was composed of chum, sockeye and coho salmon from non-ESA-listed, enhanced Alaska salmon stocks while there were only a few individual salmon from stocks that were not from Alaska (Orsi *et al*. 2013, 2014, 2015; Wertheimer *et al*. 2016).

In June 2017, 125 chum salmon were also incidentally caught by the SWFSC as bycatch offshore of Vancouver Island. While the SWFSC does not have the capability to perform stock identification using genetic testing on chum salmon or steelhead, the SWFSC did evaluate the location of bycatch capture and proximity to natal streams to determine whether the takes could be from ESA-listed ESUs (similar to the methodology reported in Shelton *et al*. 2019). Based on the evaluation, approximately 21 salmon were likely associated with an ESA-listed ESU. Fish identified as being from an ESA-listed ESU were likely from the Hood Canal summer run or the Columbia River ESU of chum salmon as these are the only two listed chum salmon ESUs in the region. Most of the chum salmon were from non-ESA listed stocks or populations.

Reporting Period January 1 – December 31, 2018

The SWFSC incidentally caught 610 salmon as bycatch during the CPS survey (591 fish) and Rockfish Recruitment and Ecosystem Assessment Survey (19 fish)[26]. Four hundred seventy-one salmon were identified to an ESU using genetics; the remaining 86 fish were discarded; however, they were visually identified as Chinook salmon. Of the 471 sampled fish, 230 were caught in Canadian waters, and of these, 62 were adipose-clipped (27%, representing ESA-listed salmon). In Washington, 90 salmon were caught, 46 of which were adipose-clipped (51%). Likewise, 98 were caught in Oregon, with 43 presenting with

[26]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

adipose-clips (44%), and 50 caught in California, with 4 presenting with adipose-clips (6%). Based on genetic sampling results, five species of Chinook salmon were identified as being from the following ESA-listed ESUs: the Snake River fall run, Snake River spring/summer run, Lower Columbia River run, Upper Willamette River run, and the North and South Puget Sound run. Three ESA-listed coho salmon ESUs were also identified in the bycatch. Six coho were from the Oregon Coast ESU, six were from the Lower Columbia River ESU and 35 coho were from the S. Oregon/N. California Coast ESU. SWFSC was not able to identify the stock association for 87 chum salmon incidentally caught. Of the total bycatch only 15 steelhead trout were caught, 12 were identified as likely associated with the ESA-listed Northern California ESU. Three steelhead trout could not be genetically identified. Forty-three other fish were not able to be identified due to degradation of the samples.

<u>Reporting Period January 1 – December 31, 2019</u>

The SWFSC incidentally caught 320 salmon as bycatch during the CPS survey (309 fish) and Rockfish Recruitment and Ecosystem Assessment Survey (11 Chinook salmon, 6 with fin clipped) in 2019. Genetic analysis is currently underway for salmon incidentally captured during the CPS Survey. Based on genetic sampling results from the Rockfish Recruitment and Ecosystem Assessment Survey, 1 salmon was identified as being from the ESA-listed Central Valley spring run, and the remaining 10 were from unlisted stocks.

Summary of Incidental Bycatch of Salmon Under Status Quo (Alternative 1)

Genetic analysis of salmon caught in several SWFSC surveys between 2016-2018 have demonstrated that the origin of ESA-listed salmon caught as bycatch in SWFSC surveys are largely from Washington and Oregon. Further, an origin of a bycaught salmon can be estimated based on the location of the survey at the time of the bycatch, and the proximity of the survey to ESU natal streams (as reported in Shelton *et al*. 2019). The composition of most of the salmon bycatch during each of the survey periods, 2016 through 2018, was represented by fish whose natal origin was from the Oregon/California border north to, at least British Columbia, Canada. Salmon and steelhead trout ESUs originating below the northern California-southern Oregon border were minimally represented in these bycatch events.

In 2016, ESA-listed Chinook salmon from two ESUs were identified in the bycatch: the Snake River fall run and the Lower Columbia River run. Coho salmon in the bycatch were from the Lower Columbia River, the Oregon Coast, and the S. Oregon/N. California Coastal ESUs.

In 2017 the largest bycatch event occurred off Vancouver Island, the northernmost reaches of the survey. The known bycatch of ESA-listed Chinook salmon came from the Snake River Fall ESU, three runs of the Columbia River/Willamette River ESUs, and Puget Sound. The SWFSC also compared the location of capture with the proximity to natal streams and estimated that 21 chum were also associated with ESA-listed stocks. The ESA-listed chum salmon in the genetic sample were likely from the Hood Canal summer or Columbia River as they are the only two ESA-listed ESUs of chum salmon in the CCRA.

More importantly, the bycatch of salmon in 2017 off Vancouver Island was largely from non-listed populations whose origins were likely British Columbia or southeastern Alaska (see Table 4-10). Sixty-eight percent of the total bycatch were from non-listed populations, mostly Chinook and chum salmon. As the survey moved north of U.S. waters, the large numbers of non-listed Chinook salmon dominated the bycatch. The northern location of the sampling site in 2017 likely relates to the small percentage of ESA-listed salmon caught (see Shelton *et al*. 2019).

The high percentage of Chinook salmon in the research trawl bycatch (Table 4-10) is consistent with the amount of Chinook bycatch in the whiting fishery off Washington. The whiting fishery has low or no bycatch of coho, chum, sockeye, or steelhead (NMFS 2017a).

In 2018, 610 salmon were caught as bycatch in SWFSC surveys. Based on the 2018 genetic identification results of 471 sub-sampled salmon, five species of Chinook salmon were identified as being from the following ESA-listed ESUs: the Snake River fall run, Snake River spring/summer run, Lower Columbia River run, Upper Willamette River run, and the North and South Puget Sound run. Three ESA-listed coho salmon ESUs were also identified in the bycatch. Six coho were from the Oregon Coast ESU, six were from the Lower Columbia River ESU and 35 coho were from the S. Oregon/N. California Coast ESU. ESUs whose origin are below the Oregon-California border were not represented in the bycatch.

Chinook salmon have also been incidentally taken during the Rockfish Recruitment and Ecosystem Assessment Surveys in 2016, 2017 and 2018 with one, four and nineteen Chinook taken, respectively. Two steelhead were also incidentally caught in 2017 during the Rockfish Recruitment and Ecosystem Assessment Survey and CPS Survey (i.e., one fish during each survey was taken).

The biological effect of the bycatch for each ESU relative to an estimate of the 2016 juvenile abundance for each ESU is considered small (i.e., approaching zero) (Table 4-10, row 6). In all cases the percentage of bycatch by ESU is significantly less than 0.01% of the estimated abundance for that ESU. While scientific research and monitoring activities have the potential to affect individual survival as a result of bycatch, scientific research has never been identified as a factor that would impact the population dynamics of an ESU or act as a threat preventing recovery of listed salmonids. However, due to the potential for incidental capture, SWFSC research activities may have a moderate adverse effect on ESA-listed Chinook salmon in terms of magnitude (i.e., there may be measurable effects on the population as defined in Table 4-1). However, SWFSC research is relatively limited in terms of geographic scope and the frequency of surveys. Therefore, considering research is relatively short-term and that research has not been identified as a factor that could impact the overall population, overall effects are considered minor adverse.

Expectations Moving Forward Regarding Potential Salmon Bycatch

Genetic analyses of salmon caught in several SWFSC surveys between 2015-2019 have demonstrated that the origin of ESA-listed salmon caught as bycatch in SWFSC CCE surveys can be estimated based on the location of the survey at the time of the bycatch, and the proximity of the survey to ESU natal streams (consistent with that reported in Shelton *et al*. 2019). However, a genetic analysis can be used only after the bycatch event has occurred. Therefore, it cannot be reasonably used as a measure to minimize or avoid bycatch during the surveys.

Despite best scientific information available, it is not currently possible to differentiate between CPS species and juvenile salmon in acoustic backscatter data. Moreover, trawl data suggests that CPS species and juvenile salmon may cohabitate and jointly school in near coastal habitats. SWFSC must continue to survey these areas to provide management with best estimates of CPS populations. Given these factors, takes of ESA-listed species may continue to exceed currently anticipated levels (see Section 4.3.2.1.1 for the analysis of salmon bycatch under future research beginning in 2020).

To reduce bycatch of protected species during trawl surveys, standard tow durations would be limited to 45 minutes or less at targeted depth, excluding deployment and retrieval time. These tow durations are intended to reduce the likelihood of attracting and incidentally taking protected species. Moving forward, SWFSC will continue to properly document and identify salmon takes, endeavor to better understand trends in catches, and contribute to management's understanding of listed salmon populations.

As additional context, as described in the 2015 BiOp for SWFSC research, salmon are caught incidentally in large commercial fisheries off the U.S. west coast including the purse seine fisheries that target coastal pelagic species (CPS) such as sardines and squid. NMFS has completed several Section 7 consultations to determine effects of the commercial fishery on ESA-listed salmon. Through this process, NMFS has concluded that incidental take of salmon in the fishery would not likely jeopardize the continued existence of the ESUs (mostly Chinook) under consideration (NMFS 1999; NMFS 2006).

Climate change and associated changes in ocean conditions have a profound effect on the distribution and abundance of anadromous fishes including salmon (Peterson *et al.* 2019). Salmon require cold water for spawning. Salmon survival rates in the marine environment have been closely tied to ocean temperature, with colder periods being generally favorable for survival and warmer periods unfavorable (NMFS 2018d; Peterson *et al*. 2019). Cold conditions are generally favorable for Chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon, whereas warm conditions are not. These physical and biological ocean conditions affect the growth and survival of juvenile salmon in the northern California Current off Oregon and Washington. For example, a 4-year period of warm ocean conditions between 2002 and 2006 negatively impacted salmon populations in the California Current (Peterson *et al* 2006; as cited in NMFS 2018d). Since the late 1970s, conditions in the California Current have been generally warm and while there was a period of high variability that began with colder, more productive conditions between 1999 and 2002, climate projections indicate that temperatures appear to continue to be increasing and generally detrimental to salmon populations (NMFS 2018d).

Physical, biological, and ecosystem indicator metrics for predicting salmon survival 1–2 years in advance are presented in Peterson *et al.* (2019). These metrics provide an example of using ocean ecosystem indicators to inform management decisions for endangered salmon. The biological indicators such as food–chain processes are directly linked to the success of salmon during their first year at sea. Biological indicators linked with physical oceanographic data can provide an understanding of the mechanisms leading to success or failure of salmon runs. For example, the authors demonstrate that larval stage winter biomass of common salmon prey in 2019 was the 20th lowest in the 22-year time series. In addition, the ichthyoplankton community in 2019 was dominated by offshore *taxa* and was similar to that seen in 2015-2017. This indicates poor food conditions for piscivorous juvenile salmon that out-migrated into the ocean in 2019 (Peterson *et al.* 2019). Generally, this suggests an adult chinook return during the period 2021-2022 (2 years out) similar to that in 2017-2018 (Peterson *et al.* 2019).

Also, when considering which salmon ESUs and steelhead DPSs might be incidentally captured in the future, survey location and timing should be taken into account for ITS take authorizations. Genetic analysis of salmonids caught in SWFSC surveys between 2016-2019 have demonstrated that the origin of ESA-listed salmonids caught as bycatch can be estimated based on the location of bycatch, and the proximity to natal streams (consistent with that reported in Shelton *et al.* 2019). The results of past surveys could be used to predict which ESUs/DPSs might be impacted based solely on the location and timing of the survey. The extent of ESA-listed salmonid take that might be anticipated in future surveys should be based on those ESUs/DPSs with the greatest likelihood of being captured due to the location of the survey relative to the origin of listed populations. According to Shelton *et al.* 2019, seasonal variation in the timing of the surveys, while important, is not as important a factor in predicting the marine location of fall Chinook salmon as was the location of the surveys relative to the natal stream (Shelton *et al.* 2019). Therefore, given no change in the spatial location of the surveys, a significant change in the structure of the bycatch is not expected. The results of past surveys can be used to make a reasonable prediction as to what ESUs may be impacted based solely on the location and timing of the survey. Several ESUs of Chinook salmon may dominate the catch throughout the survey period. Chum salmon have also been caught during each survey. As the surveys move north into Washington and Canada a large percentage of the Chinook and chum bycatch is from non-listed stocks of Canada from British Columbia and possibly southeast Alaska as would be expected. The spatial-temporal location of the surveys will continue as in the past to retain consistency over a large time-period, therefore, it is feasible to assume ESUs incidentally taken in the 2015-2019 surveys may similarly occur in future surveys.

Beginning in 2018, to further understand bycatch rates for ESA-listed salmon and to identify ESUs to the extent practicable, SWFSC began genetically sampling all individual salmon for surveys that incidentally catch 50 salmon or less. Genetic sampling of a subset of salmon bycatch is also undertaken for hauls with bycatch greater than 50 salmon. A description of the protocol used for genetic sampling is provided in C. Genetic sampling, together with evaluating salmon bycatch relative to natal streams as described by Shelton *et al.* (2019), aims to address identifying fish to species and ESU. For a discussion on potential salmon bycatch during future SWFSC research (2020 and beyond), please refer to Section 4.3.2.1.1.

Target Species

As described in Section 3.2.1.2, only three species of target fish from the CCRA changed sufficiently to warrant further analysis under the SPEA alternatives; these species are shown in Table 4-12. As shown in Table 3-3, target fish in ETPRA and ARA do not require re-analysis under the SPEA alternatives.

TABLE 4-12. SUMMARY OF POTENTIAL IMPACTS OF THE STATUS QUO/NO ACTION ALTERNATIVE ON CCRA TARGET FISH

Target Fish	Potential Impact of Status/Quo/No Action Alternative		Description
	Mortality from Surveys	Disturbance Due to Sound Sources	
Chinook Salmon (non-listed ESUs)	Minor *Adverse*	No effect	No change in ESA-listed status; however, given recent bycatch events (2016 – 2018), additional analysis under SPEA alternatives is warranted. Low level mortality from research surveys (Tables 4-11 and 4-12) is not expected to result in any measurable changes at the population level.
Pacific Hake	Minor *Adverse*	No Effect	No change in status. Recent biomass assessment indicates there is an estimated 68% chance of the spawning biomass declining from 2019 to 2020, and an 84% chance of it declining from 2020 to 2021 under current level of catch. Low level mortality from research surveys (Tables 4-11 and 4-12) is not expected to result in any measurable changes at the population level.
Pacific Sardine	Minor *Adverse*	No Effect	The fishery is closed due to precautionary measures built into sardine management to stop directed fishing when the population falls below 150,000 metric tons. The latest population estimate is below that level due to environmental conditions, and managers have closed the fishery. Low level mortality from research surveys (Tables 4-11 and 4-12) is not expected to result in any measurable changes at the population level.

Mortality from Surveys

Direct mortality of fish occurs as a result of fisheries research surveys and tagging activities. In terms of the amount of fish killed during research, the CPS survey account for some of the largest numbers of fish and weight of fish killed during research (2015 PEA). Table 4-13 shows CPS and Rockfish Recruitment and Ecosystem Assessment Survey removals of the three target species brought forward for analysis compared to spawning biomass (where available) and commercial and recreational landings.

The Pacific sardine biomass is prone to significant natural fluctuation due to large-scale changes in oceanic temperature. Biomass declined over 90% between 2006 and 2017, from approximately 1 million metric tons to 86,586 metric tons. NMFS proposed to implement annual catch limits and management measures for the northern subpopulation of Pacific sardine (hereafter, Pacific sardine), for the fishing year from July 1, 2019, through June 30, 2020 (Hill *et al*. 2019). This proposed rule is intended to conserve and manage the Pacific sardine stock off the U.S. West Coast. As shown in Table 4-13, CPS surveys remove a very small fraction of sardines compared to the spawning biomass and commercial catch. The same is true for Pacific hake. In 2017, 17.76 kg of the total of the unidentified juvenile salmon was removed during CPS surveys. Analysis of Chinook salmon biomass removals in 2018 and the 2019 is pending. For comparison purposes the Review of 2018 Ocean Salmon Fisheries (PFMC 2019) shows that commercial Chinook salmon landings in the state of California in 2018 totaled about 421,400 kg.

TABLE 4-13. CPS AND ROCKFISH RECRUITMENT AND ECOSYSTEM ASSESSMENT SURVEY REMOVALS OF CHINOOK SALMON, PACIFIC HAKE AND PACIFIC SARDINES IN THE CCRA FROM 2017-2019

Target Species	CPS Survey			Rockfish Recruitment Survey	Estimated Spawning Biomass	Commercial Landings
	2017 (metric tons)	2018 (metric tons)	2019 (metric tons)[2]	2016-2019 (total no.)[3]	(metric tons)	(metric tons)
Chinook salmon	Portion of 17.76kg of juvenile salmon	Not reported	Not reported	53	N/A	421[4]
Pacific hake	0.043	0.07	0.002	104,591	1.4 million[5]	253,100 [6]
Pacific sardine	0.081	0.112	0.183	862	19,500[7]	414[8]

Source: SWFC
[1]Sub-sample weight.
[2]Data set not complete; does not include rockfish surveys.
[3]Data provided by SWFSC Nov. 22, 2019. Note that the vast majority of these are pelagic young-of-the-year, in the 20 to 40 mm standard length size range.
[4]2018 landings from Review of 2018 Ocean Salmon Fisheries (PFMC 2019).
[5]2018 estimate (Edwards *et al*. 2018, cited in 2018 Pacific Coast Groundfish SAFE report, Nov. 2018)
[6]2016 landings in the Pacific region. Fisheries Economics of the United States 2016. NOAA Technical memorandum NMFS-F/SPO-187a
[7]Projected January 2020 spawning stock biomass (Hill *et al*. 2019).
[8]2016 landings in California. Fisheries Economics of the United States 2016. NOAA Technical memorandum NMFS-F/SPO-187a. The fishery is closed but PFMC allowed up to 8,000 metric tons to be harvested in 2016.

Therefore, for target species in the CCRA including non-ESA-listed Chinook salmon, Pacific hake, and Pacific sardines, mortality from research surveys is not expected to result in any measurable changes at the population level, and effects would be minor adverse.

As described in the 2015 PEA, SWFSC survey activities occur in five designated NMSs: Olympic Coast NMS, Cordell Banks, NMS, Gulf of the Farallones NMS, Monterey Bay NMS, and the Channel Islands NMS. Table 4-14 shows the biomass of Chinook salmon, Pacific hake, and Pacific sardines removed by surveys in these NMSs. In some cases, counts of individuals are reported instead of or in addition to kg removed. For the three target species analyzed, the table shows that removals of these species during surveys in the NMSs is very small, especially when compared to spawning biomass shown in Table 4-13 and the commercial catch of Chinook salmon in California waters. These data support the conclusion that mortality from SWFSC surveys would be minor adverse.

TABLE 4-14. BIOMASS REMOVAL WITHIN NMSS DURING SWFSC TRAWL SURVEYS 2015-2018[1]

Species		2016[2]				2017					2018				
		Olympic Coast	Cordell Banks	Greater Farallones	Monterey Bay	Olympic Coast	Cordell Banks	Greater Farallones	Monterey Bay	Channel Islands	Olympic Coast	Cordell Banks	Greater Farallones	Monterey Bay	Channel Islands
Chinook salmon	Biomass removed (kg)	NR	-	NR	-	8	-	NR	NR	-	4	-	NR	NR	-
	Count	69	-	412	-	NR	-	44	4	-	2	-	9	12	-
Pacific hake	Biomass removed (kg)	0.1	NR	NR	NR	83	NR	NR	NR	NR	9	NR	NR	NR	NR
	Count	24	1,282	165	50,770	NR	190	65	6,301	16	14	46	331	9,212	4
Pacific sardine	Biomass removed (kg)	-	-	377	0	0.05	0.16	11	0.04	NR	-	-	NR	0.4	4
	Count	-	-	3,986	42	NR	NR	5	NR	10	-	-	29	125	NR

NR - not reported
[1]Biomass removal row only represents the actual biomass removal of species from the CPS survey as this is the only SWFSC survey where biomass of catch is recorded.
[2]These species were not removed during Channel Island trawl surveys

Disturbance and Changes in Behavior due to Sound Sources

As described above for ESA-listed fish, overall, disturbance and changes in fish behavior are expected to be short-term and not result in biologically significant changes to fish populations. Therefore, SWFSC research is expected to have no effect on fish behavior.

4.3.1.2.2 Effects on Marine Mammals

As described in Section 3.2.2 and Table 3-5, a number of ESA-listed and MMPA-protected cetaceans in the CCRA and ARA have had changes to status or abundance and have been brought forward for reanalysis in this SPEA. These species are shown in Table 4-15, which summarizes the potential effects of the Status Quo/No Action Alternative on ESA-listed and non-listed cetaceans. No cetaceans or pinnipeds in the ETPRA have changed sufficiently to warrant re-analysis under the SPEA alternatives.

TABLE 4-15. SUMMARY OF POTENTIAL IMPACTS OF THE STATUS QUO/NO ACTION ALTERNATIVE ON CCRA AND ARA ESA-LISTED AND NON-LISTED MARINE MAMMALS

Marine Mammals[1,2]	Potential Impact of Status/Quo/No Action Alternative			Discussion
	Injury or Mortality	Changes in Food Availability	Disturbance from Sound Sources	
ESA-Listed				
Killer Whale Southern Resident DPS	No effect	No effect	Minor *Adverse*	The population of this stock remains below 100 individuals. Disturbance takes occur but are well below MMPA-authorized take levels (Table 4-17).
Sperm Whale	No effect	No effect	Minor *Adverse*	Estimated abundance of this species doubled from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels (Table 4-17).
Humpback Whale Central America DPS Mexico DPS	No effect	No effect	Minor *Adverse*	The Central DPS population estimate of 411 is lower than previous estimates. The Mexico DPS estimate more than doubled from 2015-2018. This DPS is considered threatened rather than endangered. Disturbance takes occur but are well below MMPA-authorized levels (Table 4-17).
Non Listed				
Humpback Whale[3] Brazil DPS Southeastern Pacific DPS Hawaii DPS	No effect	No effect	Minor *Adverse*	These ARA DPSs were delisted in 2016. Sightings of humpback whales are uncommon during ARA research activities. Disturbance takes occur but are well below MMPA-authorized levels (Table 4-18).

Marine Mammals[1,2]	Potential Impact of Status/Quo/No Action Alternative: Injury or Mortality	Changes in Food Availability	Disturbance from Sound Sources	Discussion
Harbor Porpoise Morro Bay stock Monterey Bay stock	No effect	No effect	Minor *Adverse*	Morro Bay stock estimate increased by 1.5 times and a similar estimate of the Monterey Bay stock more than doubled from 2015-2018. Disturbance takes of harbor porpoise occur but are well below MMPA-authorized levels (Table 4-19).
Dall's Porpoise	No effect	No effect	Minor *Adverse*	Abundance estimate of this stock decreased by over 16,000 from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels (Table 4-19).
Bottlenose Dolphin Coastal Offshore	No effect	No effect	Minor *Adverse*	Abundance estimate of these stocks increased slightly from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels (Table 4-19).
Striped Dolphin	No effect	No effect	Minor *Adverse*	Abundance estimate of this species almost tripled from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels (Table 4-19).
Short-beaked Common Dolphin	No effect	No effect	Minor *Adverse*	Abundance estimate of this species more than doubled from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels (Table 4-19).
Long-beaked Common Dolphin	Minor *Adverse*	No effect	Minor *Adverse*	Abundance estimate of this species almost quadrupled from 2015-2018. An M/SI take of this species occurred in 2019 (see Table 4-16). Disturbance takes occur but are well below MMPA-authorized levels (Table 4-19).
Northern Right Whale Dolphin	No effect	No effect	Minor *Adverse*	Abundance estimate of this species tripled from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels (Table 4-19).
Pacific white sided dolphin	Minor *Adverse*	No effect	Minor *Adverse*	No change to estimate of abundance. 18 MI/SI takes have occurred since the 2015 PEA (see Table 4-16). Level A and Level B take levels are below MMPA-authorized numbers (Table 4-19).
Baird's Beaked Whale	No effect	No effect	Minor *Adverse*	Abundance estimate of this species more than doubled from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels (Table 4-19).
Mesoplodon *spp.*	No effect	No effect	Minor *Adverse*	Abundance estimate of this species increased by almost 7 times from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels (Table 4-19).
Cuvier's Beaked Whale	No effect	No effect	Minor *Adverse*	Abundance estimate of this species increased over 1,000 from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels (Table 4-19).

Marine Mammals[1,2]	Potential Impact of Status/Quo/No Action Alternative			Discussion
	Injury or Mortality	Changes in Food Availability	Disturbance from Sound Sources	
Pygmy Sperm Whale	No effect	No effect	Minor *Adverse*	Abundance estimate of this species increased by over 7 times from 2015-2018. Disturbance takes occur but are well below MMPA-authorized levels (Table 4-19).
California Sea Lion	Minor *Adverse*	No effect	Minor *Adverse*	Abundance estimate decreased by about 13% and an M/SI take occurred in 2018 (Table 4-17). Level A and Level B take levels are below MMPA-authorized numbers (Table 4-19).
Crabeater Seal[4]	No effect	No effect	Minor *Adverse*	Abundance estimate is from 5-10,000,000, but MMPA-authorized Level B takes were exceeded over 10 fold in 2015-2016. On ice disturbance takes exceeded allowed numbers (Table 4-20), but due to the overall size of the population effects would be minor.

[1]All marine mammals in this table are from CCRA with the exception of for the three de-listed DPS of humpback whales and the crabeater seal as noted.
[2] Only marine mammals identified in Chapter 3 warranting re-analysis are shown in this table.
[3]These DPS may occur in the ARA during summer.
[4]Occurrs in the ARA.

Injury or Mortality Due to Ship Strikes and Entanglement in Gear

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 30 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 typically fishes 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.

As shown in Table 4-16, ten Pacific white sided dolphins were taken in the CCRA by MMPA Level A harassment (M&SI) over the period Aug. 15, 2015 to Dec 31, 2016. Three Pacific white sided dolphins and a California sea lion were taken by Level A harassment (M&SI) 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 Level A harassment take numbers authorized for trawling of 35 for Pacific white-sided dolphins, 20 California sea lions, and 11 long-beaked common dolphins (80 FR 58982). Also as stated in the 2015 PEA, PBR for white sided dolphins and long-beaked common dolphins is 193 and 610, respectively, and for California sea lion PBR is 9,200, so these removals can be considered minor adverse. No other species have suffered mortality/serious injury (M&SI) due to entanglement in gear or ship strikes during SWFSC research surveys.

TABLE 4-16. TAKES OF MARINE MAMMALS IN TRAWL GEAR DURING SWFSC CCRA 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)	Killed6-4 of the LOA	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 SWFSC, Nov 1, 2019.

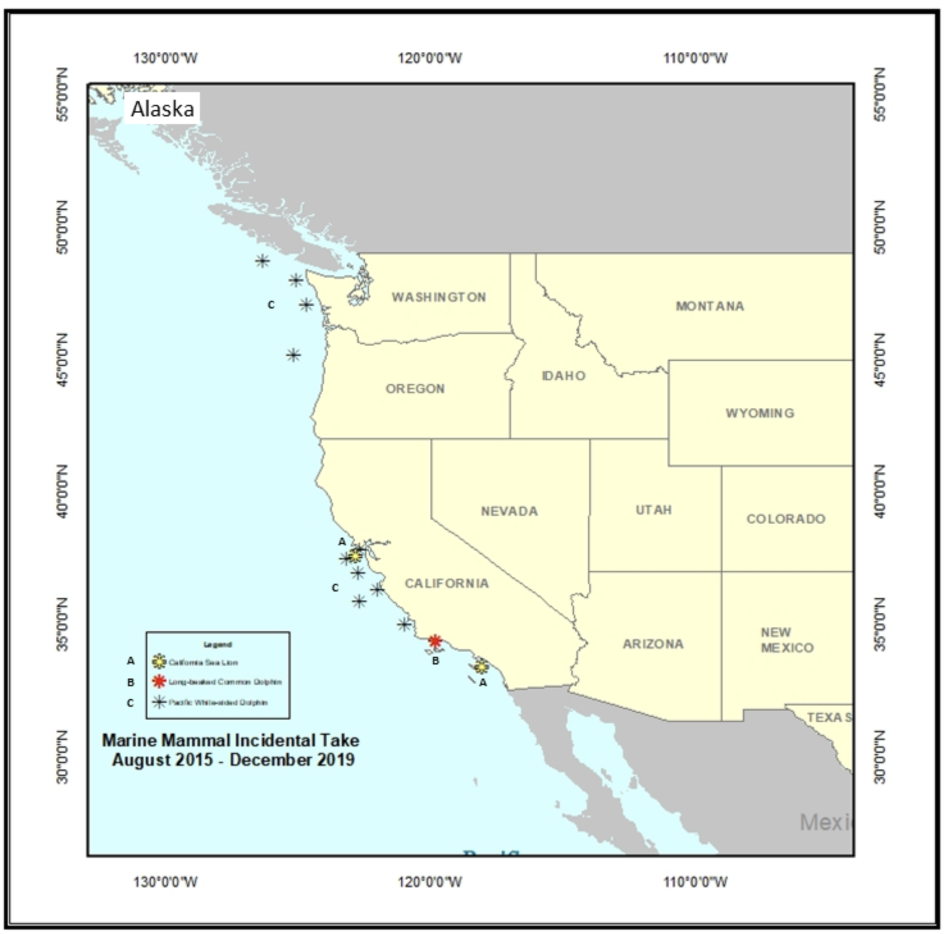
As shown in Table 4-17, one California sea lion was taken by longline gear in 2012, 2013, and 2014; the individuals were injured but released. Longline gear was not used in 2017, 2018, and 2019. Five takes of California sea lions via longline are allowed over the duration of the authorization period under the current LOA (80 FR 589). Based on the California sea lion PBR of 9,200, these takes would be considered minor adverse. Figures 4-1 and 4-2 show the locations of the M/SI takes in 2015-2016 and 2018.

TABLE 4-17. HISTORICAL TAKES OF MARINE MAMMALS IN LONGLINE GEAR DURING SWFSC SURVEYS FROM 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 4-1. LOCATION OF CETACEAN AND TURTLE TAKES DURING SWFSC RESEARCH, 2015 - 2016



Source: Southwest Fisheries Science Center 2019.

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 conducted visual and acoustic surveys prior to deploying bottom trawl gear to assess the bathymetry and whether marine mammals are present in the area. These visual and acoustic surveys have resulted in very few detections of marine mammals during trawling operations, possibly because there is infrequent spatial-temporal overlap between bottom trawl surveys and significant densities of protected species. This may help to explain the absence of marine mammal interactions with this gear during past AMLR surveys. Given this history and little 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 anticipating entanglement of marine mammals due to research activities in the AMLR.

Changes in Food Availability Due to Research Survey Removal of Prey and Discards

Several marine mammal species in the CCRA target salmon during their seasonal spawning runs. The Southern Resident DPS of killer whales feed near exclusively on chinook salmon in the summer (>80%), while chum salmon are also present in their diet from September to November (fall-winter) (Hanson *et al*. 2010; Ford *et al*. 2016; DFO 2017). Recovery plans for southern resident killer whales have identified reduced prey availability as a risk to the population. Mortality and population trends of the Southern Residents are strongly linked to Chinook salmon abundance (Caretta *et al*. 2019). There are concerns as to whether the chinook and chum salmon bycatch in SWFSC research surveys could reduce adult survival and recruitment of the listed ESUs of salmon in the bycatch samples thereby reducing prey availability to this critically endangered DPS of killer whales.

The 2015 BiOp on SWFSC research evaluated the removal of Chinook salmon by SWFSC research activities, concluding "…it is unlikely that small juvenile salmon are the primary source of prey for southern resident killer whales (SRKW), given the relatively small size of juvenile Chinook and the apparent preference of SRKWs for larger fish. As a result, removal of juvenile Chinook by SWFSC research activity is not expected to result in significant direct competition with SRKW foraging. In addition, much of SWFSC trawl research occurs in the CCE during the spring, summer, and fall, while SRKWs are typically only present in the marine waters of the CCE during the winter, further reducing the potential for direct competition. However, SWFSC salmon removals do have an impact the future marine populations of Chinook and ultimately how many Chinook will be available for SRKWs [southern resident killer whales]". Overall, the potential impact of SWFSC research on these salmon DPSs was considered minor adverse in Table 4-6. In conjunction with this SPEA, the SWFSC reinitiated ESA Section 7 consultation on the impact of the ESA-listed salmon bycatch in SWFSC trawl surveys on listed salmon ESUs, as well as the potential impact of the bycatch on the availability of prey to ESA-listed species especially the Southern Resident DPS of killer whales.

The impact of SWFSC surveys on the availability of non-salmonid prey for marine mammals can be determined by considering biomass removals (including discards) of high-quality prey species such as sardines, anchovies, mackerel, herring and squid (Table 4-18). Note the biomass numbers in Table 4-18 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 4-18. 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]Biomass is not collected from Juvenile Rockfish Surveys, only quantity.

Table 4-18 shows that biomass of prey species removed during surveys varies but has decreased from 2016 likely due to reduced level of survey efforts. The 2015 PEA analyzed the potential impacts of prey removals on marine mammal species and determined that 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 CCRA. 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.

<u>Disturbance and Changes in Behavior Due to Sound Sources</u>

Generally, temporary changes in an animal's typical behavior are the most common responses of marine mammals to increased noise levels (Richardson *et al.* 1995). However, the exposures to sound levels that exceed behavioral thresholds (therefore potential MMPA Level B harassment takes) considered in this SPEA would be short-term, localized, and would have no biological significance to reproduction and survival rates or population trends. This is especially relevant to endangered or small populations such as the Southern Resident DPS of killer whales may be particularly sensitive and vessel noise is a large-part of their ambient environment. There is general recognition that minor and brief changes in behavior generally do not have biologically significant consequences for marine mammals (NRC 2005). The low level of takes due to acoustic disturbance (Table 4-19) is evidence that potential behavioral effects from exposure to vessel noise during routine fisheries research activities would result in anything more than minor, biologically insignificant consequences for any individual marine mammals or for a population of marine mammals.

California Current Research Area

Table 4-19 shows the actual Level B harassment takes from August 2015 to December 2018 in the CCRA as compared to the authorized numbers. Only species identified in Chapter 3 for further analysis are presented in this table. There have been Level B harassment takes of other marine mammal species as described in the annual reports, but the takes have been below the authorized annual take numbers and these species are not discussed further. Because recorded takes over the period 2015-2018 are all well below authorized levels for the species brought forward for analysis, impacts are considered to be minor adverse.

Eastern Tropical Pacific Research Area

Marine mammals that may occur within the ETPRA have not experienced notable changes in status or regulatory management to warrant additional evaluation under SPEA alternatives and the proposed SWFSC fisheries and ecosystem research planned for the period 2020-2025. Therefore, please refer to the evaluation of potential impacts on marine mammal species found within ETPRA as evaluated in the 2015 PEA.

Antarctic Research Area

Table 4-20 shows the number of Level B takes by acoustic sources for humpback whales and crabeater seals in the ARA over the period August 31, 2015 to December 31, 2016. Humpback whale DPSs potentially encountered in the ARA and the crabeater seal are not ESA-listed. No research was conducted by SWFSC in the ARA in 2017 or 2018. As shown in the table the authorized take of crabeater seals was exceeded during the reporting period; the animals were encountered during the Austral Winter Krill and Ecosystem survey. The survey was conducted over the same area, during the same months, and for the same duration as previous years when large numbers of crabeater seals were not encountered. 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 (see Chapter 3). The last year of the survey was 2016 and there are no plans or funding to conduct another winter survey in the ARA.

TABLE 4-19. TOTAL ANNUAL LEVEL B HARASSMENT TAKES BY ACOUSTIC SOURCES FOR CCRA MARINE MAMMALS, 2015-2018

Species[1]	2015 -2020 Authorized Annual Level B Take[2]	Aug 31, 2015- Dec. 31, 2016[2]	Jan. 1- Dec. 31, 2017[3]	Jan 1 - Dec 31, 2018[4]
ESA-Listed				
Killer Whale Southern Resident	13	3	1	1
Sperm Whale	65	37	15	14
Humpback Whale	14	3	1	1
Non-Listed				
Harbor Porpoise	682	142	44	40
Dall's Porpoise	1365	284	88	80
Bottlenose Dolphin	32	7	2	2
Striped Dolphin	301	63	20	18
Short-beaked Common Dolphin	5592	1161	362	329
Long-beaked Common Dolphin	348	72	23	20
Northern Right Whale Dolphin	176	37	11	10
Pacific White Sided dolphin	378	79	25	22
Baird's Beaked Whale	34	19	8	7
Mesoplodon *spp.*	40	22	9	8
Cuvier's Beaked Whale	146	83	34	31
Pygmy Sperm Whale	42	24	10	9
California Sea Lion	4302	894	279	253

[1]Only species considered are those identified in Table 3-5 as warranting re-analysis.
[2]80 FR 58982
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.

[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]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.

TABLE 4-20. TOTAL ANNUAL LEVEL B HARASSMENT TAKES FOR ARA MARINE MAMMALS, 8/31/2015–12/31/2016[1]

Species	2015 -2020 Authorized Annual Level B Take[5]	On Ice Disturbance Takes	Acoustic Takes	Reporting Period Level B Takes
Humpback Whale	92	n/a	23	23
Crabeater Seal	7	93	0.4	93.4

[1]Only species considered are those identified in Table 3-5 as warranting re-analysis. Individuals from the Brazil, Southeastern Pacific and Hawaii DPS may occur in the ARA during summer but are rarely seen during research surveys.
[2]80 FR 58982
[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 August 31, 2015 – December 31, 2016.

The authorized number of Level B harassment takes was not exceeded although small numbers of Level B takes were recorded for: spectacled porpoises, hourglass dolphins, Arnoux's beaked whales, sperm whales, killer whales, southern bottlenose whales, long-finned pilot whales, Antarctic Minke whales, southern right whale, fin whales, Antarctic fur seals (acoustic and on ice disturbance takes), Weddell seals, leopard seals, and southern elephant seals. These species are not discussed further in this SPEA. Acoustic disturbance to humpback whales in the ARA can be considered minor adverse because recorded takes are well below MMPA-authorized takes. Even though takes for crabeater seals were more than 10 times the allowed amount in 2016 (the last year surveys occurred in the ARA), the population is large and impacts to this species could be considered negligible to minor adverse.

Mitigation Measures to Protect Marine Mammals

Mitigation measures to protect marine mammals under Status Quo/No Action Alternative are described in detail in Chapter 2, Table 2-3. They focus on procedures to avoid marine mammal encounters during surveys, use of deterrent devices, and guidelines to handle and report encounters:

- Continuing coordination and communication among all relevant parties to review the mitigation measures.
- Following predetermined vessel speeds during all surveys.
- Adhering to all marine mammal handling procedures and record-keeping requirements;
- Conducting visual monitoring for protected species 30 minutes prior to the deployment of gear, and during gear deployment, active fishing, and retrieval.
- Using the "move-on" rule if marine mammals (with the exception of baleen whales) are sighted within 1 nm of the vessel in the 30 minutes prior to setting gear or during active fishing.
- Following the recommendations of the Chief Scientist or officer on watch if protected species are observed within 1 nm of the vessel.
- Using a marine mammal excluder device (MMED) in the NETS Nordic 264 trawl gear.

- Placing two to four acoustic deterrent devices or pingers on the headrope or footrope of midwater trawl gear.
- Consider postponing haul-back during longline surveys, if risk of interaction with marine mammals exists (see exceptions listed in Table 2-3).
- Prohibiting chumming during long line surveys.
- Prioritizing protected species incidentally captured in gear and handling them accordingly.
- Continuing to review, and identify potential factors influencing incidental take of protected species, and to provide mitigation and monitoring training for Chief Scientists and applicable crew members.

4.3.1.2.3 Effects on Sea Turtles

Historically, SWFSC research activities rarely encounter sea turtles. One green sea turtle was taken in 2016; the turtle was released alive (see 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). Future SWFSC research is not likely to result in interactions with sea turtles different from those summarized in Section 4.3.6 of the 2015 PEA and Section 2.5.1 of the 2015 Biological Opinion. The 2015 BiOp concluded "it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of: leatherback sea turtle; North Pacific loggerhead sea turtle; olive ridley sea turtle; or green sea turtle and is not likely to affect the designated critical habitat for leatherback sea turtles. This conclusion is still valid based on the proposed SWFSC research for the period 2020 – 2025.

4.3.1.3 Effects on the Social and Economic Environment

Section 3.3.1 of this SPEA describes how SWFSC fisheries and ecosystem research activities may have direct and indirect effects on the economics of U.S. communities and ports in which they operate. As described in the 2015 PEA, SWFSC facilities are located throughout California, the Antarctic Ecosystem Research Division maintains two field stations (Cape Shirreff and Copacabana) while the ETPRA includes waters extending from Mexico to Peru. Cumulative effects to the communities in these regions are obviously complex and involve multiple factors that result in driving changes both socially and economically. For the purposes of assessing the effects of SWFSC research on socioeconomics in these areas, this SPEA relies on information from the commercial and recreational fisheries to provide a general sense of revenues and economic impact. NMFS's recent report titled *'The Fisheries Economics of the United States'* (NMFS 2018b) provides information on commercial market conditions, total tonnage of commercial fish landed and revenue by region and state, recreational fishing expenditures and levels of participation by region and state, key species, and community profiles which has been summarized in Section 3.3 of this SPEA.

Annual expenditures of the SWFSC for fisheries and ecosystem research have ranged from $17 – 22 million for the period 2016 – 2018. This funding is used to support field surveys, data collection and analysis, permitting, reporting and other administrative functions. Through direct expenditures on fisheries and ecosystem research, SWFSC contributes to the communities and ports throughout the research areas located in the CCRA, ETPRA and ARA with the majority of influence likely occurring in the states of California, Oregon and Washington due to the number of communities in those states that could interact with research activities. While the contribution of research-related employment and purchased services is beneficial on an individual basis, the total contribution of research is very small when compared to the value of commercial and recreational fisheries in the communities. Fisheries research is considered a minor beneficial effect to the economic status of communities within the research areas.

4.3.1.3.1 Collection of Scientific Data Used in Sustainable Fisheries Management

Stock assessments in the Southwest research regions rely on the data collected from long-term standardized resource surveys conducted by NOAA fishery research vessels. Fishery managers use the extended time-series of data to identify trends and to inform fisheries management decision-making. This information is essential for establishing annual species-specific sustainable harvest limits. Harvest limits that are set too high may lead to overfishing of specific stocks and more restrictive management measures in the future to rebuild those stocks. Harvest limits that are set too low do not allow a maximum sustainable harvest that benefits commercial and recreational fisheries and the communities and services that support them. In addition, the predictability and reliability of long-term data sets and the harvest limits they support is essential for economic stability in the fisheries over time.

4.3.1.3.2 Economic Influence of Research

The SWFSC's roughly $40 million in annual operations costs provide both primary and secondary economic influences on the communities and ports in the region. These funds are distributed among U.S. research stations located in La Jolla, Santa Cruz, Monterey, Arcata, Granite Canyon, and Piedras Blancas, California. The operating budget directly supports employees and operations of facilities at these locations. Approximately $17 million is spent annually on collecting data at-sea over a geographic area extending from Oregon to Antarctica. This does not include ship or aircraft time, in some cases. Funds are expended for ship and aircraft time, equipment and logistics, contracts, crew wages, and taxes and fees. NOAA-owned ships, charters, and leased research vessels operate from several home ports, and are serviced in many others. Some commercial fishing operations are compensated for participation in cooperative research projects through grants or shares in fishing quotas that they sell on the market.

4.3.1.3.3 Collaborations Between the Fishing Industry and Fisheries Management

Cooperative research is an important element in establishing communication, trust, and information exchanges between scientists, fisheries managers, and the fishing industry. Cooperative research is used to: a) increase the precision and expand the scope of resource surveys; b) provide supplemental information about fishing operations; c) incorporate fishing expertise into the design and implementation of research; and d) build mutual understanding and respect among scientists and people in the fishing industry. Collaboration in the development of new gear and techniques encourages participation in developing sustainable fishing practices and contributes to a broader understanding of management for marine resources.

4.3.1.3.4 Fulfillment of Obligations to Communities Specified by Laws and Treaties

A list of applicable laws is shown in Chapter 6 of the PEA (NMFS 2015a). These obligations include the 1996 amendment to the MSA, which requires assessment, specification, and description of the effects of conservation and management measures on participants in fisheries, and on fishing communities (NMFS 2007); and EO 12898 on environmental justice, which directs agencies to assess actions that may disproportionately affect low income and minority populations. The fisheries research programs conducted in the CCRA, ETPRA, and ARA help fulfill these obligations under the MSA.

4.3.2 Effects of the Preferred Alternative (Future Fisheries Research Beginning 2020)

As described in Chapter 2, this alternative includes all of the studies described in Alternative 1 (Status Quo/No Action) plus the following additional activities:

- The CPS survey would include sampling in nearshore depths not currently surveyed.
- The Purse Seine Survey would be conducted at the nearshore depths in conjunction with the CPS survey.
- Using hook and line or other gear the Life History and Reproductive Ecology Investigations of Rockfish survey would target additional new species such as *Sebastes* spp. Gear would include rod and reel with shrimp flies, often baited with squid, on braided spectra line; typically about 20 to 40-pound test.
- The Juvenile Salmon Survey would include micro-trolling (hook and line) and unmanned systems.
- HMS survey proposes to use hook and line gear rather than only longline gear (as under Status Quo/No Action) to target these species. Gear would include angler hook and line consisting of 80-pound line (or greater) and wither barbed or unbarbed hooks.
- Use of deep set buoy gear.
- Antarctic Living Marine Resources Program (FREEBYRD) would use autonomous underwater vehicles such as gliders that would be deployed for longer periods and at greater depths.
- COAST Survey would use unmanned systems.
- Ecosystem Based Fisheries Management and Stock Assessment would include Monterey Bay or other regions within the CCRA.

The assessment of impacts of this alternative retains all of the impacts described in Section 4.3.1 for the Status/Quo No Action Alternative, plus additional assessment of impacts due to the use of new technologies such as micro-trolling gear and unmanned systems, and the conducting of surveys in nearshore waters from 20-50 m deep.

4.3.2.1 Effects on the Physical Environment

Under the Preferred Alternative, the SWFSC would sample in nearshore areas not currently surveyed. Surveys supporting the Ecosystem Based Fisheries Management and stock assessment would be conducted in Monterey Bay. Unmanned systems would be used for studies in the ARA and CCRA. The expansion of EFH conservation areas and NMFS boundaries would also be expected to have minor beneficial impacts under the Preferred Alternative. Therefore, impacts on EFH, closed areas, the Cordell Banks and Gulf of Farallones NMSs as described in Section 4.3.1.1 for the Status Quo/No Action Alternative would be expected to be the same for this alternative. Impacts of the preferred alternative on the physical environment are expected to be minor beneficial.

4.3.2.2 Effects on the Biological Environment

As described in Section 4.3.2.1 for the Status Quo/No Action Alternative, only certain ESA-listed fish, target fish, ESA-listed marine mammals, and non-listed marine mammals have been brought forward for analysis in this SPEA.

4.3.2.2.1 Effects on Fish

ESA-Listed Species

Impacts on ESA-listed fish would be the same under the Preferred Alternative as described in Section 4.3.1.2.1 for the Status Quo/No Action Alternative (see Table 4-6). The impacts are expected to be minor adverse.

The targeting of additional *Sebastes* spp. and use of hook and line gear under the Preferred Alternative would not change the overall effort or technique and would not be expected to affect ESA-listed fish species differently than the Status Quo Alternative. Likewise, the use of unmanned systems would not be expected to adversely affect ESA-listed species and may even reduce impacts if used instead of trawling or other efforts that would remove fish.

Although grouper are found in close proximity to shore, the addition of nearshore pelagic locations in the CPS and Inshore Purse Survey would not encounter these bottom fish and additional impacts under the Preferred Alternative would not be expected.

The majority of eulachon bycatch occurs during offshore shrimp trawl fisheries (Gustafson *et al*. 2019) and additional sampling in nearshore areas would not change the Status Quo/No Action Alternative impact determination for this species.

Expectations Moving Forward Regarding Salmon Bycatch

Salmon bycatch during future SWFSC research beginning in 2020 is expected to continue at similar levels as described in Section 4.3.1.2.1 for the previous period (2015 – 2019). When considering which salmon ESUs might be taken in the future, survey location and timing should be taken into account when ITSs are prepared. Genetic analysis of salmon caught in several SWFSC surveys between 2015-2019 have demonstrated that the origin of ESA-listed salmon caught as bycatch in SWFSC CCE surveys can be estimated based on the location of the survey at the time of the bycatch, and the proximity of the survey to ESU natal streams (consistent with that reported in Shelton *et al*. 2019). This is a significant finding as the SWFSC considers how future SWFSC fisheries surveys might be designed such that they may reduce impacts on ESA-listed salmon.

Further, the results of past surveys demonstrate how to make a reasonable prediction as to what ESUs might be impacted based solely on the location and timing of the survey. Several species of salmon dominate the catch throughout the survey period: the Snake River fall-run Chinook ESU,the Lower Columbia River ESU, the Upper Willamette River ESU, the Upper Columbia River spring-run ESU, and the Puget Sound Chinook ESU. Chum salmon have also been caught during each survey. As the surveys move north into Washington and Canada, a large percentage of the Chinook and chum bycatch is from non-listed stocks of Canada from British Columbia and possibly southeast Alaska as would be expected. Seasonal variation in the timing of the surveys while important, is not as important a factor in predicting the marine location of fall-run Chinook salmon as was the location of the surveys relative to the natal stream (Shelton *et al.* 2019). Therefore, ESA take of ESUs with the greatest likelihood of being captured in future surveys is likely due to the survey location and timing relative to the origin of listed populations.

Assuming the spatial-temporal distribution of future SWFSC surveys remains similar to past survey locations to ensure consistency in research, it is highly likely that the same salmon ESUs incidentally caught as bycatch in the 2015-2019 surveys will also dominate bycatch in future surveys. A significant change in the structure of salmon bycatch during future SWFSC research is not expected, though continued genetic sampling of salmon bycatch may provide additional information as described below.

Beginning in 2018, SWFSC began implementing protocol to conduct genetic sampling for surveys that incidentally catch salmon in order to help identify ESUs to the extent possible. A description of the protocol used for genetic sampling is provided in Appendix C. In future research, for hauls less than 50 salmon, genetic sampling of all fish will be conducted while any hauls with greater than 50 salmon caught will conduct genetic sampling on a subset of those salmon. Genetic sampling, together with evaluating salmon bycatch relative to natal streams as described by Shelton *et al*. 2019, aims to address identifying fish to species and ESU.

The salmon ESUs discussed in Section 4.3.1.2.1 are also found close to shore at certain life stages. As described under the Status Quo, trawl data suggests that CPS species and juvenile salmon may cohabitate and jointly school in near coastal habitats. SWFSC must continue to survey these areas to provide management with best estimates of CPS populations. Under Alternative 2 (Future Research), the addition of nearshore sampling stations (see Table 2-2) is not likely to cause additional effects that would rise above the overall minor adverse rating for certain ESUs of Chinook and coho salmon as described in Section 4.3.1.2.1 for the Status Quo/No Action Alternative.

Gear type may also be a factor influencing salmon bycatch. The vast majority of the salmon bycatch during each of the CCE trawl survey periods 2015 through 2019, was represented by fish whose natal origin was from the Oregon/California border north to (at least) British Columbia, Canada. A majority of that bycatch occurred while using surface trawls or the Nordic trawl. In contrast, most salmon caught off California occurred in the Rockfish Recruitment and Ecosystem Assessment Surveys using a different modified trawl than used in the CCE surveys. The use of micro-trolling gear in the Juvenile Salmon Survey, if used in place of trawling, would likely require considerably more effort to catch the same number of fish as the present surveys using trawl gear. The decreased catch/effort using micro-trolling gear would be such that the switch in gear-type would likely result in an overall reduction in the total numbers of fish caught during the survey. For example, over 1,800 juvenile salmon were incidentally caught in 2017 in one trawl set. If the survey switched gear types and caught 1 fish/minute using micro-trolling gear it would take 30 hours of micro-trolling to reach 1,800 fish. Therefore, even though the increased surveys in nearshore waters may incidentally take a few additional salmon, the effect would remain as minor adverse for Chinook and coho. Likewise, there should be no additional effects on chum and sockeye salmon from a switch to micro-trolling gear. If any effects are noticed, it seems likely that a positive, similar reduction in catch should occur due to a switch in gear type. Eiler *et al.* (2019) found that no juvenile Chinook salmon showed signs of physical injury when tagged with acoustic transmitters.

Based on this information, similar types of passive acoustics used in the future to monitor and assess salmon populations are not expected to have an adverse effect on ESA-listed salmon.

Mitigation Measures for ESA-Listed Fish

To reduce bycatch of protected species during trawl surveys, standard tow durations would be limited to 60 minutes or less at targeted depth, excluding deployment and retrieval time. These tow durations are intended to reduce the likelihood of attracting and incidentally taking protected species, including ESA-listed salmon.

When considering which salmon ESUs might be taken in the future, survey location and timing should be taken into account when ITSs are prepared. The results of past surveys demonstrate how to make a reasonable prediction as to what ESUs might be impacted based solely on the location and timing of the survey. The extent of ESA-listed salmon take that might be anticipated in future surveys should consider the results of the genetically identified ESA-listed ESUs captured in the 2015-2019 surveys but also those ESUs with the greatest likelihood of being captured due to the location of the survey relative to the origin of listed populations (following Shelton *et al.* 2019). Moving forward, SWFSC will continue to properly document and identify salmon takes, endeavor to better understand trends in catches, and contribute to management's understanding of listed salmon populations.

Target Fish Species

Table 4-21 summarizes the impacts of the Preferred Alternative on target fish that are different than those discussed in Section 4.3.1.2.1 and shown in Table 4-7. The targeting of additional *Sebastes* spp. under the Preferred Alternative and the use of unmanned systems, would not be expected to affect target fish species differently than the Status Quo Alternative. The impacts are expected to be minor adverse.

As described above, impacts to Chinook salmon from the additional nearshore surveys, juvenile salmon surveys using micro trolling, the use of additional hook and line gear[27] in the HMS surveys, and the use of unmanned systems, would not be expected to be different from the Status Quo/No Action Alternative and are expected to be minor adverse.

Pacific hake are offshore, semi-pelagic fish so the additional nearshore surveys would not be expected to increase interactions with the species. Pacific sardine are epipelagic and migrate along the coasts in large schools. The population has fallen below 150,000 metric tons, and the directed fishery is closed. Additional removals from nearshore sampling under the Preferred Alternative could be measurable at the population level however, in terms of geographic scope and frequency, research would likely result in a minor adverse effect at the population level (see Table 4-21).

[27] Consisting of 80-pound line and either barbed or unbared hooks.

TABLE 4-21. SUMMARY OF POTENTIAL IMPACTS OF THE PREFERRED ALTERNATIVE ON CCRA TARGET FISH

Target Fish	Potential Impact of the Preferred Alternative		Description
	Mortality from Surveys	Disturbance Due to Sound Sources	
Pacific Sardine	Minor *Adverse*	No Effect	Sardines are coastal epipelagic fish that migrate along the coast in large schools. The addition of nearshore sampling locations would collect data on nearshore abundance of sardines. Because the fishery is currently closed and biomass is at historically low levels, the additional removals may result in a minor adverse effect due to the limited geographic scope and frequency.

4.3.2.2.2 Effects on Marine Mammals

The impacts of the Preferred Alternative on marine mammals are not expected to be different from those discussed in Section 4.3.1.2.2 and shown in Table 4-15. The impacts are expected to be negligible to minor adverse. For the species in Table 4-15, including all ESA-listed marine mammals, no additional impacts from the use of micro trolling in Juvenile salmon surveys or the targeting of additional *Sebastes* spp. are expected. Additional surveys in Monterey Bay would not be expected to impact the Monterey Bay stock of harbor porpoise. Estimates indicate that this stock more than doubled over the period 2015-2018 and current Level B takes of 40 animals are well below the authorized take of 682 animals. The use of hook and line gear in the HMS surveys would not impact cetaceans. Over the period 2003-2016 only one California sea lion was taken as bycatch in the Oregon and California nearshore hook and line commercial fisheries, and nine individuals were taken over the same period in the limited entry commercial sablefish fishery (Jannot *et al*. 2018). It is not expected that the addition of hook and line gear to the HMS fishery will take California sea lions at a greater rate that described for the Status Quo/No action Alternative that employs only longline gear. The addition of rod and reel/handlines would be used to opportunistically target HMS species as it presents a unique opportunity to collect samples from an area where HMS thrive during the four times a year the surveys are in the offshore areas, which are otherwise difficult to sample with regularity.

The SWFSC proposes to conduct purse seine surveys in nearshore areas. The 2019 List of Fisheries (84 FR 22051) 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. 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 (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 (84 FR 22051). 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 (84 FR 22051), however, this fishery is in areas farther offshore than the planned SWFSC purse seine surveys.

While the risk of entanglement with purse seines during SWFSC research is low for pinnipeds and certain delphinid species due to the limited duration and extent of the research surveys, to be precautionary, SWFSC requests M/SI takes (Level A) for the following species over the five-year authorization period due to purse seine gear: California sea lion, harbor seal, Pacific white-sided dolphin, Dall's porpoise, harbor porpoise, northern right whale dolphin, and Risso's dolphin. With the addition of purse seine surveys that may occur in the nearshore environment, the potential effects of Alternative 2 may result in slightly higher rates of incidental entanglement of marine mammals which is reflected in the request for mortality and serious injury takes (Level A) in the MMPA LOA application (Appendix B).

Regarding deep-set buoy gear, based on the type of gear and methods to be utilized, the SWFSC does not anticipate these surveys to result in any marine mammal takes. This determination is based on the following factors:

- No historical takes using deep-set buoy gear - Gear is designed specifically to eliminate protected species interactions. In the Pacific, no takes have occurred during the previous 54 sets (approximately 2,200 hook hours).
- Deep-set buoy gear has minimal visual or sensory attractants in the upper water column (e.g., no surface chumming or offal discharge, no visual cues from multiple hooks that are sinking to depth slowly). Therefore, the risk of hooking or entanglement is extremely low to non-existent.
- This gear features a single weighted monofilament line with virtually no slack or sag which minimizes entanglement risk.

All other gears used in SWFSC fisheries research (e.g., a variety of plankton nets, CTDs) 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, 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.

Regarding the effects of unmanned systems on marine mammals, 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.

Recognizing that the use of unmanned systems 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. As listed in Section 4.3.2.1.3, proposed mitigation measures align with the guidance provided in the 2018 publication by the Secretariat of the Antarctic Treaty.

Under the Status Quo, Level B disturbance takes from sound sources, or from on ice disturbance in the case of pinnipeds, are well below allowed levels for all but one marine mammal, the crabeater seal in the ARA. All species shown in Table 4-15 would be impacted at a minor level from sound sources under the Status Quo. Any potential positive or negative influences of using UAS would not change the impact determination because the impacts under the Status Quo/No Action are already minor and Level B takes in all cases except crabeater seals are well below the authorized levels (see Table 4-19).

Autonomous underwater vehicles that would be used in the FREEBYRD survey in the ARA can sample previously impenetrable environments such as the sea surface, the deep sea, and under-sea ice and are typically small and quiet (Fernandes *et al*. 2003) The use of these systems may reduce on ice disturbance to crabeater seals, but due to the uncertainty, and to the fact that the crabeater seal population is large, the potential impact of the Preferred Alternative on this species also remains the same as the Status Quo/No Action Alternative, minor adverse (see Table 4-15).

<u>Mitigation Measures for Marine Mammals</u>

Mitigation measures to protect marine mammals under the Preferred Alternative are described in detail in Chapter 2 Table 2-3. They include the measures described under the Status Quo/No Action Alternative with the following modifications as proposed for future research:

- During trawl surveys conduct visual monitoring for protected species 15 minutes prior to the deployment of gear, and during deployment of gear, active fishing, and gear retrieval. Use the “move-on” rule if marine mammals (with the exception of baleen whales) are sighted within 1 nm from the vessel in the 15 minutes prior to setting trawl or pelagic longline gear, or during active fishing. If protected species are observed within 1 nm of the vessel, the most appropriate response to avoid interaction with the gear is determined through the use of professional judgment of the Chief Scientist or officer on watch;
- Standard tow durations of no more than 45 minutes at target depth for distances less than 3 nm;
- SWFSC will continue to investigate ways to better understand marine mammal-trawl gear interactions to the extent possible. For example, SWFSC is considering using an acoustic camera to collect data on mammal interactions with trawl gear. The objective of these investigations is to first determine what interactions may be occurring and second, to develop additional potential mitigation measures to reduce them.
- During pelagic longline surveys, conduct visual monitoring during a pre-clearance period (15 minutes) same as for trawl surveys.
- During purse seine surveys, if killer whales or other large whales are seen at any distance, the net will not be set and the move-on rule is applied. If any dolphins or porpoises are observed within approximately 500 m of the purse seine survey location, the move-on rule is applied. If any dolphins or porpoises are observed in the net, the net will be immediately opened to let the animals go.
- Use of UAS must comply with applicable 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[28] 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.

Specifically, standard tow durations of not more than 45 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.

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

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. Wainwright *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. Use of 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.

4.3.2.3 Effects on the Social and Economic Environment

The addition of inshore survey areas, targeting of new *Sebastes* spp., and the use of micro trolling and unmanned systems in surveys is not expected to have different effects on the social and economic environment as described in Section 4.3.1.3 for the Status/Quo/No action Alternative and are expected to have minor to moderate beneficial effects.

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5 CUMULATIVE EFFECTS OF THE ALTERNATIVES

This section provides an update to the evaluation of potential cumulative effects of both Alternatives for SWFSC fisheries and ecosystem research that was published in the 2015 PEA. A brief summary of notable events or external activities that may interact with research that have occurred since 2015 as well as reasonably foreseeable future events and activities that may occur between 2020 and 2025 are included in this analysis of Alternatives 1 and 2 described in Chapter 2. A publication by Murray *et al*. (2014) provides a detailed discussion of cumulative effects on marine ecosystems from human-caused activities. This section discusses both human-caused and natural stressors than may result in cumulative effects on resources within SWFSC research areas.

5.1 Spatial and Temporal Scope

This cumulative effects analysis considers actions and events where SWFSC surveys occur within the CCRA, ETPRA, and ARA, as described in Section 1.1 and illustrated in Figure 1-1. Some actions that originate outside of SWFSC research areas such as discharge of pollutants or commercial fisheries, could contribute to cumulative effects within these geographic areas of interest. Other changes such as ocean acidification or climate change may be geographically widespread but also affect resources within the SWFSC research areas. The baseline condition described in the 2015 PEA as supplemented where necessary by Chapter 3 of this SPEA serves as the point of reference for analyzing cumulative effects. The temporal scope of this analysis covers notable events and actions that have occurred since the 2015 PEA through 2020.

5.2 Relevant Past, Present and Reasonably Foreseeable Future Actions and Events Within the Research Areas

Relevant past and present external actions and events that may interact with SWFSC fisheries and ecosystem research may include both human controlled activities (such as shipping or marine debris), and natural events, such as predation or climate change. Reasonably Foreseeable Future Actions (RFFAs; human activities or natural events) are those that:

- Have already been or are in the process of being funded, permitted, or described in coastal zone management plans;
- Are included as priorities in government planning documents; or
- Are likely to occur or continue based on environmental data, or historical patterns.

Judgments concerning the probability of future impacts must be informed rather than based on speculation. RFFAs to be considered must also fall into the temporal and geographic scope described below.

Reasonably foreseeable future actions and natural events were screened for their relevance to the alternatives proposed in this SPEA. Because the regulations in 40 CFR 1508.8 state that the actions and events must be considered probable, not just possible, only those actions that have a “high probability” of occurring have been included for analysis. Future actions and events were categorized as having a high probability of occurring based on whether they have undergone or are currently being evaluated by state or federal agencies, or whether permits have been issued authorizing the activity (i.e., undersea cable projects). Other activities and natural events categorized as high probability include those that have occurred for several years previously and are likely to continue occurring such as commercial and recreational fisheries, tourism or shipping. Due to the large geographic scope of the research areas, the identification of RFFAs was conducted on a broad scale, although some specific RFFAs were considered where applicable. Table 5-1 provides a list of past, present and RFFAs and natural events considered in the cumulative effects analysis in this SPEA.

Recognizing that not all past, present and future actions and events listed in Table 5-1 result in effects on every resource, only the actions or events that could contribute to cumulative effects are listed in Table 5-2- through 5-7 in the resource-specific discussions below.

TABLE 5-1. PAST, PRESENT AND REASONABLY FORESEEABLE FUTURE ACTIONS AND EVENTS WITHIN SWFSC RESEARCH AREAS

Category	Action/Event	Time Period	Location	Additional Description	Current Status	Reference
Construction	Rothera Modernisation - Phase 1 Initial Environmental Evaluation	2018	Antarctica	Proposed activities are part of the Natural Environment Research Council's plans to modernize Rothera as the United Kingdom's gateway to Antarctica and to support the new polar research vessel, the Royal Research Ship Sir David Attenborough currently being built and funded by the United Kingdom Government department Business, Energy and Industrial Strategy.	Ongoing	https://www.bas.ac.uk/project/uk-antarctic-hub-rothera-modernisation/
Construction	Multiple Coastal Projects US West Coast	Multi-year	Coastal Areas	Construction projects that may interact with the same resources as SWFSC research include but are not limited to port improvement projects, beach improvement projects, golf courses, housing developments, marinas, etc.	Ongoing	Various
Commercial Fishing	Multiple Gear Types and Vessels	Multi-year	US Pacific Region	CPS are highly variable, environmentally sensitive stocks that provide food for marine mammals, birds, and fish. Species include Pacific sardine, northern anchovy, Pacific and jack mackerel, and market squid. Of these, Pacific sardine is the most commonly targeted CPS finfish in commercial fisheries in the region. Landings revenue increased in the Pacific Region (up $131.2 million or 24%) from 2015 to 2016 largely due to the increase in crab landings revenue ($111.7 million) during this period.	Ongoing	NMFS (2018b)
Commercial Fishing	Multiple gear Types	Multi-year	Antarctica	All fishing activity in the ocean around the Antarctic Continent — including the harvesting of Antarctic krill (*Euphausia superba*)— has been strictly regulated by the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) since 1980 with the primary purpose of protecting and conserving living marine resources in the waters surrounding Antarctica, including krill, icefish and other finfish, mollusks, crustacea, and all other species of living organisms. NOAA is a party to the Convention.	Ongoing	CCAMLR (2018)
Geophysical/ Geotechnical Surveys	Seismic imaging, bathymetric surveys, etc.	Multi-year	Coastal and Offshore Areas	Marine geophysical and geotechnical surveys occur with some frequency off the US West Coast for various purposes ranging from seismic safety (i.e., earthquake assessment) to resource mapping to assessing underwater hazards (i.e., shipwrecks).	Ongoing	https://www.usgs.gov/centers/pcmsc/science/us-west-coast-and-alaska-marine-geohazards?qt-science_center_objects=0#qt-science_center_objects
Marine Debris	Garbage and flotsam	Multi-year	Coastal and Offshore Areas	Marine debris is continuously mixed by wind and wave action and widely dispersed both over huge surface areas and throughout the top portion of the water column. Debris can entangle marine fauna and be ingested, causing injury, illness or mortality. Between 2007-2013, 500 tons of debris were removed from Port of San Diego. A program to remove derelict fishing gear is active in Puget Sound. Marine Debris Action Plans are in effect in Oregon (2019) and Washington (2018); California has an Ocean Litter Prevention Strategy (2019).	Ongoing	https://marinedebris.noaa.gov/
Marine Sanctuaries and Protected Areas	ONMS	Multi-year	Coastal and Offshore Areas	In accordance with this definition, MPAs encompass a large fraction of the area where research surveys are conducted. They include: California's State Marine Reserves, State Marine Parks, State Marine Conservation Areas, and State Marine Recreational Management Areas; Oregon's MPA's; Washington's MPA's; Wildlife Refuges; National Parks; and National Marine Sanctuaries, as well as Marine World Heritage Sites and Marine Management Areas. In March 2015, NOAAs National Marine Sanctuary Program published a final rule that expanded the Gulf of Farallones NMS and Cordell Banks NMS from approximately 3,394 square kilometers (km^2) to approximately 8,544 km2 (80 FR 13078).	Ongoing	https://sanctuaries.noaa.gov/
Military	USCG Polar Security Cutter Final PEIS	2019	Antarctica	The Coast Guard proposes the design and build of up to six PSCs, each with a planned service life of 30 years. The Coast Guard also proposes to conduct polar security cutter operations and training to meet Coast Guard mission responsibilities, in addition to vessel performance testing post-dry dock in the Pacific Northwest near the current homeport of Seattle, Washington. PSCs would be transcontinental vessels supporting the Coast Guard's missions in the Antarctic and Arctic proposed action areas.	Ongoing	https://media.defense.gov/2019/Sep/20/2002185061/-1/-1/1/POLAR%20SECURITY%20CUTTER%20FINAL%20PROGRAMMATIC%20ENVIRONMENTAL%20IMPACT%20STATEMENT.PDF
Military	Hawai`i-Southern California Training and Testing	2018 (New every 5 years)	Southern California	The Study Area consists of the in-water areas of the Southern California Range Complex (including San Diego Bay) and areas on the high seas where training and sonar testing and maintenance may occur during vessel transit between the Hawaii and Southern California Range Complexes; the Temporary Operating Area west of the Hawaii Range Complex; and specific Navy pier-side, port, and harbor locations. Activities include the use of active sound navigation and ranging (sonar) and explosives.	Ongoing	https://www.hstteis.com
Natural Events	Hurricane/Typhoon	Multi-year	US and Mexico West Coast	In the Pacific basin there are an average of 16 tropical storms annually, with 9 becoming hurricanes, and 4 becoming major hurricanes. Since 2015, there have been 10 hurricanes off the California coast alone. The 2018 hurricane season produced the highest accumulated energy on record in the Pacific Basin.	Ongoing	https://www.nhc.noaa.gov/climo/
Natural Events	Climate Change	Multi-year	Global	Increased ocean temperatures, increased ocean acidity, shift in currents, sea level rise. See additional details in Section 4.	Ongoing	https://www.epa.gov/climate-indicators/oceans https://www.climate.gov/news-features/understanding-climate/understanding-climate-antarctic-sea-ice-extent

Category	Action/Event	Time Period	Location	Additional Description	Current Status	Reference
Natural Events	Unusual Mortality Events (UMEs) – Grey Whale	Various	West Coast of the U.S.	Two UMEs: 1999 to 2000 and 2019-2020. Grey whale stock has increased despite these events.	Ongoing	Carretta *et al*. (2019) https://www.fisheries.noaa.gov/national/marine-life-distress/2019-2020-gray-whale-unusual-mortality-event-along-west-coast.
Natural Events	UMEs – Guadalupe Fur Seal	Various	CA coast WA and Or coasts	Occurring since 2015 along the CA coast; elevated stranding numbers observed along WA and OR coasts starting in 2019	Ongoing	https://www.fisheries.noaa.gov/national/marine-life-distress/2015-2020-guadalupe-fur-seal-unusual-mortality-event-california.
Oil and Gas	Liquid Natural Gas (LNG) Terminals (Sempra Energy Terminal, Ensenada Mexico; Jordan Cove Project, Coos Bay, OR	Ongoing		The Jordan Cove Liquid Natural Gas (LNG) terminal would be located in Coos County, OR and would include: a pipeline gas conditioning facility; five natural gas liquefaction trains; two full-containment LNG storage tanks and associated equipment; LNG loading platform and transfer line; marine facilities; an access channel from the existing Coos Bay Federal Navigation Channel to the LNG terminal; modifications adjacent to the existing Federal Navigation Channel; and other support structures. As proposed, the LNG terminal would be called upon by about 120 LNG carriers per year. In Mexico there are three liquid natural gas (LNG) terminals supplied from places such as Palmira, Tamaulipas, Manzanillo, Colima and Costa Azul, being the latest located 23 kilometers north of Ensenada, Baja California (B.C.). Between 2018 and 2019 the US Department of Energy granted authorization to ECA LIQUEFACTION (formerly Energía Costa Azul) to develop an LNG terminal off the Baja California coast in Mexico.	Ongoing	FERC (2019) https://www.ferc.gov/industries/gas/enviro/eis/2019/03-29-19-DEIS.asp Quintero- Nuñez et al. (2014) https://www.energy.gov/fe/downloads/energ-costa-azul-s-de-rl-de-cv-dkt-no-18-144-lng-eca-mid-scale-project
Other Research (External to SWFSC and Partners)	Rothera Biological & Oceanographic Times Series (RaTS)	1997	Antarctica	The RaTS program has been running at Rothera since 1997 and comprises an integrated suite of oceanographic and biochemistry data (e.g. temperature, salinity, macronutrients, chlorophyll) collected at a key site of rapid climate warming and high inter-annual variability on the Antarctic Peninsula.	Ongoing	https://www.bas.ac.uk/wp-content/uploads/2019/11/Rothera-Modernisation-Phase-1-IEE-Final.pdf
Other Research (External to SWFSC and Partners)	Multiple Parties (see description)	1956 - Ongoing	Antarctica	The NSF funds Antarctic-related science on the Antarctic continent, at U.S. universities, federal laboratories, and other similar U.S. organizations. Science research and field projects may include organizations such as Leidos, Air National Guard, USAF, Joint Task Forces Support Antarctica, Air Center Helicopters, Inc., Kenn Borek Air Ltd., US Navy, USCG, University programs from several countries, NASA, USGS and others.	Ongoing	https://www.usap.gov/aboutusapparticipants/#SciencePrograms
Predation	N/A	Multi-year	Coastal and Offshore Areas	Predation of animals in their environment by natural predators (i.e., sharks preying on seabirds around French Frigate Shoals or fish predation in the ocean) or introduced predators such as rats that may prey on species such as seabirds or sea turtles (eggs).	Ongoing	Various
Recreational Fishing	Recreational Fishing Charter, Fishing Tournaments	Multi-year	Coastal and Offshore Areas	In 2016, 1.2 million recreational anglers who fished in the Pacific Region. Key species included rockfishes and scorpionfishes (4.2 million fish), barracuda, bass and bonito (19.5 million fish), and surfperches (1.8 million fish) were most frequently caught by recreational fishermen. In 2016, recreational fishermen took 5.2 million fishing trips in the region.	Ongoing	NMFS (2018b)
Renewable Energy	Wind, Hydrokinetic, Wave	2009 – Ongoing	Pacific Outer Continental Shelf	The BOEM Pacific Outer Continental Shelf (OCS) Region has an active Renewable Energy Program and is currently processing wind and wave energy lease requests. BOEM's The Emerging Technologies Program is a research element within the Bureau of Safety and Environmental Enforcement. The Program supports renewable energy research associated with Operational safety, engineering standards and pollution prevention.	Ongoing	http://hinmrec.hnei.hawaii.edu/nmrec-test-sites/wave-energy-test-site/ OCS renewable energy development off Oregon and California (at https://www.boem.gov/renewable-energy-state-activities/)
Tourism/Recreation	Yacht Racing, Cruises, Ecological Safaris, Whale and dolphin watching, Shark Tours	2014 – Ongoing	Antarctica	As required by the Antarctic Science, Tourism, and Conservation Act of 1996, EPA has issued regulations that provide for the environmental impact assessment of nongovernmental activities (including tourism) in Antarctica, and that coordinate the information review of environmental impact assessments received from other Parties. These activities are called for by the Protocol on Environmental Protection to the Antarctic Treaty of 1959. These tourism and other types of activities have been evaluated and assessment documents are posted on the EPA website listed at right.	Ongoing	https://19january2017snapshot.epa.gov/international-cooperation/receipt-environmental-impact-assessments-eias-regarding-nongovernmental_.html
Tourism/Recreation	Ocean Economy	Multi-year	California and Western US Coast	Two sectors of the ocean economy—tourism and recreation and marine transportation—are significant both at the state level and on a national scale. In California alone, tourism and recreation are the largest of the state's six ocean-dependent sectors, accounting for 39 percent of the ocean economy's GDP ($17.6 billion), 75 percent of the ocean economy's employment (368,000), and 46 percent of the ocean economy's wages ($8.7 billion) in 2012 (NOAA ENOW, 2015).	Ongoing	https://coast.noaa.gov/data/digitalcoast/pdf/california-ocean-economy.pdf
Undersea Cables	Telecommunication	Multi-year		To help ensure coordination of cable placement and mitigation of any adverse impacts, a number of U.S. agencies have authority to regulate the laying and maintenance of cable off of our nation's shores. In addition, while this webpage focuses on the federal government's authority to regulate submarine cables, it is worth noting that a number of U.S. states also exercise control over submarine cables that land on their shores. E.g., Undersea Cable – Regulatory Framework Created, Haw. Clean Energy Initiative (June 27, 2012)	Ongoing	https://www.gc.noaa.gov/gcil_submarine_cables_domestic.html https://www.submarinecablemap.com/
Vessel Traffic	Shipping	Multi-year	Coastal and Offshore Areas	The U.S. West Coast has some of the heaviest ship traffic associated with some of the largest ports in the country, including the Ports of Los Angeles/Long Beach, San Francisco, Seattle, and the Columbia River.	Ongoing	https://www.marinetraffic.com https://www.fisheries.noaa.gov/west-coast/marine-mammals-west-coast-ship-strikes

5.2.1 Climate Change

A 2018 report by Sievanen *et al*. synthesized current scientific understanding about the impacts of climate change on California's coast and ocean which provide a good understanding of potential effects of climate changes across the US west coast. Sea-level rise, warming ocean temperatures, fluctuations in ocean chemistry changes, and other greenhouse gas-driven changes to the US west coast and oceans are occurring and are projected to have significant consequences for the coastal economy, communities, ecosystems, culture, and heritage. These consequences will affect areas within the SWFSC research areas off the US west coast that have the potential to extend into the U.S. economy (Sievanen *et al*. 2018). Climate change is increasing ocean temperature and levels of carbon dioxide resulting in ocean acidification and shifting weather patterns (Hoegh-Guldberg 2010, Koetse and Rietveld 2009). The increase in temperature and changes in weather patterns may shift currents carrying waste and debris. In marine ecosystems, changes in temperature, ocean circulation, stratification, nutrient input, oxygen content, ocean acidification and increased atmospheric carbon dioxide may have significant biological effects (Doney *et al*. 2012). Climate change has led to massive coral bleaching events with permanent consequences for local habitats (Donner *et al.* 2005).

An anomalously warm water mass began to form in the North Pacific and Gulf of Alaska during autumn 2013 due to a lack of cyclonic storms that usually mix and subsequently cool the water column. This warm water mass was aptly named "the Blob". The Blob spread across the entire North Pacific in spring 2014, producing temperature anomalies of 3 to 4.5°C by summer 2014. This resulted in a complete replacement of the "cold water, lipid-rich" food chain with a "warm-water, lipid poor" food chain. By winter (Jan-Mar) 2015, the sea surface temperature pattern across the Pacific resembled the positive Pacific Decadal Oscillation pattern and this sea surface temperature pattern continued through all of 2015 and 2016.

Generally, the California Current is strongly influenced by seasonal upwelling of cool, deep, water that is high in nutrients and low in dissolved oxygen and pH. Ecological effects of climate change in the California Current are very sensitive to impacts on upwelling intensity, timing, and duration (Bakun *et al.* 2010; NWFSC 2015). While the warm Blob was moving east in the North Pacific Current in spring of 2014, an El Niño Southern Oscillation (ENSO) warm phase developed at the equator, creating the first pulse of warm water typical of an El Niño along the eastern equatorial Pacific. An El Niño developed the following year, as pulses of warm water moved eastward along the equator in spring and autumn 2015, producing extremely warm surface temperatures from November 2015 through January 2016. This El Niño event evolved into the strongest event in 19 years, and likely reached northern California Current by summer 2016.

Record high temperatures from 2014–2016 along the Pacific Coast from Baja California, Mexico, to Vancouver Island, Canada (Jacox *et al*. 2018) was unprecedented in this region. Very high single-year sea surface temperatures were recorded in the California Current in 2015 and record 3-year average temperatures occurred 2014–2016. These high sea surface temperatures resulted in mass strandings of sick or starving birds and sea lions, northward shifts of pelagic red crabs, tunas, and other sub-tropical fish into coastal waters of California, and closures of commercial fisheries (Cavole *et al*. 2016, as cited in Sievanen *et al*. 2018).

Harmful algal blooms (HABs, such as domoic acid and Pseudo-nitzschia) have occurred off the US West Coast for several consecutive years and can have major effects on commercial fisheries and human health. Improving scientific understanding of the environmental conditions or triggers for these harmful algal blooms including their connection with warmer ocean temperatures is needed (Sievanen *et al*. 2018). Oxygen depleted areas in nearshore waters due, in part, to terrestrial stormwater runoff or sewage outfalls, have adverse effects on many marine species.

Studies in Antarctica reported in Holland *et al*. (2019), discuss recent sea ice melting from the Western Antarctic Ice Sheet and in the Amundsen Sea. Holland *et al*. (2019) also present climate model projections suggesting that strong future greenhouse gas will create persistent mean westerly shelf-break winds by 2100, further enhancing warm ocean anomalies. In 2019, the lowest sea ice extent since 1979 was recorded in Antarctica. Sea ice extent in 2017 and 2018 were the lowest on record for both winter maximum and summer minimum (Scott 2019). Figure 5-1 shows the annual cycle of sea ice extent in the Southern Ocean since 2010.

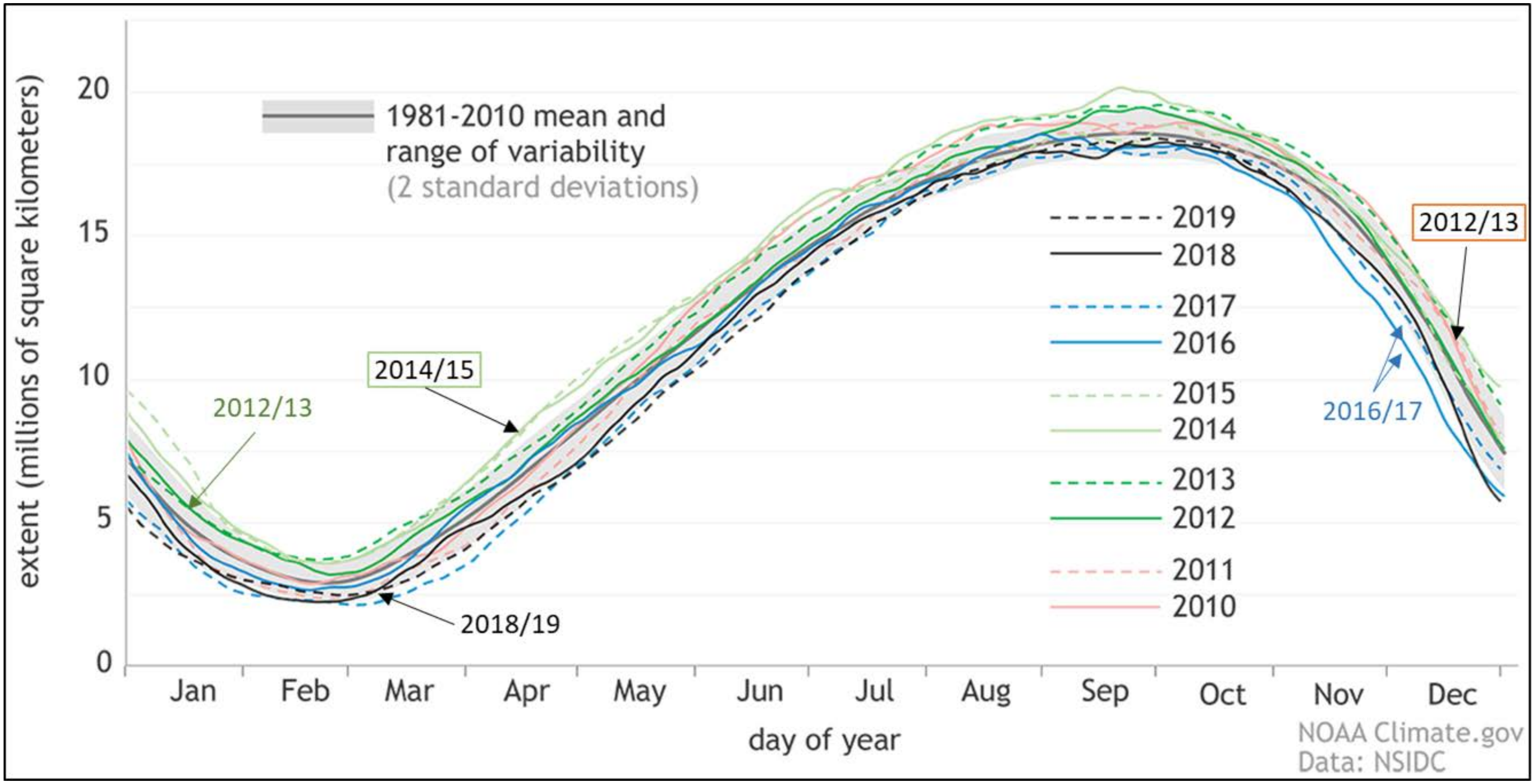
In the ARA, Turner *et al*. (2009) stated that accelerated global warming and increased UV-B levels resulting from the ozone hole that develops in spring are the most important anthropogenic changes currently affecting the Antarctic. They note that the Antarctic marine ecosystem has been affected by climate change over the last fifty years, especially on the western side of the Antarctic Peninsula, with warming ocean temperatures and declining sea ice. This region is among the fastest-warming areas on the planet (Ducklow *et. al* 2012). These biological and physical perturbations have affected the ecosystem profoundly (Trivelpiece *et al*. 2011). A projected continued decline in sea ice could affect production of marine algae, with cascading effects through higher trophic levels, fish included (Trivelpiece *et al* 2011). Increased ocean acidification is another potential side effect of environmental change (Turner *et al*. 2009).

5.2.2 Physical Environment

Dozens of trans-Pacific undersea cables occupy the seafloor that run through the SWFSC research area off the US and Mexico west coasts (see Figure 5-2). Modern cables are typically about 1 inch in diameter and weigh about 2.5 tons per mile. These cables disturb the benthic habitat, however studies have indicated that cables pose minimal threats to the benthic environment, and in some cases provide habitat for invertebrates to grow (Carter 2009). Wind farms could also affect the geologic features of research areas where the anchors are set. Military training is unlikely to impact offshore geologic resources, although missile testing, and other exercises may accumulate munitions and other military hardware on the seabed. Natural disasters known to occur in the region (i.e., tsunamis, hurricanes, typhoons) could cause the deposition of various debris and structures on the seabed as well.

Overall, the cumulative effects of proposed SWFSC fisheries and ecosystem research when combined with other past, present and future actions, would likely result in negligible cumulative effects on the physical environment. Large objects deposited on the seabed such as from marine debris, undersea cables or wind farms, would have an impact, although sometimes these objects may create new habitat in a relatively homogenous, flat environment. Nevertheless, the spatial extent of these impacts would involve a small, localized area. While effects from actions external to SWFSC research could be long-term, the magnitude of SWFSC research is not expected to alter habitat function or cause wide-spread changes to the geologic structure of the research areas (see Table 5-2).

FIGURE 5-1. ANNUAL CYCLE OF SEA ICE EXTENT IN THE SOUTHERN OCEAN SINCE 2010

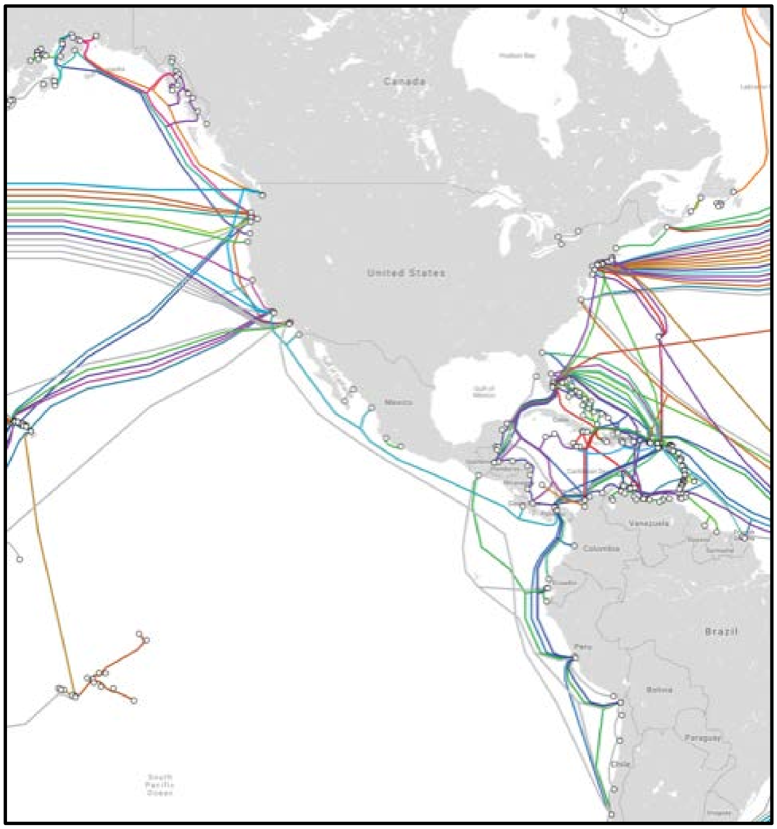


Source: Scott 2019

TABLE 5-2. PAST, PRESENT AND RFFAS POTENTIALLY AFFECTING PHYSICAL FEATURES AND BENTHIC HABITAT

RFFA or Natural Event	Net Effect	Types of Effects
Renewable Energy Projects	Minor Adverse	• Benthic disturbance
Undersea Cables	Minor Adverse	• Benthic disturbance
Military Training and Testing	Minor Adverse	• Benthic disturbance • Munitions and other military hardware on the seabed
Marine Protected Areas/EFH/Closed Areas	Major Beneficial	• Reduced disturbance • Habitat protection
Hurricanes, Typhoons, Tsunamis	Minor to Moderate Adverse	• Potential for equipment, vessels, and land-based structures to be deposited on seabed • Habitat alteration
Climate Change	Minor Beneficial and Adverse	• Habitat alteration
Port and Harbor Construction	Minor to Moderate Adverse	• Nearshore benthic disturbance • Nearshore habitat alteration
Scientific Research	Minor Beneficial and Adverse	• Gain knowledge of seafloor • Benthic disturbance

FIGURE 5-2. MAP OF UNDERSEA CABLES WITHIN OR NEAR SWFSC RESEARCH AREAS



5.2.2.1 Special Resource Areas and EFH

Special marine resource areas often straddle regulatory boundaries. An MPA, signed into law by EO 13158, is defined as "any area of the marine environment that has been reserved by federal, state, tribal, territorial, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein". Not all special sensitive marine areas are set aside for protection by federal or state laws or regulations. Therefore, not all biologically sensitive marine areas are found inside an established MPA. The State of California Coastal Act provides a definition of an "environmentally sensitive area" as "any area in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which could be easily disturbed or degraded by human activities…" (Section 30107.5).

As described in Chapter 3, in March 2015, a final rule to expand Gulf of Farallones and Cordell Bank NMSs was published (80 FR 13078). SWFSC. The Pacific Coast Groundfish FMP Amendment 28 to modify current closed areas to protect EFH or re-open areas considered rebuilt would likely result in both beneficial and adverse minor effects on EFH. EFH has not been designated in the ETPRA or the ARA. Overall, SWFSC research would not contribute towards a cumulative effect on special resource areas or EFH within the research areas.

5.2.3 Biological Environment

5.2.3.1 Fish

Cumulative effects on fish and fish populations are complex and while there is a body of evidence on the effects of a single stressor on fish populations, identifying the consequences (and the causes) of multiple stressors is more complex (Murray *et al*. 2014). That said, fisheries research has documented multiple stressors from single fishing types. For example, stressors from benthic trawling include direct mortality to target species, bycatch mortality and injury, sedimentation, and habitat destruction (Hiddink *et al*. 2006 as cited in Murray *et al*. 2014). The spatial scale of the cumulative effects of a single activity can vary across local and regional scales, as well as their duration and frequency over time. While direct mortality from fisheries may occur only within a fished area, sedimentation may be widespread and habitat destruction could be long-term (Watling and Norse 1998 and Boutillier 2012 as cited in Murray *et al*. 2014). The consequences of these cumulative effects also depends heavily on the condition (i.e., health) of the resource exposed. For example, an ESA-listed species would be more vulnerable to long-term consequences of cumulative effects than a non-listed species. For additional details regarding cumulative effects on ESA-listed fish within the SWFSC research areas, please refer to the BiOp published by NMFS West Coast Region on August 31, 2015 (NMFS 2015b).

Climate change may have effects on weather patterns and sea surface temperature, which may shift the distribution of fish populations. Marine fish and invertebrate species are impacted by climate change and decadal variability. For example, the historical oscillation between Pacific sardine and northern anchovy populations in the California Current is evidence of this linkage. Other activities in the action area that may affect fish include recreational and commercial fisheries, renewable energy, predation, MPAs, construction and military activities. Table 5-3 lists the past, present and RFFAs that have or could affect fish. When considering SWFSC research with other past, present and future actions, cumulative effects on fish overall are minor. The overall level of biomass removal compared to commercial and recreational fisheries is very low.

NOAA scientists recently published a report (the first of its kind) to assess the climate vulnerability of 82 fish and invertebrate species in the Northeast region (Hare *et al*. 2016). Overall, climate vulnerability was high to very high for approximately half the species assessed on the northeast continental shelf; diadromous and benthic invertebrate species exhibit the greatest vulnerability (Hare *et al*. 2016). Ocean temperatures, shallow-water temperatures, and ocean acidification were the climate factors with the largest magnitude of expected changes. In addition, the majority of species included in the assessment have a high potential for a change in distribution in response to projected changes in climate. A subsequent change in distribution of fishery landings and potentially the distribution and magnitude of fishing effort were documented by Hare *et al*. (2016). A similar assessment is underway for the California Current Ecosystems[29].

Climatic conditions affect salmonid abundance, productivity, spatial structure, and diversity through direct and indirect impacts at all life stages (e.g., Lindley *et al.* 2007; Crozier *et al*. 2008, 2019; Moyle *et al*. 2013; Wainwright and Weitkamp 2013). High temperatures in the lower mainstem of the Columbia

[29] https://www.fisheries.noaa.gov/new-england-mid-atlantic/climate/northeast-vulnerability-assessment

River and tributaries in early 2015 caused a failure in the sockeye run (DART 2016; Crozier 2016). Sacramento winter-run Chinook salmon survival in 2014 and 2015 was the lowest ever observed and has been attributed to the California drought (Poytress 2016 as cited in Crozier 2016). Further evidence of the effects of warming climate were reported by PFMC (2016 as cited in Crozier 2016) regarding the low Oregon coho salmon returns from a recent El Nino event and the warm "blob" described in Section 4.4.1.1. Ocean acidification, loss of adaptability to climate extremes, and introduction of non-native species predators have all been associated with climate change (Crozier 2016). Generally, climate impacts in one life stage generally affect body size or timing in the next life stage. For this reason, the cumulative life-cycle effects of climate change must be considered to fully appreciate the scope of risk to a given population (NWFSC 2015). Even without interactions among life stages, the sum of impacts in many stages will have cumulative effects on population dynamics

A recent assessment of climate impacts on Pacific salmon was completed by Crozier *et al*. (2019). This assessment highlighted high-risks due to climate change for several endangered and threatened ESUs of salmon, some taken by SWFSC fisheries research. Changes in water temperatures, and distinct flow conditions or water pathways are the characteristics that contribute to high vulnerability for these life history types and make them particularly sensitive to climate change (Crozier *et al.* 2019). These include more extreme high and low flows and hotter oceans and rivers. Certain Chinook, coho, and sockeye salmon population groups are the most vulnerable to expected environmental shifts with climate change. For example, both the late-fall and winter-run Chinook ESUs face extinction without continued intensive management/propagation. Similarly, for chum salmon, the summer-run faces relatively greater vulnerability than the more common fall or winter-run life history types in northern regions (Crozier *et al*. 2019). Steelhead, pink and chum salmon face less risk, either because they are more adaptable to varying conditions (steelhead) or spend less time in freshwater (pink and chum). Generally, populations within distinct ESUS are at most risk along the periphery of the ESU range, especially in interior and southern regions, exactly where climate is expected to change the most (Crozier *et al*. 2019).

Globally, a publication by Crowder *et al*. (2008), presented information on the impacts of fisheries (i.e., commercial recreational and artisanal) on marine ecosystems. Researchers have attributed fishing as one of the oldest and most significant factors modifying marine ecosystems (Jackson *et al*. 2001 as cited in Crowder *et al*. 2008). Fishing, combined with other anthropogenic stressors, has resulted in a loss of biodiversity (Worm *et al*. 2006 as cited in Crowder *et al*. 2008). Bycatch of sharks and rays in commercial fisheries generally occurs outside of the SWFSC research areas or are from non-listed populations. NMFS (2018b) reviewed historical abundance data for 124 species in 38 regions worldwide compared ocean temperature and found that eight percent of these populations were adversely impacted by warming while four percent experienced beneficial effects. Significant discrepancies exist among regions with regard to the magnitude of these effects, with East Asia seeing the largest declines (15 to 35 percent) in fisheries productivity (Free *et al*. 2019).

Fully understanding how climate change will continue to affect fisheries research and/or commercial fisheries in the future will require additional research such as that conducted by SWFSC. The potential far-reaching impacts of climate change on fish habitat due to warming ocean temperatures, decreased habitat for selected species, changing distributions and abundance, changes in productivity and subsequent production, far exceed the minor impacts of fish removal as a result of SWFSC fisheries research.

Closed areas within SWFSC research areas do protect fish and their habitat from some stressors (such as fishing) listed in Table 5-3. Since the 2015 PEA, on June 11, 2019, NMFS proposed Amendment 28 to the PFMC Groundfish FMP to reconfigure closed areas to the rockfish EFH conservation area boundaries (84 FR 27072). The combination of new and revised EFH conservation areas and the reopening of trawling in selected areas is anticipated to minimize adverse impacts to groundfish EFH from the effects of fishing. In addition to closed areas within the U.S. EEZ the states of California, Oregon, and Washington have established additional closed areas within state waters.

For Chinook, coho and pink salmon, EFH is designated and extends from the nearshore and tidal submerged environments within state territorial waters to the seaward boundary of the U.S. EEZ along the coasts of Washington, Oregon, and California north of Point Conception (PFMC 2003). For ESA-listed species of fish including Pacific salmon and steelhead, EFH and critical habitat often overlap considerably. The 2015 PEA and Biological Opinion addressed cumulative effects on these ESA-listed species and based on the scope of research in the SPEA Alternatives, the conclusions presented in those assessment have not changed.

A series of closed areas in the ARA were established by Convention for the Conservation of Antarctic Living Marine Resources (CCAMLR) conservation measures, as discussed in CCAMLR (2010). Taking of all finfish, other than for scientific research purposes, is prohibited in selected CCAMLR statistical subareas 48.1 and 48.2, which overlap with the SWFSC ARA. In addition, directed fishing for certain species in certain areas (except for scientific research purposes) is prohibited as described in a series of CCAMLR conservation measures. Directed fishing for sharks (except for scientific research purposes) is prohibited throughout the CCAMLR convention area, and any sharks caught accidentally are required to be released alive, if possible.

Overall, the contribution of SWFSC research to cumulative effects on fish is negligible and could be considered positive when considering overall benefits from new information gained through research.

TABLE 5-3. PAST, PRESENT AND RFFAS POTENTIALLY AFFECTING FISH

RFFA or Natural Event	Net Effect	Types of Effects
Renewable Energy Projects	Minor Adverse	• Alter distribution and migration • Mortality due to targeted fishing
Commercial and Recreational Fishing	Minor to Moderate Adverse	• Mortality • Alter species composition through targeting specific species
Undersea Cables	Minor Adverse	• Potential effects from electromagnetic fields
Military Training and Testing	Minor Adverse	• Habitat disturbance • Mortality • Potential exposure to contaminants
Tourism/Ocean Economy	Minor Adverse	• Disturbance • Alter distribution and migration
Marine Protected Areas/EFH/Closed Areas	Major Beneficial	• Reduced Disturbance • Habitat protection • Reduced mortality
Climate Change	Minor to Major Beneficial and Adverse	• Habitat alteration • Alter distribution and migration • Changes in prey availability (*i.e.*, increase or decrease)
Vessel Traffic	Minor to Major Adverse	• Habitat disruption • Underwater noise • Spills of contaminants

5.2.3.2 Marine Mammals

As discussed in Sections 4.3.1.3 and 4.3.2.3 (Effects of the Alternatives on Marine Mammals), the proposed SWFSC research would likely result in no effect or minor adverse direct and indirect effects. As described in Section 4.3.1.3, M/SI takes of marine mammals have occurred during research including Pacific white-sided dolphins and a California sea lion due to entanglement, entrapment, or collision. SWFSC research activities have also disturbed a certain number of marine mammals due to vessel presence and underwater noise. However, any disturbance is expected to be minor and these effects are not expected to result in population-level changes to any species.

A summary of potential past, present and RFFAs that may contribute to cumulative effects on marine mammals is presented in Table 5-4. The majority of impacts on marine mammals arising from RFFAs are associated with potential collision, entanglement, disturbance (including vessel or human presence and underwater noise), habitat alteration, and potential exposure to contaminants (*i.e.*, due to spills). These impacts arise from vessel activities, commercial fisheries, undersea cables, tourism, shipping and cruise ships, and military training activities occurring or proposed to occur within or near the research areas. Figure 5-3 presents an example of vessel traffic within the SWFSC research areas off the Pacific coast. Also, numerous natural and anthropogenic threats to marine mammals in the SWFSC research areas may affect their continued existence. These threats include oceanic and climatic regime shifts, UMEs, habitat degradation, fisheries interactions, vessel strikes, and disease and other disturbances associated with human activities (see Table 5-4). Fishery interactions with protected species are considered as having the greatest impact on marine mammal mortality worldwide and are routinely evaluated by NMFS through the preparation and issuance of environmental impact analyses, biological opinions and marine mammal SARs. More than 97 percent of whale entanglements are the result of interaction with derelict fishing gear (Baulch and Perry 2014). Detailed information on bycatch of ESA-listed marine mammals in active U.S. commercial fisheries in areas where SWFSC conducts research is monitored on an annual basis. Information on whale entanglements in commercial fisheries from the most recent Pacific SARS (Carretta *et al*. 2018, 2019) is presented in Section 5.2.3.2.1.

Overall, the contribution of SWFSC research to cumulative effects on marine mammals is negligible within the context of the past, present and RFFAs listed in Table 5-4, and discussed in the following subsections.

5.2.3.2.1 Commercial and Recreational Fishery Interactions

In the CCRA, several commercial fisheries interactions with ESA-listed marine mammals were reported in Carretta *et al*. (2018 and 2019). Two blue whales were seriously injured in California Dungeness crab pot gear and a third whale was seriously injured in an unidentified pot/trap fishery during the period 2012-2016 (Carretta *et al*. 2018). Entanglements of blue whales in the California swordfish drift gillnet fishery have not been observed during the 27-year observer program (Carretta *et al.* 2018). For the period 1990 – 2016, only one fin whale death was observed (in 1999) in the California swordfish drift gillnet fishery (Carretta *et al.* 2018).

A total of 123 human-related interactions involving humpback whales are summarized for the 5-year period 2012-2016 by Carretta *et al.* (2018). These include serious and non-serious injuries, and mortality involving pot/trap fisheries (57), unidentified fishery interactions (49), vessel strikes (13), gillnet fisheries

(3) and marine moorings (1). The number of human-related deaths and injuries for each humpback whale feeding group 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 DPS (Calambokidis *et al*. 2017).

From 2012 to 2016, 57 observed interactions with pot and trap fisheries were observed (Carretta *et al.* 2018). Unusually warm temperatures and an increase in harmful algal blooms along the Pacific coast resulted in shellfish contamination which in turn delayed the opening of the Dungeness crab fishery in 2015. The delayed opening of the fishery then resulted in increased usage of fishing gear (such as crab pots) in nearshore waters during late spring of 2016, which coincided with a record numbers of humpback whale entanglements (Sievanen *et al*. 2018). Eighteen records involved non-serious injuries resulting from human intervention to remove gear, or cases where animals were able to free themselves. Two records involved dead whales, including one humpback recovered in sablefish pot gear in Oregon and one case where severed humpback flukes were 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 (Caretta *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.

Commercial fisheries are the primary activity impacting fish species in the ETPRA and, historically, small cetacean populations. However, they rarely interact with ESA-listed marine mammal species. The tuna purse seine fishery is one of the largest and most closely monitored, largely due to present and historical marine mammal by-catch. Yellowfin tuna, skipjack and big-eye tuna are the primary target species of the tuna fishery in this region.

One humpback whale was also found entangled in a marine research ‘wave-rider’ buoy moored in Monterey Bay on October 4, 2014. The whale was disentangled five days later. The buoy was not one maintained by NMFS but upon investigation it was found to be maintained by the Coastal Data Information Program (CDIP) program at the Scripps Institution of Oceanography (J. Carretta, SWFSC, Personal Communication, June 12, 2020). A subsequent review of the overlap of humpbacks in the CA Current with other CDIP buoys indicated that the buoys are scattered throughout the U.S. West Coast and have been in place for decades. This was the first whale entanglement in these buoys and such an entanglement has not occurred since 2014. Therefore, but the likelihood of an entanglement similar to what occurred in 2014 would be rare.

5.2.3.2.2 Collisions with Ships

Collisions with ships are a primary source of mortality for large whales. Ship strike mortality was recently estimated for blue whales in the U.S. West Coast EEZ (Rockwood *et al*. 2017). The estimated number of annual ship strike deaths was 18 blue whales. However, this number was only for the months July – November when whales are most likely to be present and the season that overlaps with cetacean habitat models (Becker *et al*. 2016, Rockwood *et al*. 2017). This estimate of annual mortality (18 blue whales), represents approximately 1% of the estimated population size of the stock. An estimated number of 43 deaths annually of fin whales were attributed to ship strike in the U.S. West Coast EEZ during the months July – November (Rockwood *et al*. 2017).

Thirteen humpback whales (8 deaths, 2.6 serious injuries, and 2 non-serious injuries) were struck by vessels between 2012 and 2016 (Carretta *et al*. 2019). 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. This estimated annual mortality (22 humpback whales) represents approximately 0.7% of the estimated population size of the stock (22 deaths / 2,900 whales) (Carretta *et al*. 2019). Estimating the impact of 22 mortalities on the two DPSs that occur within the California/Oregon/Washington DPS suggests that approximately 3-6 of these mortalities could have originated from the Central American DPS (population size 431-783 whales). This assumes that mortality is distributed evenly throughout the region, and members of the much more abundant Mexico DPS are affected. Assuming this distribution a worst-case scenario, an estimated 1.3% of the Central American humpback whale DPS could have been killed by ship strikes during this period.

5.2.3.2.3 Natural Events

The cumulative effects of typhoons, hurricanes, and tsunamis could cause changes in prey distribution or result in injury or mortality to marine mammals. The extent and magnitude of such impacts would depend on the storm event and the number of animals affected.

Cumulative effects of climate change on marine mammals result in changes in sea temperature, prey availability, changes in the frequency of major storm events and changes in habitat. As described in Moore and Huntington (2008), certain marine mammal species may have greater ability than others to adapt to major climate shifts and ecosystem disturbances. It is difficult to predict how cumulative effects may impact specific marine mammal species in any given location. However, the contribution of climate change to cumulative effects could range from minor to major depending on the specific species and the context of their exposure to other stressors such as the proposed aquaculture program. The most likely impact of climate change on cetaceans could be changes in the area these species currently occupy due to changes in distribution of prey species with particular thermal requirements (81 FR 62259). According to McLeod (2009), ranges of approximately 88 percent of cetaceans may be affected by changes in water temperature resulting from global climate change. A climate variability assessment is currently underway to assess the potential impacts of climate change on marine mammal populations in the Pacific (https://www.fisheries.noaa.gov/national/climate/climate-vulnerability-assessments). The combined cumulative effects on marine mammals of climate change and proposed SWFSC research is considered minor adverse under Alternatives 1 and 2. Relative to RFFAs, the frequency and duration of SWFSC research under Alternatives 1 and 2 is infrequent and short-term, particularly within the context of other past, present and RFFAs listed in Table 5-4. Unusual Mortality Events (UMEs) could contribute to cumulative impacts on ESA-listed marine mammals in the Action Area. Gray whales, California sea lions, and Guadalupe fur seals have been affected by these mortality events.

The population size of the North Pacific gray whale stock has increased over several decades despite a UME in 1999 and 2000 (Carretta *et al*. 2019) and a recent UME in 2019-2020[30]. Since January 1, 2019,

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

gray whale strandings have been documented along the west coast of North America from Mexico through Alaska. As of March 13, 2020, a total of 264 whales have stranded. Figure 5-4 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.

Elevated strandings of California sea lion pups have been occurring in Southern California since January 2013[31]. 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.

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[32]. 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.

5.2.3.2.4 Closed Areas and Marine Sanctuaries

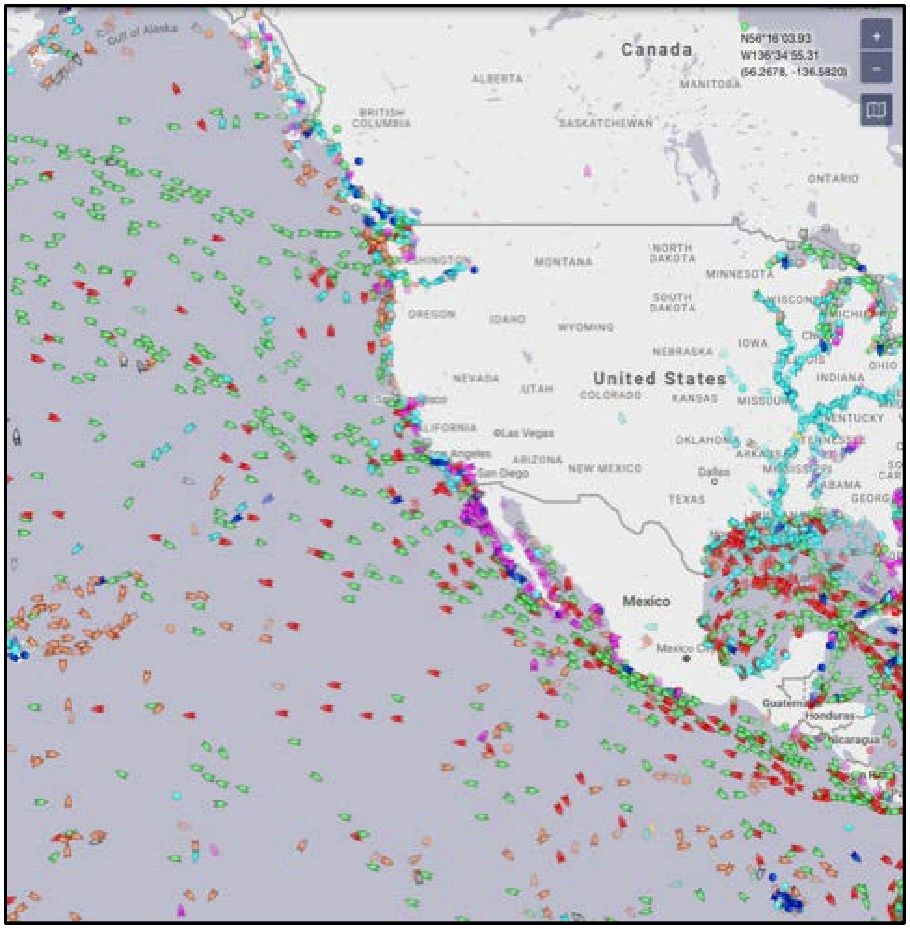
Marine managed areas protect healthy diverse ecosystems. Marine mammals benefit from these protected areas due to reduced disturbance, protection of prey species, reduced risk of entanglement or collision, among other benefits. The sanctuaries located within SWFSC research areas have beneficial effects which may offset some adverse cumulative effects from other human-induced or natural events.

[31] https://www.fisheries.noaa.gov/national/marine-life-distress/2013-2017-california-sea-lion-unusual-mortality-event-california
[32] https://www.fisheries.noaa.gov/national/marine-life-distress/2015-2020-guadalupe-fur-seal-unusual-mortality-event-california.

TABLE 5-4. PAST, PRESENT AND RFFAS POTENTIALLY AFFECTING MARINE MAMMALS

RFFA or Natural Event	Net Effect	Types of Effects
Renewable Energy Projects	Minor Adverse	• Disturbance • Potential entanglement leading to injury or mortality
Commercial Fishing	Minor to Moderate Adverse	• Potential entanglement leading to injury or mortality
Undersea Cables	Minor Adverse	• Disturbance • Potential entanglement leading to injury or mortality
Military Training and Testing	Minor Adverse	• Disturbance • Potential ship strike leading to mortality or injury • Potential exposure to contaminants
Whale/Dolphin Watching; Shark Tours	Minor Adverse	• Disturbance
Cruise Ships, Shipping	Minor to Moderate Adverse	• Disturbance • Potential ship strike leading to mortality or injury • Introduced non-native species • Potential exposure to contaminants
Marine Debris	Minor to Major Adverse	• Mortality and serious injury • Habitat modification
Marine Protected Areas/EFH/Closed Areas	Major Beneficial	• Reduced Disturbance • Habitat protection • Reduced risk of entanglement or ship strike
Other Research	Minor Adverse to Major Beneficial	• Disturbance • Mortality • Habitat protection • Habitat alteration
Hurricanes, Typhoons, Tsunamis	Minor to Moderate Adverse	• Disturbance • Habitat alteration • Potential exposure to contaminants • Mortality or injury
UMEs	Minor to Major Adverse	• Mortality
Port and Harbor Construction	Minor to Moderate Adverse	• Disturbance • Habitat alteration • Potential exposure to contaminants
Climate Change	Minor to Major Beneficial and Adverse	• Mortality or injury • Habitat alteration • Introduced non-native species • Changes in prey availability (*i.e.*, increase or decrease)
Vessel Traffic	Minor to Major Adverse	• Mortality • Habitat disruption • Underwater noise • Spills of contaminants

FIGURE 5-3. EXAMPLE OF DAILY VESSEL TRAFFIC OFFSHORE



Source: marinetraffic.com; to represent daily vessel traffic.

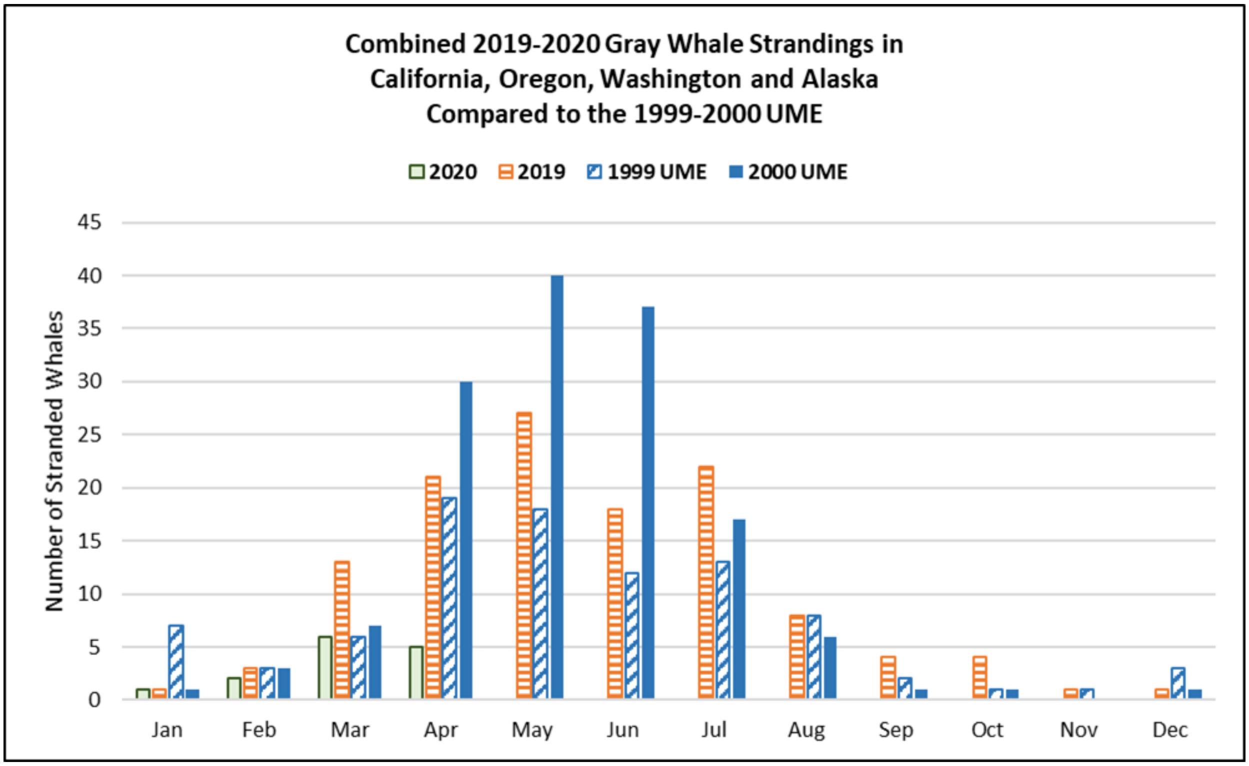


FIGURE 5-4. 2019-2020 GRAY WHALE STRANDINGS COMPARED TO 1999-2000 UME

5.2.3.3 Seabirds

The combination of stressors such as sea-surface temperature changes, habitat modification or loss due to human activities (i.e., urbanization) or large storm events in addition to the effects of climate change can place additional stress on seabird reproduction or foraging. Disturbances from human activities or natural events such as those listed in Table 5-5 can result in a reduction in seabird population health due to mortality, breeding failure or colony abandonment. Disturbance can cause long-term effects to health and survival of affected marine species, and when coupled with changing oceanic conditions and other human-induced stressors, cumulative small impacts can impart large-scale harm (National Ocean Service [NOS] 2019).

For example, as reported in Webb and Kench (2010), sea-level rise would likely lead to more frequent over-wash of nesting islands by waves, and eventually to complete inundation on many islands and atolls used by breeding seabirds.

Long-term changes to sea-surface temperature and marine chemistry are projected to have severe impacts marine ecosystems (IPCC 2007). Prey species can be affected by wind and current patterns which alter their distribution and in turn can affect the behavior and movements of predators including seabirds (Behrenfeld *et al*. 2006). Foraging habitat changes may result in negative consequences on reproductive success for seabirds (Kappes *et al*. 2010). Adélie and chinstrap penguin populations have declined more than 50% during the last 30 years in the South Shetland Islands (Trivelpiece *et al.* 2011) due to loss of sea ice and resulting loss of prey availability to penguins. More energy may be expended by seabirds to find food if their foraging habitat becomes degraded or is redistributed to different areas (Suryan *et al*. 2008).

Large-scale changes in krill biomass best explain why populations of Adélie and chinstrap penguins have decreased as a result of climate change and a decrease in available prey and of increased competition for krill from recovering whale and fur seal populations (Trivelpiece *et al* 2011).

Coral bleaching and inhibited coral growth could also negatively affect marine communities that support prey species in the most convenient foraging habitats for nesting seabirds. Overall, the contribution of SWFSC research to cumulative effects on seabirds is negligible within the context of the past, present and RFFAs listed in Table 5-5.

TABLE 5-5. PAST, PRESENT AND RFFAS POTENTIALLY AFFECTING SEABIRDS

RFFA or Natural Event	Net Effect	Types of Effects
Commercial Fishing	Minor Adverse	• Potential entanglement leading to injury or mortality
Predation	Minor to Moderate Adverse	• Mortality of eggs and hatchlings due to predation of ground nesting birds from wild and feral animals • Loss of production • Decreased survivorship to adulthood
Marine Debris	Minor to Major Adverse	• Mortality and serious injury • Habitat modification
Seabird Tours	Minor Adverse	• Disturbance
Marine Protected Areas/EFH/Closed Areas	Major Beneficial	• Reduced disturbance • Habitat protection • Reduced mortality • Increased prey availability
Climate Change	Minor to Major Adverse	• Destruction of nesting habitat • Reduced egg production and survivorship • Potential loss of habitat with sea level rising • Potential re-distribution of prey • Potential loss of foraging habitat • Potential redistribution of prey • Loss of nearshore habitats
Hurricanes, Typhoons, Tsunamis	Minor to Moderate Adverse	• Potential loss of roosting and nesting habitats • Loss of nests and production • Reduced survivorship of hatchlings • Potential increased mortality of adults
Construction	Minor Adverse	• Habitat Alteration and Destruction • Disturbance • Potential exposure to contaminants and pollution • Contaminants entering food chains
Vessel Traffic	Minor to Major Adverse	• Mortality • Habitat disruption • Underwater noise • Spills of contaminants

5.2.3.4 Sea Turtles

Sea turtles are threatened by several natural and anthropogenic impacts including but not limited to those listed in Table 5-6. Overall, the contribution of SWFSC research to cumulative effects on sea turtles is negligible within the context of the past, present and RFFAs listed in Table 5-6 and described in the following subsections.

5.2.3.4.1 Marine Debris

Accumulation of marine debris offshore as well as on beaches poses a threat for entanglement, to foraging and to nesting (NOAA 2014; Duncan *et. al* 2017). The initial developmental stages of all turtle species are spent in the open sea. During this time both juvenile turtles and their buoyant food are drawn into fronts (convergences, rips, and driftlines). The same process accumulates large volumes of marine debris, such as plastics and lost fishing gear, in ocean gyres. Ingestion of plastic debris can block the digestive tract which can cause turtle mortality as well as sub-lethal effects including reduced fitness, and absorption of toxic compounds (Lutcavage *et al*. 1997). The probability of green (*Chelonia mydas*) and leatherback turtles (*Dermochelys coriacea*) ingesting debris has increased significantly in the past several decades, and hawksbill turtles (*Eretmochelys imbricata*) were overall most likely to ingest debris (~47% of individuals with plastic in the gut (Schuyler *et al.* 2014). Plastic was the most commonly ingested debris (Schuyler *et al*. 2014; Duncan *et al.* 2017).

5.2.3.4.2 Commercial Fisheries

Several species of Pacific sea turtles, including the Pacific leatherback and the loggerhead, can be affected by commercial fisheries using hook and line, pelagic longline, drift gill net and purse seines. For example, leatherback and loggerhead turtles are taken in the Hawaii shallow-set pelagic longline fishery (HI SSLL). From 2004 - 2018, the HI SSL fishery interacted with 105 adult and subadult leatherback sea turtles, leading to the deaths of 21 of these turtles (NMFS 2019b). Leatherback sea turtles captured in the HI SSL fishery are thought to be from the West Pacific population; this population may range from 68,000 to 360,000 individuals (NMFS 2019b).

Observer data from 1994-1999 has shown that about 85% of leatherback sea turtle interactions could be attributed to the shallow-set fishery. In January of 2019, NMFS and the WNPFMC proposed Amendment 10 to the Fishery Ecosystem Plan for the Pelagic Fisheries of the Western Pacific (FEP) (85 FR 3889). The amendment would manage HI SSLL fishery interactions with sea turtles by recommending a minimization measure, or a suite of minimization measures, designed to reduce the incidental capture and mortality of leatherback and loggerhead sea turtles in the HI SSLL fishery. On February 4, 2019, NMFS proposed revised measures to mitigate and reduce the number of turtles that can interact with the fishery, including individual limits of two leatherback turtles and five loggerhead turtles (85 FR 6131). Currently, the annual limits for the fishery are set at 26 interactions with leatherbacks and 17 interactions with loggerheads. As of March 18, 2020, the HI SLL fishery has interacted with two leatherbacks and 13 loggerheads[33]. If the limit is reached the fishery would be shut down.

[33] https://www.fisheries.noaa.gov/pacific-islands/bycatch/sea-turtle-interactions-hawaii-shallow-set-longline-fishery

Other fisheries such as the drift gill net fishery and purse seine fishery may also interact with sea turtles. In 2001, the drift gillnet fishery was annually prohibited between August 15th and November 15th in the area where most leatherback interactions occurred (81 FR 70660). The seasonally closed area is designated as the "Pacific Leatherback Conservation Area," and stretches diagonally from Pt. Sur to a point due west of Pt. Conception, out to 129°W and 45°N latitude (PFMC & NMFS 2006 p. 122). SWFSC CPS and CalCOFI surveys that use hook and line gear and occur potentially in September (CPS) or October (CalCOFI) may overlap slightly with this spatial and temporal restriction. The HMS survey, which employs longline techniques would not. On September 12, 2019, Plaintiffs, Center for Biological Diversity and Turtle Island Restoration Network, filed a motion for summary judgment, in which they challenged the National Marine Fisheries Service's issuance of permits to allow commercial longline fishing in federal waters off the coast of California. The court granted the Plaintiff's motion for summary judgement, and the exempted fishing permits, 2018 Biological Opinion, EA, and FONSI were vacated and set aside.

While the similarity of gear type between research sets and commercial sets may result in infrequent interactions with sea turtles, the scale of the NMFS research program using longline gear, the use of observers to look for sea turtles and mitigate capture, and implementation of the move-on rule if turtles are detected should result in no more than minor adverse interactions with Pacific sea turtles and would not be expected to add to cumulative effects on sea turtles.

5.2.3.4.3 Natural Events and Climate Change

Coastal development continues to remove habitat and increase artificial lighting along the coastline which can alter turtle behavior (NMFS and USFWS 2013). Sea turtles are also threatened by global climate change (Hawkes *et al*. 2007; Fuentes *et al*. 2011). Sea turtles with high fecundity and low juvenile survival are the most vulnerable to climate change and elevated levels of environmental variability (Cavallo *et al.* 2015). Temperature changes and sea level rise may change ocean currents and the movements of hatchlings, surface-pelagic juveniles, and adults (Hawkes *et al.*, 2009; Poloczanska *et al.* 2009; Cavallo *et al.* 2015). A rise in sea level could restrict green turtle nesting habitat in the Pacific. Climate change and sea level rise may have moderate to major impacts on sea turtles depending upon future trophic changes, including changes in the distribution, amount, and types of seagrasses and macroalgal species (Harley *et al.* 2006), thus altering green turtle foraging habitat (Hawkes *et al.* 2009). Sea level rise is likely to reduce the availability and increase the erosion rates of nesting beaches, particularly on low-lying, narrow coastal and island beaches (Fuentes *et al.* 2009; Hawkes *et al.* 2009; Anastácio *et al.* 2014; Pike *et al.* 2015).

The forage-base of green turtles and hawksbill turtles, including invertebrates, seagrasses, and algae, is likely affected by ocean acidification; however, how these changes would impact the turtles is not clear (Hamann *et al.* 2007; Poloczanska *et al.* 2009). Within the context of these global changes and stressors on sea turtles, the contribution of SWFSC research to cumulative effects on sea turtle populations and their habitat is negligible.

TABLE 5-6. PAST, PRESENT AND RFFAS POTENTIALLY AFFECTING SEA TURTLES

RFFA or Natural Event	Net Effect	Types of Effects
Commercial Fishing	Minor to Moderate Adverse	• Potential entanglement leading to injury or mortality
Predation	Minor to Moderate Adverse	• Mortality of eggs and hatchlings due to nest predation from wild and feral animals • Reduced survivorship • Increased mortality • Natural predation of hatchlings in marine environment
Tourism; Ecological Tours	Minor Adverse	• Disturbance • Risk of injury due to ship strike
Ecosystem effects - Global Warming, acidification and coral bleaching	Minor to Major Adverse	• Destruction of nesting habitat • Reduced Productivity and survivorship of all ages • Destruction and alternation of foraging habitats including seagrass beds and reefs • Loss of foraging habitat in coral reefs (hawksbill and green turtles) • Loss of nearshore habitats • Reduced productivity and survivorship
Hurricanes, Typhoons, Tsunamis	Minor to Moderate Adverse	• Disturbance • Habitat alteration or Loss • Loss of nests, production and nesting habitats • Reduced productivity • Mortality or injury
Construction	Minor to Major Adverse	• Disturbance from development • Habitat alteration • Potential exposure to contaminants and pollution • Erosion
Marine Protected Areas/EFH/Closed Areas	Minor Beneficial	• Increased prey availability • Increased survival of hatchlings and young age classes • Potential resting and safe harbor for hatchlings and young age-class turtles in open water
Vessel Traffic	Minor to Major Adverse	• Mortality • Habitat disruption • Underwater noise • Spills of contaminants

5.2.3.5 Invertebrates

Other activities in the action area that may affect benthic organisms include undersea cables (see Figure and wind farms. Benthic organisms directly under anchors, anchor chains, cables, or pipes would perish. However, these impacts would occur over a small, localized area for each occurrence, and would not cause wide-spread mortality. Cumulative impacts associated with actions and events listed in Table 5-7 on benthic organisms from research and these past, present and future actions are expected to be negligible.

Dozens of trans-Pacific undersea cables occupy the seafloor within research areas (see Figure 5-2). These cables disturb the benthic habitat and associated organisms. Impacts to benthic habitat and associated organisms are expected to be minor (Carter 2009). The cables transmitting the electricity islands could create the greatest disturbance to the benthos. These potential future actions would disturb the benthic environment and likely kill organisms during installation of cables/pipes, though the effect would be localized and the environment should recover. Overall, the contribution of SWFSC research to cumulative effects on invertebrates is negligible within the context of the past, present and RFFAs listed in Table 5-7.

TABLE 5-7. PAST, PRESENT AND RFFAS POTENTIALLY AFFECTING BENTHIC ORGANISMS

RFFA or Natural Event	Net Effect	Types of Effects
Renewable Energy	Minor Adverse	• Disturbance of habitat • Localized mortality of benthic organisms
Undersea Cables	Minor Adverse	• Disturbance of habitat • Localized mortality of benthic organisms
Military Training and Testing	Minor Adverse	• Disturbance of habitat • Potential release of contaminants • Toxicity effects from munitions and other military hardware on the seabed
Marine Protected Areas/EFH/Closed Areas	Major Beneficial	• Habitat protection
Hurricanes, Typhoons, Tsunamis	Minor to Moderate Adverse	• Habitat alteration
Climate Change	Minor Beneficial and Adverse	• Habitat alteration • Alter nutrient flow • Alter temperature regime • Introduced non-native species
Construction	Minor to Moderate Adverse	• Nearshore benthic disturbance • Nearshore habitat alteration
Scientific Research	Minor Beneficial and Adverse	• Gain knowledge of marine life • Benthic disturbance
Vessel Traffic	Minor to Major Adverse	• Mortality • Habitat disruption • Underwater noise • Spills of contaminants

5.2.3.6 Social and Economic Environment.

Activities external to SWFSC fisheries research that could potentially affect the social and economic environment in the CCRA, ETPRA, and ARA may include construction, commercial and recreational fisheries, shipping, coastal development, oil extraction, other scientific research, military operations, climate change, and ocean acidification (see Table 5-8). The potential cumulative effects described in the 2015 PEA have not changed due to new activities or events within the SWFSC research areas. The following discussions summarize the findings from the 2015 PEA for each research area.

TABLE 5-8. PAST, PRESENT AND RFFAS POTENTIALLY AFFECTING SOCIOECONOMICS

RFFA or Natural Event	Net Effect	Types of Effects
Construction	Minor to Major Beneficial or Adverse	• Job creation • Support Services • Disruption of current activity
Commercial and Recreational Fishing	Minor to Major Beneficial	• Job creation • Economic inputs • Support Services • Food security
Climate Change	Minor Beneficial and Adverse	• Increased storm events • Habitat alteration • Changes in fisheries (positive and negative) • Erosion • Introduced non-native species
Military	Minor to Moderate Beneficial or Adverse	• Job creation • Support Services • Disruption of current activity
Hurricanes, Typhoons, Tsunamis	Minor to Moderate Adverse	• Increased storm events • Natural disaster declarations • Erosion
Renewable Energy	Minor Adverse	• Disturbance of habitat • Localized mortality of benthic organisms
Oil and Gas	Minor to Major Beneficial or Adverse	• Job creation • Support Services • Disruption of current activity
Undersea Cables	Minor Adverse	• Disturbance of habitat • Localized mortality of benthic organisms
Scientific Research	Minor Beneficial and Adverse	• Gain knowledge of marine life • Benthic disturbance
Tourism/ Recreation	Minor to Major Beneficial	• Job creation • Support Services • Economic inputs

5.2.3.7 California Current Research Area

5.2.3.7.1 External factors in the CCRA

The cumulative effects of fisheries research and management associated with the CCRA are closely related to socioeconomic conditions in Washington, Oregon, and California. Potential future socioeconomic cumulative effects from developments in non-fishing industries, such as liquid natural gas terminals, oil extraction, shipping commerce, or climate change cannot be feasibly estimated with available data but would be expected to dominate the economy in the future. The cumulative effects of fishing and non-fishing industry actions may be more noticeable in coastal communities. Specific fisheries management decisions such as reductions in fish stocks as a result of ocean ecosystem changes, or overfishing, would result in noticeable changes in the socioeconomic status of communities. SWFSC research may contribute certain economic benefits to local communities through research-related expenditures however, these effects are likely minor compared to other key factors that affect communities, economics and the global economy.

5.2.3.8 Eastern Tropical Pacific Research Area and Antarctic Research Area

RFFAs associated with both fishing and non-fishing industries, and climate change, have the potential to affect international economic dynamics, in a region extending from Mexico to Peru. The SWFSC has only limited interaction with coastal communities associated with the ETPRA, and few at-sea missions there and therefore, would not likely contribute to cumulative effects on socioeconomics in these areas.

RFFAs associated with both fishing and non-fishing industries, and climate change, have the potential to affect international socioeconomic dynamics. The SWFSC has only limited interaction with coastal communities associated with Antarctica, and few at-sea missions there. The Antarctic area is distinguished by treaty agreements that establish cooperative research, although the U.S. provides the bulk of information about the Scotia Sea region of the Southern Ocean (the ARA).

SWFSC research has limited interaction with ports in South America and Antarctic field stations. SWFSC research in the Antarctic area contributes to an understanding of the Southern Ocean ecosystem, which supports many international economic ventures. International fishing and non-fishing activities and practices in the vast area of the ARA contribute to cumulative fisheries outcomes and management in many countries. The research conducted by the SWFSC is an important component of fisheries management decisions made by CCAMLR, especially with the economically important krill fisheries. When aggregated with other past, present, and reasonably foreseeable future activities, the research alternatives would add a moderate beneficial contribution to socioeconomic cumulative effects that would be dominated by international fisheries and tourist industry elements.

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APPENDIX A

SWFSC Research 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.

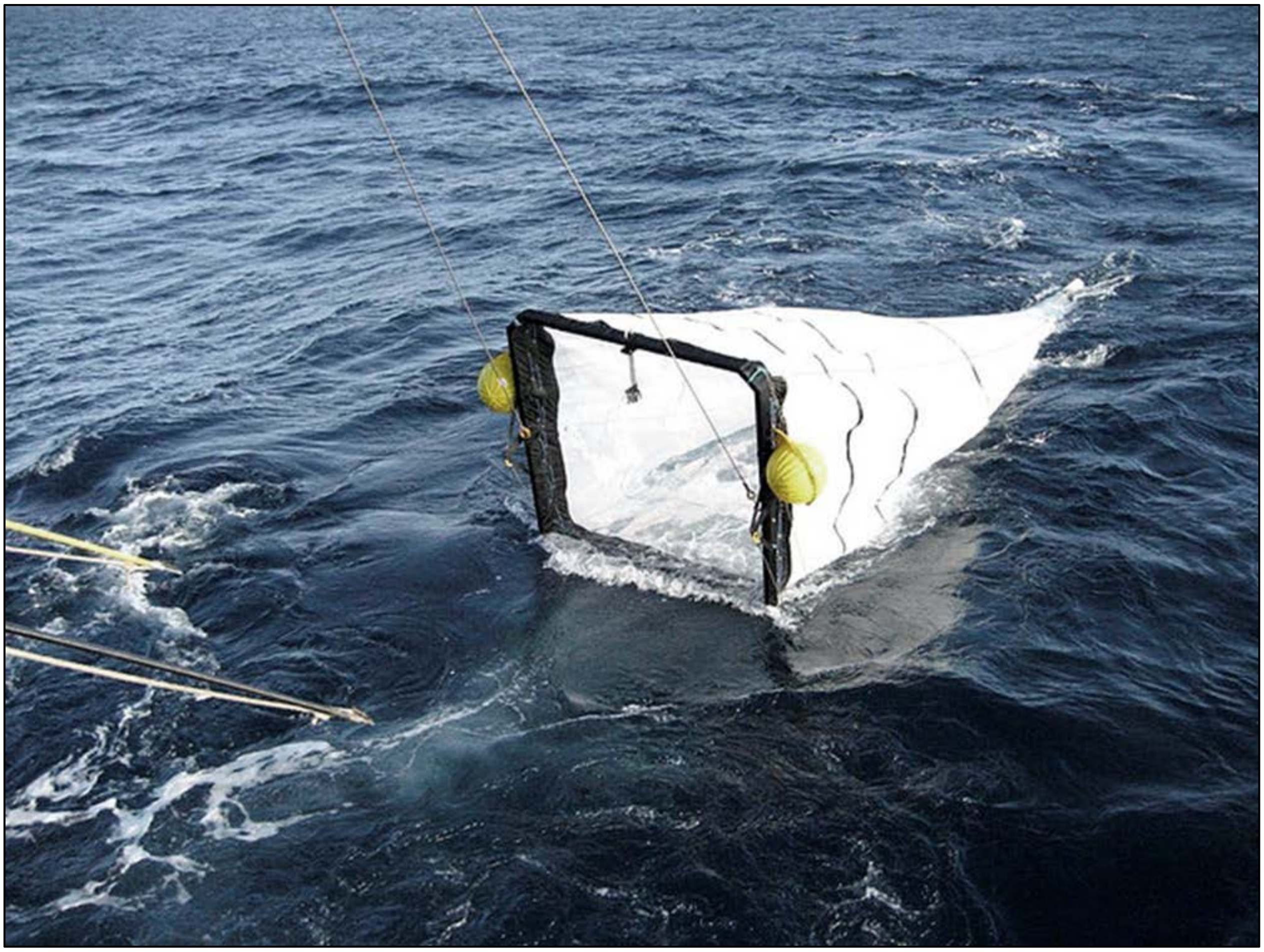


Figure B-2 Oozeki trawl at the surface as it is deployed from the vessel.

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).

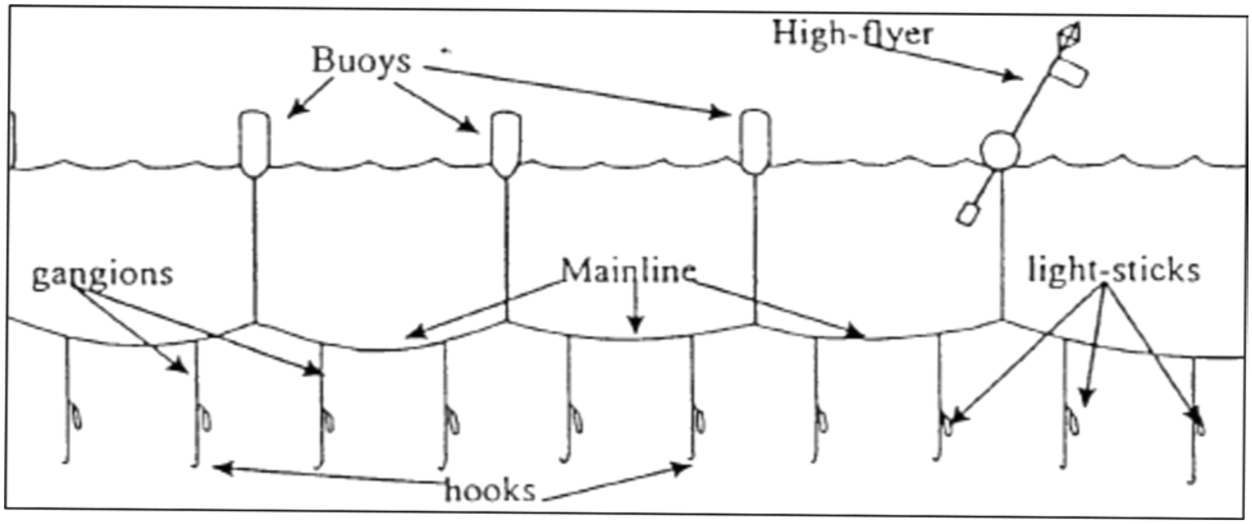


Figure B-3 Schematic example of pelagic longline gear.

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.

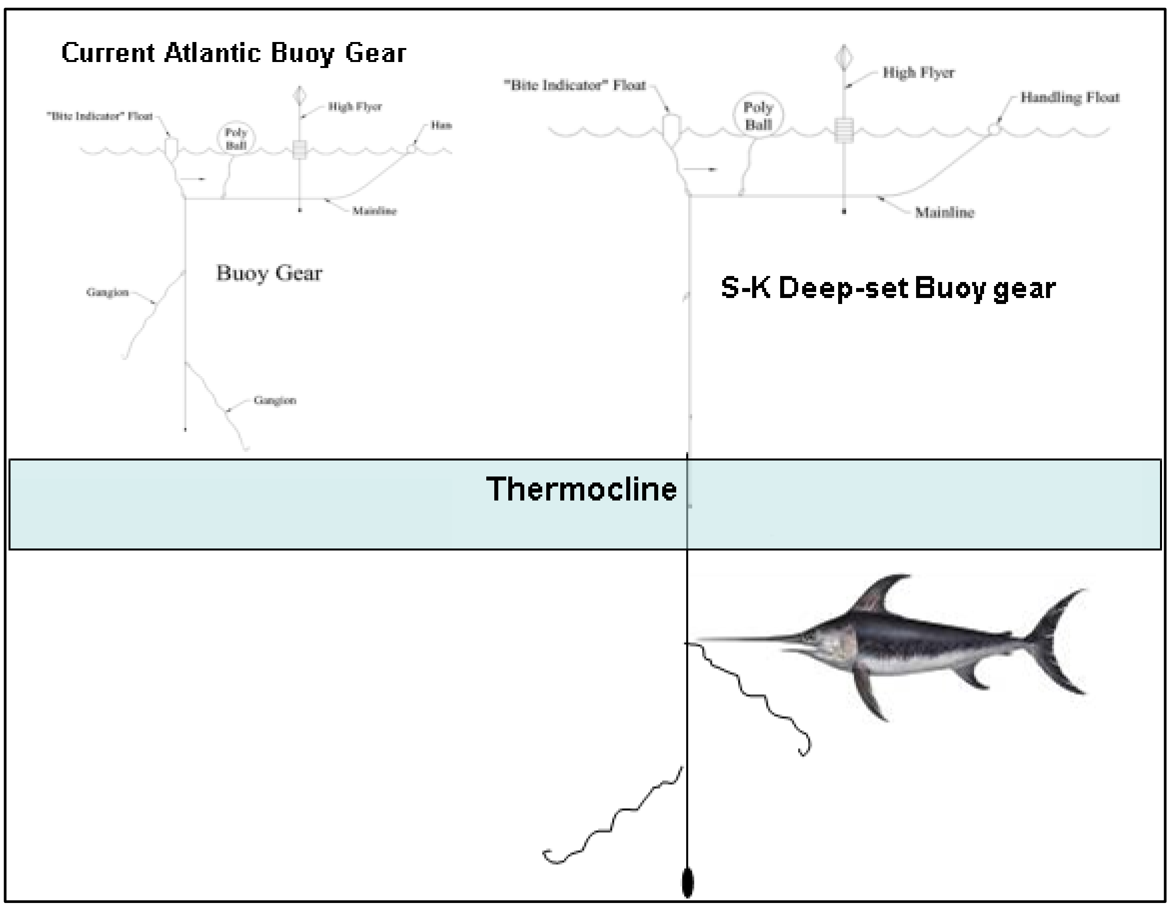


Figure B-4 Schematic of the Atlantic shallow-set buoy gear and swordfish deep-set buoy gear.

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.

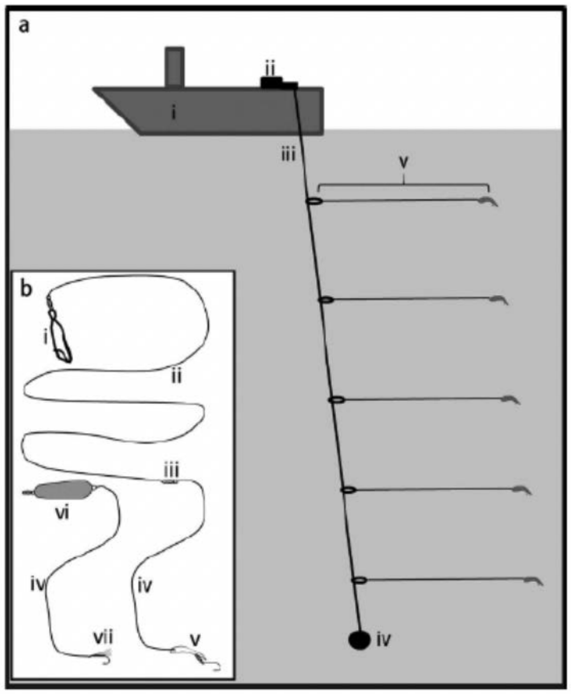


Figure B-6 Micro-trolling Schematic

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

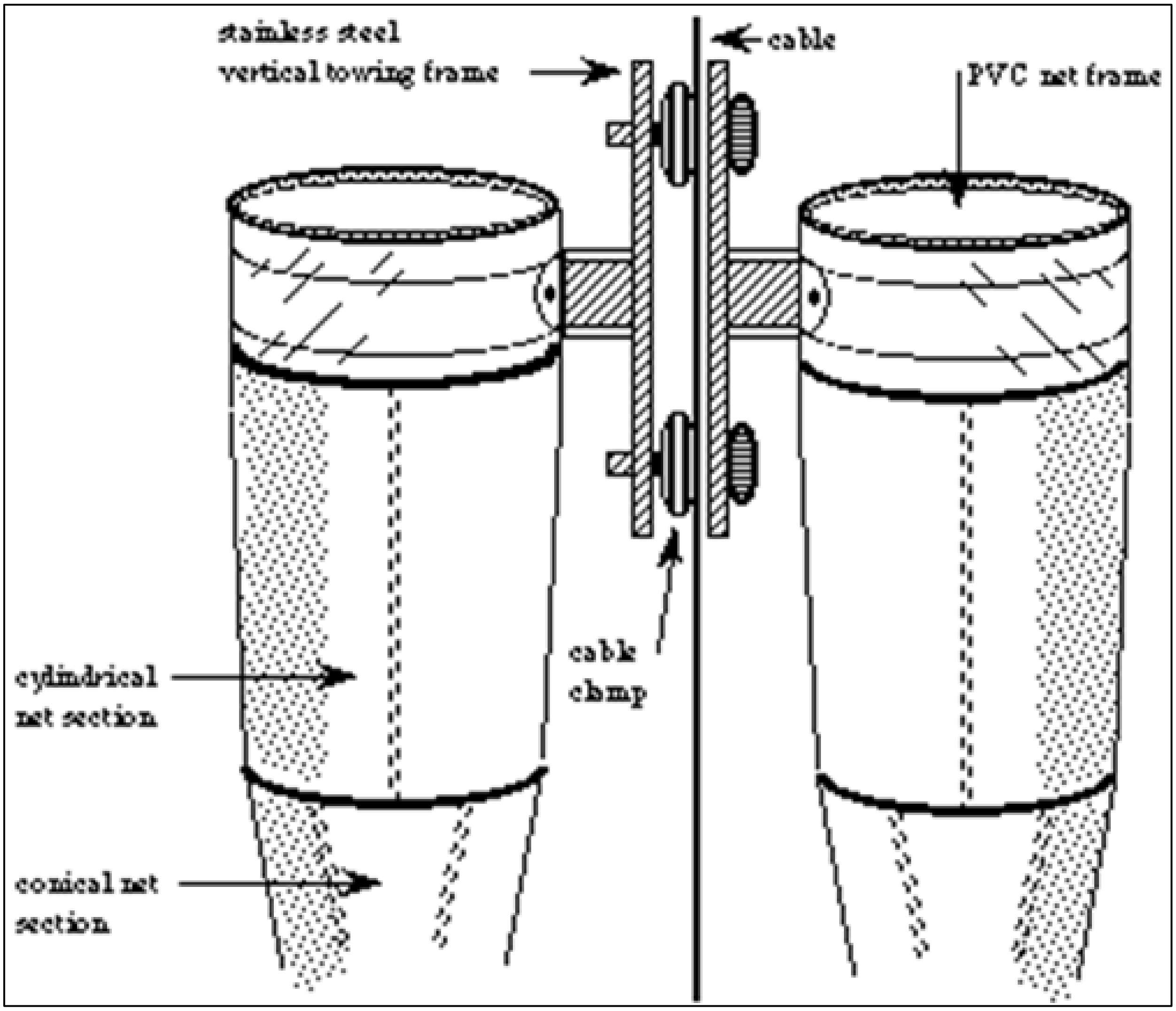
SWFSC research activities include the use of several plankton sampling nets that employ very small mesh to sample plankton and fish eggs from various parts of the water column. Plankton sampling nets usually consist of fine mesh attached to a weighted frame. The frame spreads the mouth of the net to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

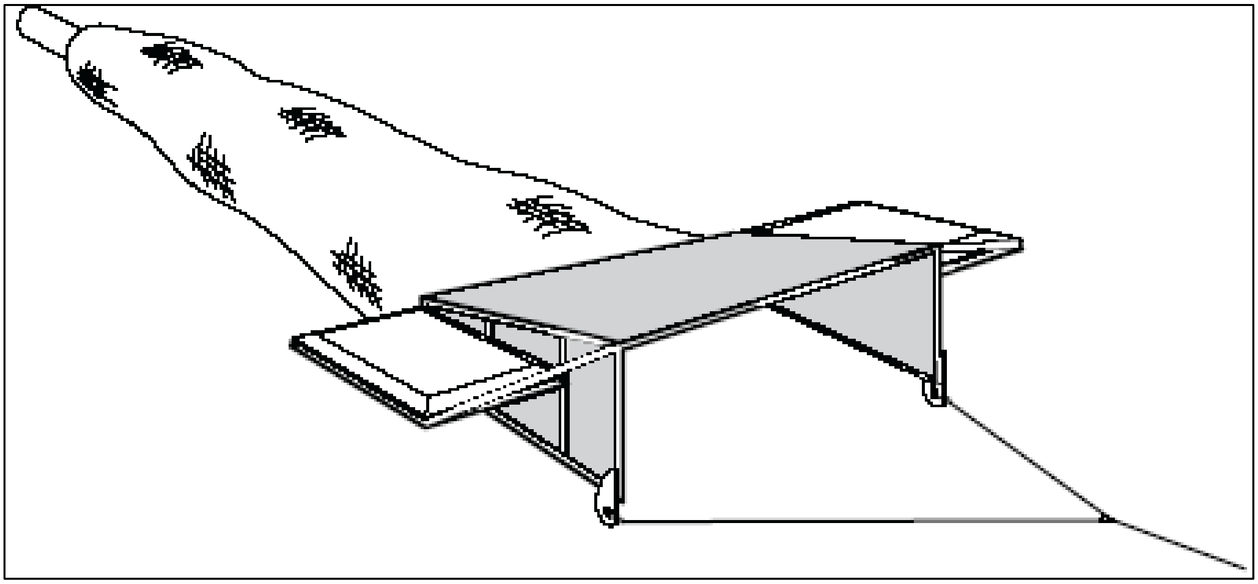
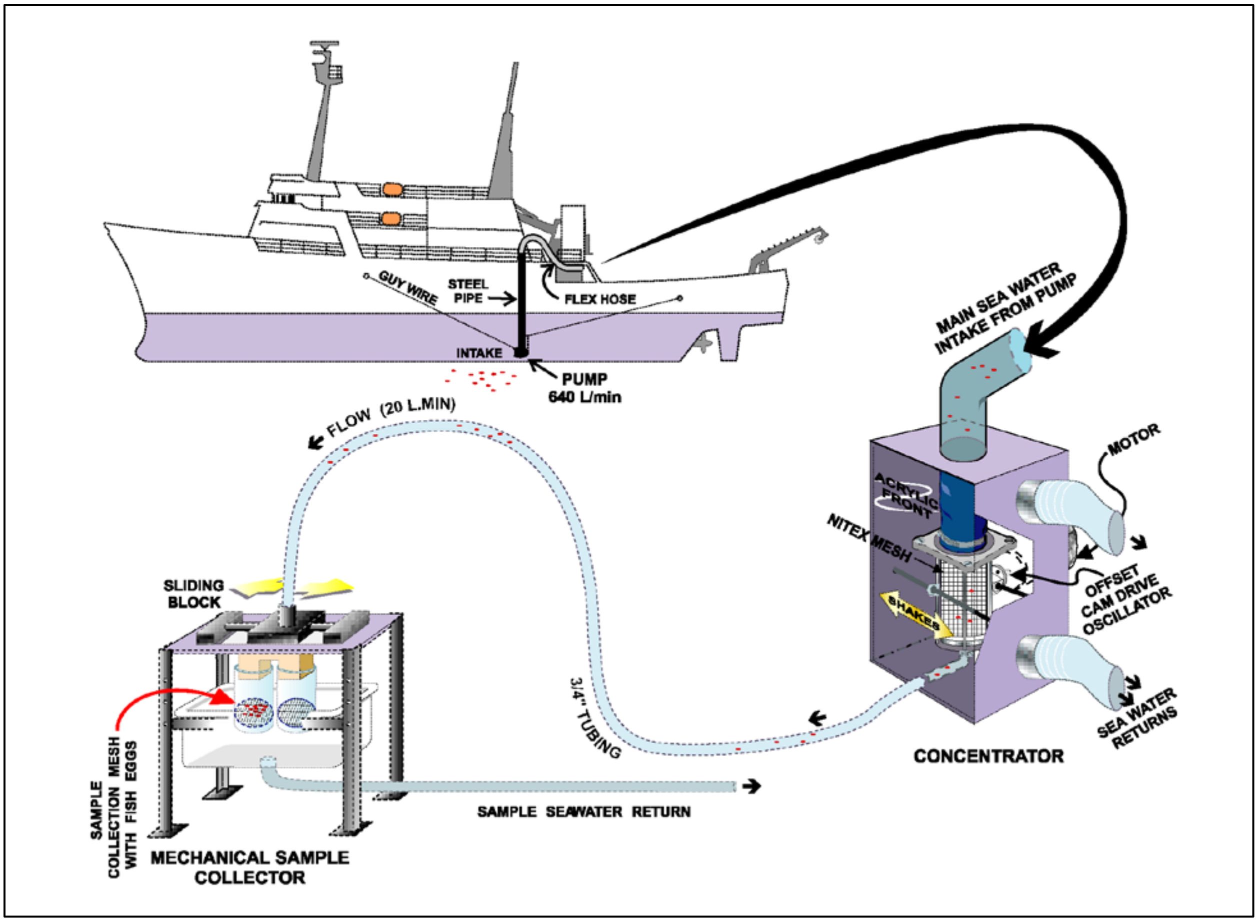


Figure B-8 Conceptual diagram of a Manta net.

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.



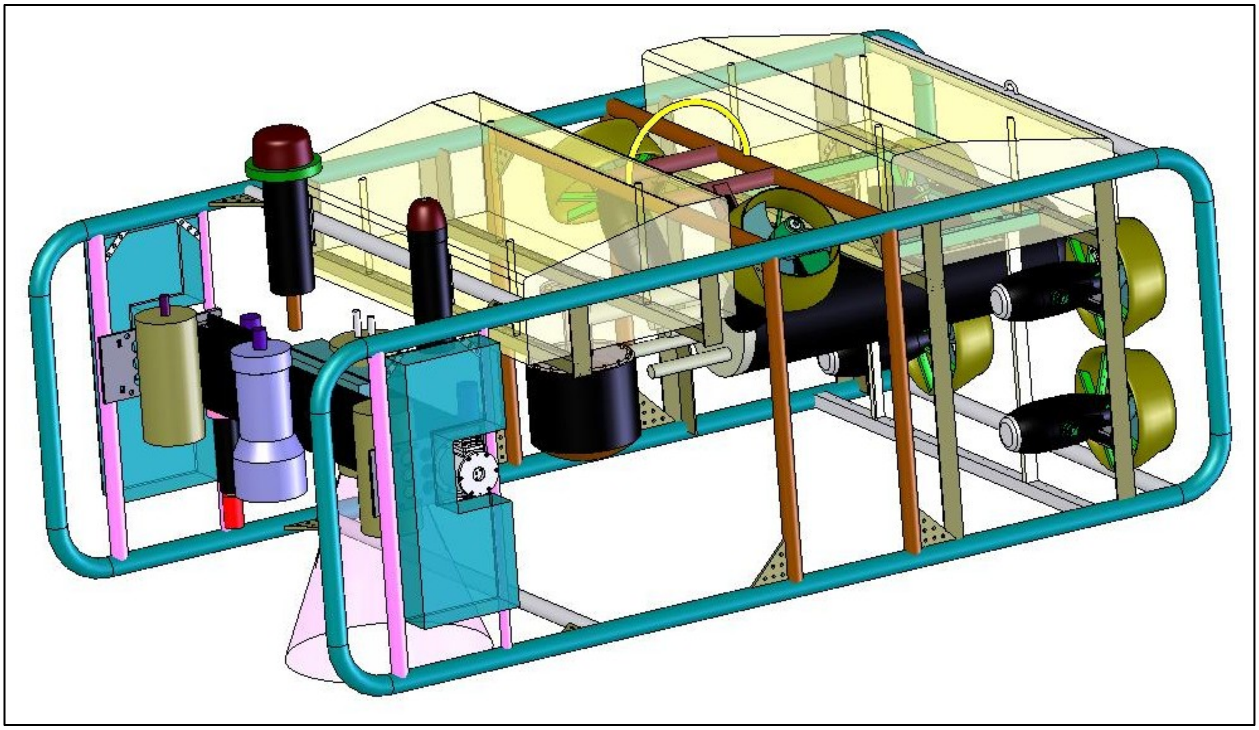
(Source: http://cufes.ucsd.edu/graf/egg-pump.pdf)

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.

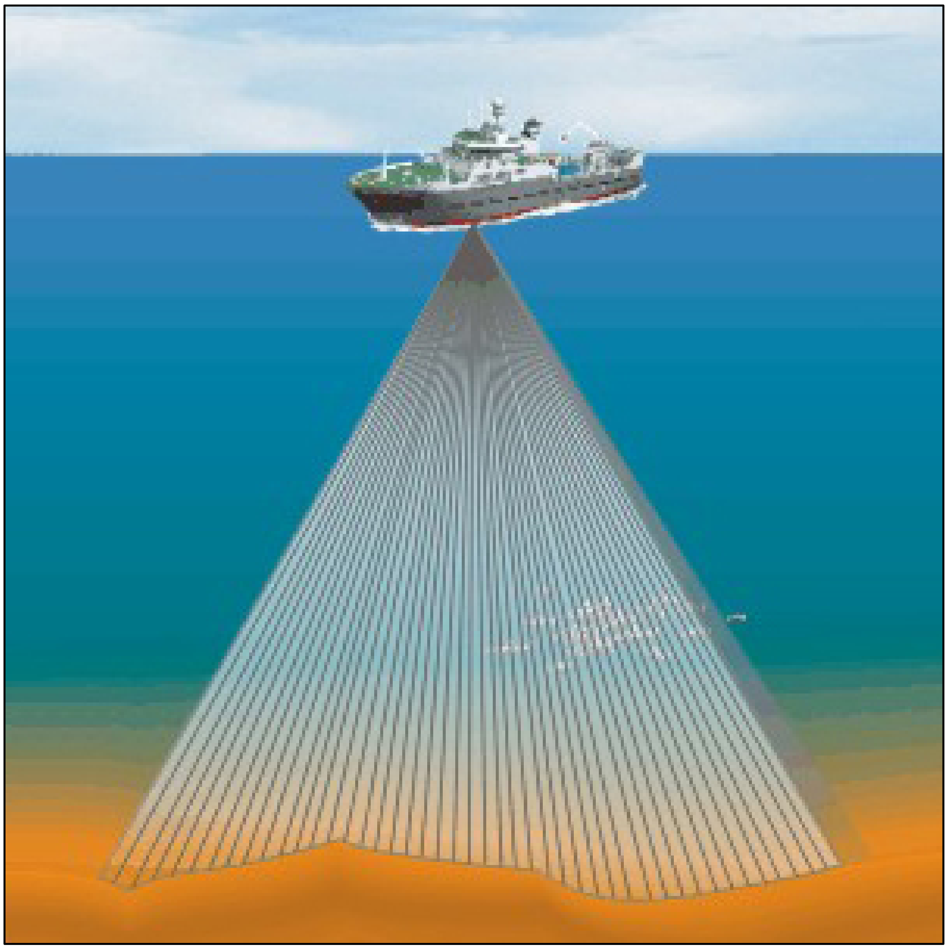
Since the 2015 LOA was issued, SWFSC plans to use an EK80 echosounder. The EK80 has a different hardware and software design to the EK60 and validation that the EK80 gives near-identical results to the EK60 is an essential prerequisite to the use of EK80s for quantitative acoustic surveys. The narrowband 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.

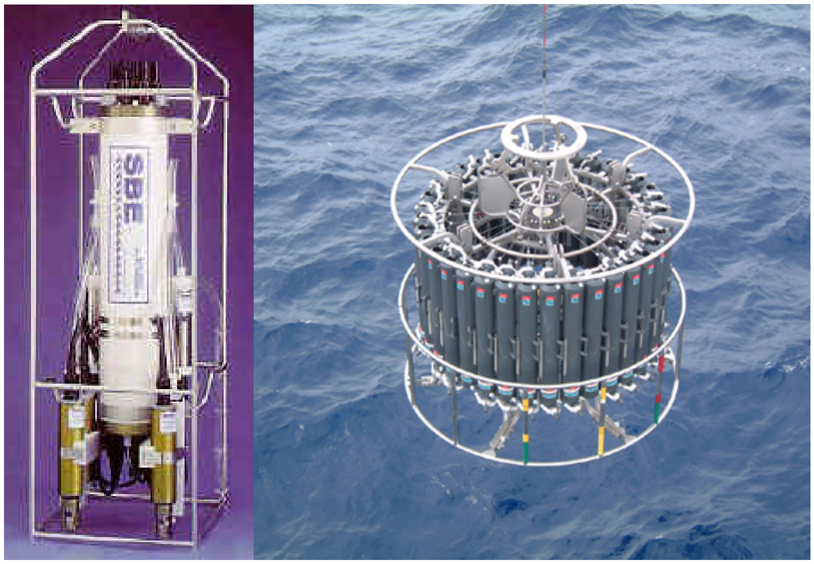
The ADCP measures water currents with sound, using the Doppler Effect. A sound wave has a higher frequency when it moves towards the sensor (blue shift) than when it moves away (red shift). The ADCP works by transmitting "pings" of sound at a constant frequency into the water. As the sound waves travel, 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:

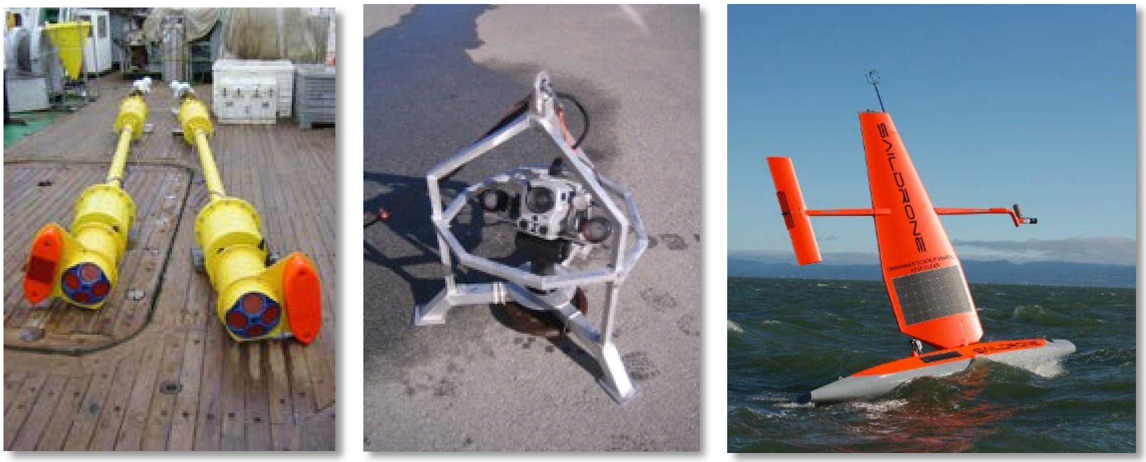
Unmanned aerial systems (UAS) can be used to conduct aerial surveys and can reduce disturbance to marine mammals due to human, vessel, or manned aircraft presence. Using UAS to conduct aerial surveys also may increase the number of aerial surveys, and could improve population assessments. The types of 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

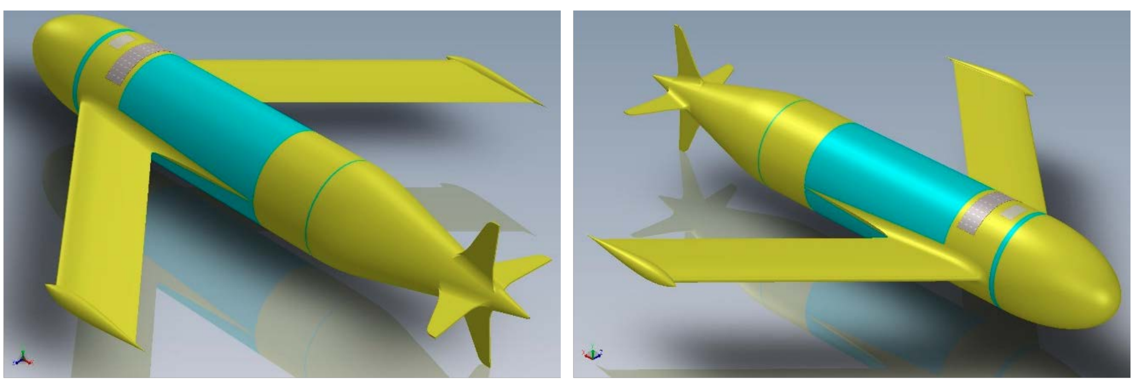
USVs such as the saildrone may be used for collecting oceanographic and other data during research cruises. As an example of such equipment, the saildrone vehicle consists of a narrow seven-meter-long hull, a five-meter-tall wing, and a keel with a 2.5-meter draft. Saildrone USVs weigh approximately 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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APPENDIX B

Marine Mammal Protection Act Letter of Authorization Application 2020

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The 2020 MMPA Incidental Take Authorization LOA application was accepted by NMFS Office of Protected Resources on April 23, 2020. NMFS published a Notice of Receipt of the application in the Federal Register on May 8, 2020 which initiated a 30-day public comment period. No formal comments were received on the Notice of Receipt of the LOA application. One comment letter was received from the Center for Biological Diversity on the Draft SPEA. Substantive comments from the Center for Biological Diversity were considered when developing the Final SPEA and the final MMPA rule. Additional information about the final MMPA rule and LOA will be available at:

https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-research-and-other-activities#authorizations-in-process

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APPENDIX C

Protected Fish Sampling Protocol: Salmon

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Protected Fish Sampling Protocol: Salmon

All incidental takes of protected species should be reported directly to PSIT within 48 hours (https://www.st.nmfs.noaa.gov/finss/psit/psitMain.jsp).

If internet is not available, report the incident to the SWFSC Environmental Compliance Hotline at (858) 334-2863 by leaving a detailed message with take information. Additional instructions for reporting are outlined below.

Salmon

Live sub-adults should be handled as priority and are expected to be quickly counted, weighed, and returned immediately to the water as soon as practicable.

For small catches <50 fish, ALL fish should be processed for length, weight, and DNA fin clip.

Large catches >50 fish may be subsampled as described below[1].

1. Subsample *at least* 50 fish
   - 1.1. Evenly separate all salmon into 3-5 containers so each container holds roughly the same weight of fish
   - 1.2 Weigh & record each container of fish
   - 1.3 Randomly pull out the same number of fish from each container (for example, if there were 5 containers of fish then pull out 10 fish from each container at random)
   - 1.4 Weigh each group of fish & record the totals from each container
2. Assign a unique identifier to each fish
3. Measure FL and/or weight
4. Check for adipose fin (record if present or absent)
5. Check for tag
6. Take caudal fin clip for all dead fish (follow drying procedures provided by genetics team)
7. Release (if alive) or Discard (if dead) fish after data collection

[1]Subsampling procedures were adapted from *FAO Manual of Fisheries Science Part 2: Methods of Resource Investigation and their Application, Section 2.6*.

Protected Fish Sampling Protocol: Salmon