Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion

Continuing Operation of the Pacific Coast Groundfish Fishery and Effects to Humpback whale (*Megaptera novaeangliae*) and Leatherback sea turtle (*Dermochelys coriacea*)

NMFS Consultation Number: WCRO-2024-00905
ARN 151422WCR2024PR00087

Action Agency: The National Marine Fisheries Service (NMFS) Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Humpback whale (*Megaptera novaeangliae*) – Central America DPS	Endangered	Yes	No	No	No
Humpback whale – Mexico DPS	Threatened	Yes	No	No	No
Leatherback Sea turtle (*Dermochelys coriacea*)	Endangered	Yes	No	No	No

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By: Chris E Yates
For Jennifer Quan
Regional Administrator

Date: November 22, 2024

LIST OF ACRONYMS

ACL – Annual Catch Limit ACT – Annual Catch Target
APPS – Authorizations and Permits for Protected Species AS – At-Sea
BOEM – Bureau of Ocean Energy Management
BRA – Bycatch Reduction Area
BSEE – Bureau of Safety and Environmental Enforcement CA – California
CBD – Center for Biological Diversity CCA – Cowcod Conservation Area
CCE – California Current Ecosystem CCL – Curved Carapace Length
CDFW – California Department of Fish and Wildlife
CHRT – Critical Habitat Review Team
CITES – Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMM – Conservation and Management Measures
CP – Catcher-Processor
CPS – Coastal Pelagic Species
CS – Catch Share
CV – Coefficient of Variation
DDT – Dichlorodiphenyltrichloroethane
DGN – Drift Gillnet
DIP – Demographically Independent Populations DPS – Distinct Population Segment
DQA – Data Quality Act
DSBG – Deep-Set Buoy Gear
DSLBG – Deep-Set Linked Buoy Gear DSLL – Deep-Set Longline
DSSL – Deep-Set Short Line
EA – Environmental Assessment
EEZ – Exclusive Economic Zone EFH – Essential Fish Habitat
EFHA – Essential Fish Habitat Assessment
EFHCA – Essential Fish Habitat Conservation Areas
EFP – Exempted Fishing Permits
EM – Electronic Monitoring
ENSO – El Niño-Southern Oscillation
EPO – Eastern Pacific Ocean
ESA – Endangered Species Act
FAO – Food and Agriculture Organization
FMP – Fishery Management Plan
GCA – Groundfish Conservation Area
GEMM – Groundfish Expanded Mortality Multi-Year
GT – Gross Ton
HAB – Harmful Algal Bloom
IAC – Inter-American Convention for the Protection and Conservation of Sea Turtles

IATTC – Inter-American Tropical Tuna Commission
IMO – International Maritime Organization IFQ – Individual Fishing Quota
IPCC – Intergovernmental Panel on Climate Change
ITS – Incidental Take Statement
IUCN – International Union for Conservation of Nature
IUU – Illegal, Unreported and Unregulated fishing IWC – International Whaling Commission
JMC – Joint Management Committee
LE – Limited Entry
LEFG – Limited Entry Fixed Gear LL – Long Line
M/SI – Mortality and/or Serious Injury MMPA – Marine Mammal Protection Act MS – Mothership
MSA – Magnuson-Stevens Fishery Conservation and Management Act
mtDNA – Mitochondrial DNA
NCS – Non-Catch Share
NLAA – Not Likely to Adversely Affect
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NSBG – Night-Set Buoy Gear
NWFSC – Northwest Fisheries Science Center
OA – Open Access
OCP – Organochlorine Pesticides
OR – Oregon
PBF – Physical or Biological Feature PBR – Potential Biological Removal
PCB – Polychlorinated Biphenyls
PCE – Primary Constituent Element
PCGF – Pacific Coast Groundfish Fishery PDO – Pacific Decadal Oscillation
PFMC – Pacific Fishery Management Council
PLCA – Pacific Leatherback Conservation Area PNW – Pacific Northwest
POP – Persistent Organic Pollutants
PSMFC – Pacific States Marine Fisheries Commission
PRD – Protected Resources Division
PVA – Population Viability Analysis
PWSA – Port and Waterways Safety Act
RAMP – Risk Assessment and Mitigation Program RCA – Rockfish Conservation Area
RecFIN – Recreational Fisheries Information Network
RPM – Reasonable and Prudent Measures
SAR – Stock Assessment Report
SBC – Southern British Columbia SFD – Sustainable Fisheries Division
SPLASH – Structure of Populations, Levels of Abundance and Status of Humpbacks
SS – Shoreside

SSLL – Shallow-Set Longline SST – Sea Surface Temperature
SWFSC – Southwest Fisheries Science Center TAC – Total Allowable Catch
TL – Trip Limit
TSS – Traffic Separations Scheme
U&A – Usual and Accustomed Fishing Areas
USCG – United States Coast Guard
USFWS – United States Fish and Wildlife Service VMS – Vessel Monitoring Systems
VSR – Vessel Speed Reduction WA – Washington
WCGOP – West Coast Groundfish Observer Program
WCPFC – Western and Central Pacific Fisheries Commission WCR – West Coast Region
WPO – Western Pacific Ocean WWF – World Wildlife Fund
YRCA – Yelloweye Rockfish Conservation Area

Table of Contents

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3, below.

1.1 Background

NOAA Fisheries (National Marine Fisheries Service, or NMFS) prepared the biological opinion (Opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402, as amended.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov]. A complete record of this consultation is on file at the West Coast Region (WCR) Long Beach Office.

1.2 Consultation History

The effects of the Pacific Coast Groundfish Fishery (PCGF) on ESA-listed species and designated critical habitats, as managed through the Pacific Coast Groundfish Fishery Management Plan (referred to herein as “FMP” or “Groundfish FMP”), are described through several different ESA consultations that address different species, habitats, and components of the PCGF, as appropriate. Unless otherwise indicated and described below, those consultations remain intact and in force.

NMFS completed a consultation in 2012 (NWR-2012-876) and determined the fishery is likely to adversely affect the following listed species and critical habitats:

- Humpback whales (*Megaptera novaeangliae*),
- Steller sea lions (*Eumetopias jubatus*),
- Eulachon (*Thaleichthys pacificus*),
- Green sturgeon (*Acipenser medirostris*) and their critical habitat, and
- Leatherback sea turtles (*Dermochelys coriacea*) and their critical habitat

In that consultation, NMFS also determined the fishery is not likely to adversely affect the following listed species and critical habitats:

- Green sea turtles (*Chelonia mydas*),
- Olive ridley sea turtles (*Lepidochelys olivacea*),
- Loggerhead sea turtles (*Caretta caretta*),
- Sei whales (*Balaenoptera borealis*),
- North Pacific right whales (*Eubalaena japonica*),
- Blue whales (*Balaenoptera musculus*),
- Fin whales (*Balaenoptera physalus*),
- Sperm whales (*Physter macrocephalus*),
- Southern Resident killer whales (*Orcinus orca*),
- Guadalupe fur seals (*Arctocephalus townsendi*), and
- Critical habitat of Steller sea lions.

In 2018, NMFS completed a reinitiated consultation on eulachon following exceedance of the incidental take statement from the 2012 Opinion (WCR-2018-8635). In 2020, NMFS completed a reinitiated consultation on humpback whales due to the revised listing of the species as 14 distinct population segments (DPS), including a conference on the proposed critical habitat designation for ESA-listed humpback DPSs that overlapped with the PCGF, which was confirmed in 2021 following final designation of the critical habitat. (WCRO-2018-01378). In 2022, NMFS completed an updated informal consultation and letter of concurrence on the effects of the continued operation of the PCGF on Southern Resident killer whales (WCRO-2022-02582). Copies of the resulting ESA documents for these consultations can be found at the NOAA Library Institutional Repository [https://repository.library.noaa.gov].

On March 20th, 2024, NMFS Sustainable Fisheries Division (SFD) requested reinitiation of ESA consultation on the ongoing operation of the fisheries managed through the PCGF Management Plan based on new information about recent interactions of humpback whales with PCGF hook-and-line and trawl gear, which are detailed in Section 2.5 *Effects of the Action* below. Additionally, SFD requested consideration of action by the Pacific Fisheries Management Council (PFMC or Council) to improve gear marking and the ability for NMFS to identify gear involved in entanglements in the PCGF fishery, and to reduce risks of entanglement for humpback whales.

On March 26th, 2024, NMFS SFD requested to voluntarily reinitiate consultation on the PCGF for leatherback sea turtles and their designated critical habitat. This request is considered voluntary because none of the regulatory triggers that would require reinitiation of the 2020 Biological Opinion under 50 CFR 402.16 have been met. That is, the action has not changed in a way that causes effects to leatherbacks or their critical habitat not considered in the 2012 Biological Opinion, new information does not reveal effects of the action that may affect leatherbacks and their critical habitat not previously considered, and the amount or extent of take specified in the ITS has not been exceeded. However, given that NMFS is already reinitiating ESA consultation with respect to humpback whale entanglements, and humpback whales and leatherback sea turtles share some similarities in terms of known vulnerability to entanglement in vertical lines associated with fixed gear, completing consultation for both species is an efficient use of NMFS's limited resources.

Following receipt of these ESA consultation requests, NMFS Protected Resources Division (PRD) reviewed the information provided, and requested additional information needed to complete one ESA consultation on both ESA-listed species and their designated critical habitats. Throughout April and May of 2024, there were numerous meetings and exchanges of information that occurred between PRD and SFD, which also included engagement with staff from NMFS Northwest and Southwest Fishery Science Centers (NWFSC and SWFSC, respectively) to gather updated information on PCGF fishing effort and ESA-listed species.

On June 12, 2024, SFD transmitted an email (Maggie Summer, NMFS WCR SFD, to Dan Lawson, NMFS WCR PRD) describing the final PFMC action on gear marking and entanglement risk reduction measures taken at a June 10, 2024 PFMC meeting. The details of the timeline on NMFS action were further clarified on July 18, 2024. Having received this information, we initiated consultation on July 18, 2024.

Throughout November 2024, NMFS WCR PRD and WCR SFD had numerous exchanges and meetings to discuss the feasibility of the Terms of Conditions, which reflect the final results of coordination in this Opinion.

Updates to the regulations governing interagency consultation (50 CFR part 402) were effective on May 6, 2024 (89 FR 24268). We are applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act. 89 Fed. Reg. at 24268; 84 Fed. Reg. at 45015. We have considered the prior rules and affirm that the substantive analysis and conclusions articulated in this biological opinion and incidental take statement would not have been any different under the 2019 regulations or pre-2019 regulations

1.3 Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). The proposed action is the continued operation of the PCGF, consistent with the Groundfish FMP, under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 U.S.C. §§ 1801 et seq. The Groundfish FMP is implemented through regulations that are generally recommended by the PFMC and adopted by NMFS. The Groundfish FMP regulates fishing in the Exclusive Economic Zone (EEZ) with respect to species listed in chapter 3 of the FMP.

1.3.1 Overview of the Components and Operation of the Pacific Coast Groundfish Fishery

The PCGF is a year-round, multi-species federally-managed fishery that occurs off the coasts of Washington, Oregon, and California within the EEZ. The PCGF includes commercial and recreational harvest of many species, including Pacific whiting (*Merluccius productus*, also known as hake), sablefish (*Anoplopoma fimbria*), lingcod (*Ophiodon elongatus*), and various species of rockfish and flatfish. For Pacific whiting, an annual international catch limit is set under the Agreement between the Government of the United States of America and the Government of Canada on Pacific Hake/Whiting ("Pacific Whiting Agreement"), done at Seattle, November 21, 2003. For other species, harvest specifications, including annual catch limits (ACLs), are set and allocated to sectors of the fishery through a biennial process that also establishes management measures for the fishery. A few target groundfish species or stocks are typically caught nearly up to their ACLs, but many species in the fishery are caught at levels significantly below their ACLs. The PCGF includes vessels that use a variety of gear types to harvest groundfish directly or to land groundfish incidentally caught while targeting non-groundfish species. Biennially, the council reviews the groundfish harvest specifications, considers new information, and then establishes specifications for the next two-year period, with harvest specifications for the current biennium outlined in Tables in 50 CFR 660, Subpart C. For a full description of the PCGF, see the Stock Assessment and Fishery Evaluation Report (PFMC, 2024)[1].

Fisheries that impact groundfish but are not directly regulated through the FMP are managed by the coastal states. These include state-managed nearshore fisheries which target some of the same species included in the FMP fisheries and those that target species not included in the FMP and that incidentally catch species in the FMP. Examples of the latter include the California halibut fishery and the pink (ocean) shrimp fishery. The FMP and its implementing regulations

[1] https://www.pcouncil.org/documents/2024/08/status-of-the-pacific-coast-groundfish-fishery-stock-assessment-and-fi shery-evaluation-august-2024.pdf/

limit the retention of groundfish in these fisheries, but they do not directly regulate the harvest of the target species. Most nearshore fixed gear fishing regulated by the states occurs between 0 and 3 miles offshore. These state-managed fisheries are not part of this proposed action, as they are not directly managed under the FMP.

There are multiple ways in which someone may participate in the PCGF based upon which type of commercial Federal permit one holds (a Federal limited entry permit (Limited Entry fishery) or a directed open access permit (Open Access fishery)), treaty rights (Tribal fishery), or fishes recreationally (Recreational fishery). Based on fishery, gear, and target strategy, the PCGF can be further broken down into the following components (Table 1).

1. The Limited Entry (LE) fishery encompasses all commercial fishermen who hold a Federal LE permit. The program was established in 1994, and the total number of LE permits available is restricted. LE permits are issued with one or more of the following gear endorsements: trawl, longline, and trap (or pot) gear. Vessels with an LE permit often have access to a larger portion of the total allowable catch for commercially desirable species than do vessels without an LE permit. The LE fleet catches the majority of commercial groundfish harvest.

2. The Open Access (OA) fishery encompasses commercial fishermen who do not hold a Federal LE permit. The OA fishery takes groundfish incidentally or in small amounts. The OA fishery participants may use, but are not limited to longline, vertical hook-and-line, and pot. The OA fishery includes both vessels targeting groundfish and vessels that target other species but incidentally catch and retain groundfish. Directed OA participants will be newly required to hold a federal, non-limited, permit.

3. The Tribal fishery includes Pacific Coast Treaty commercial fishermen in Washington State that have treaty rights to fish groundfish. Participants in the tribal fishery use gear similar to that used in the non-tribal fisheries.

4. The Recreational fishery includes recreational anglers who target or incidentally catch groundfish species. However, only recreational groundfish fishing that occurs in the EEZ is included in this proposed action. Recreational groundfish fishing that occurs in state waters is not included.

Table 1. Summary of gear and components by fishery managed through the Groundfish FMP.

Fishery	Gear	Components
Limited Entry (LE) vessels	**Trawl—At-sea Pacific whiting cooperatives**	**Catcher-processor cooperative Mothership sector cooperative**

registered to Federal LE groundfish permits (non-tribal)	**Trawl—Shorebased Individual Fishing Quota (IFQ) program - Catch Shares**	**Pacific whiting midwater trawl** **Non-Pacific whiting midwater trawl Bottom trawl Fixed gear (gear switching)**
	Fixed gear (longline & pots/traps) - Non-Catch Shares	**Sablefish tier limit fishery** **LE fixed gear (LEFG) trip limit fishery (a.k.a. zero tier or non-sablefish endorsed)**
Open Access (OA)	**See text for description - Non-Catch Shares**	**Directed OA Incidental OA**
Tribal	**Gear similar to LE fishery**	**Pacific whiting midwater trawl** **Non-Pacific whiting midwater trawl Bottom trawl Fixed gear**
Recreational	**Hook-and-line Spear**	**Commercial passenger vessels and private party vessels operating in the EEZ**

Groundfish Conservation Areas (GCAs) are depth-based management tools used to close certain areas to commercial, and in some cases recreational, fishing. GCAs apply to all groundfish fisheries and are further described in Section 1.3.9.1 *Groundfish Conservation Areas* as they relate to the PCGF. Specific GCAs include Rockfish Conservation Areas (RCAs) (Section 1.3.9.2, and 1.3.10.1), Cowcod Conservation Areas (CCAs) (Section 1.3.9.3), Yelloweye Rockfish Conservation Areas (YRCAs), and Bycatch Reduction Areas (BRAs) (Section 1.3.10.2). Commercial RCAs are specified for a particular gear group and can differ north and south of 40°10' N. In December 2023, NMFS approved Amendment 32 to the Groundfish FMP which reduced RCA closures off of Oregon and California for non-trawl commercial PCGF sectors, including the sablefish pot fishery, opening ~2,411 square miles of fishing grounds to non-trawl commercial fisheries (PFMC, 2023). Amendment 32 also established new Essential Fish Habitat Conservation Areas (EFHCAs) off of Oregon which are further described within their relationship to the PCGF in Section 1.3.9.4. Amendment 32 also removed the CCA closures off of California for several sectors.

Amendment 28 to the Groundfish FMP, effective January 1, 2020, also added new habitat protections by closing the portion of the EEZ deeper than 3,500 m to all bottom contact gear, including bottom trawl, bottom longline, and pot/trap gear. Amendment 28 also made revisions to EFHCAs, including closure of most of the Southern California Bight to bottom trawl gear and reopening the trawl RCA off of Oregon and California.

1.3.2 Overview of Trawl Fisheries

In 2011, NMFS implemented a catch share program, also referred to as the trawl rationalization program, for PCGF trawl fisheries. This program constrains both the number of vessels participating in the fishery and the amount of fish they may catch. Catch shares (CSs) are used for the shorebased trawl fleet and harvester cooperatives for the at-sea mothership (MS) and catcher-processor (CP) fleets. The CS system divides the portion of the ACL allocated to the trawl fishery into shares controlled by individual fishermen or groups of fishermen (cooperatives). The shares can be harvested largely at the fishermen's discretion. Catch of IFQ species (e.g. Pacific whiting, sablefish) is deducted from the fisherman's individual quota or the cooperative pooled quota. Under the catch share program, some management measures from the previous management structure remain in place; these measures include trip limits for non-IFQ species, size limits, and area restrictions.

The trawl fishery is divided into a number of sectors for management purposes. A portion of the fishery targets Pacific whiting, a midwater species, which will synonymously be referred to as hake throughout this opinion. This portion of the fishery is further divided into vessels that catch whiting and deliver to onshore processors (shoreside, or SS), vessels that catch whiting and process at sea on the same vessel (catcher-processor or CP), or vessels that catch whiting and deliver to separate vessels that process at sea (mothership sector, or MS). Another portion of the fishery targets bottom-dwelling groundfish species (bottom trawl). Finally, there is a growing fishery for non-Pacific whiting midwater groundfish species, typically referred to as midwater rockfish trawl effort. This latter fishery is expected to expand in the future to a year-round fishery as restrictions put in place to allow testing under exempted fishing permits are moved into regulation.

Rockfish Trawling

The rockfish midwater trawl fishery has expanded effort recently as former restrictions to protect overfished species have been lifted. The rockfish midwater trawl fishery currently has the same regulatory season start date as the hake shorebased IFQ fishery (May 1). However, since 2017, midwater rockfish trawling has been allowed from January 1 until the hake season start date under an exempted fishing permit, creating a year-round fishing opportunity. To date, the rockfish midwater trawl fishery has not yet established a clear seasonality. Groundfish landings in this sector generally increased from 2011-2018 as the fishery has evolved over this time, although groundfish retention decreased slightly in 2019 and 2020, before returning to 2018 levels in 2021-2023 (Somers et al., 2023; Figure 3). Approximately ⅔-¾ of landings in each time period occurred along the Oregon and Washington borders, with effort concentrating off Astoria and Newport, Oregon. From 2011-2018, landings of midwater non-whiting occurred from central Washington to central Oregon, and expanded in 2019-2021 to southern Oregon and northern California as a part of an Exempted Fishing Permit (EFP). Based on the fact that rockfish trawling effort distribution and magnitude has not changed drastically over the most recent decade (Figure A-9, Table A-5), it is assumed the geographic distribution of the fleet and harvest levels will be similar to patterns seen in recent years. The rockfish midwater trawl sector has fairly low landings in comparison to the hake midwater trawl fishery, and has stayed relatively consistent through time (Figure 3).

Hake Trawling

Pacific hake or whiting is managed under the Pacific Whiting Agreement, which allows the Joint Management Committee (JMC) to recommend annual catch levels for the stock found in both U.S. and Canadian EEZs. The U.S. portion of the annual Pacific whiting total allowable catch (TAC) is variable, but the TAC has been trending higher in recent years. Each year, the TAC may be fully harvested, and it is assumed the Pacific whiting fishery will operate in the same geographical footprint as it has in recent years, as the distribution of fishing effort has not changed substantially over the most recent decade (Figure A-9 and A-10). However, there is evidence to suggest that hake trawl hours are increasing over time (Table A-5 and A-6). Trawling effort only occurs north of 40°N latitude, and has operated over relatively the same amount of space in the most recent decade (Figures A-9 and A-10). Landings of hake made by PCGF midwater trawl gear include catch from SS, MS, and CP sectors (Figure 3). Although trawl hours have increased over the most recent decade (Figure 1), landings have remained relatively stable (Figure 3). Overall, the trends in landings are captured in Figure 3 and match the findings of Somers et al. 2023.

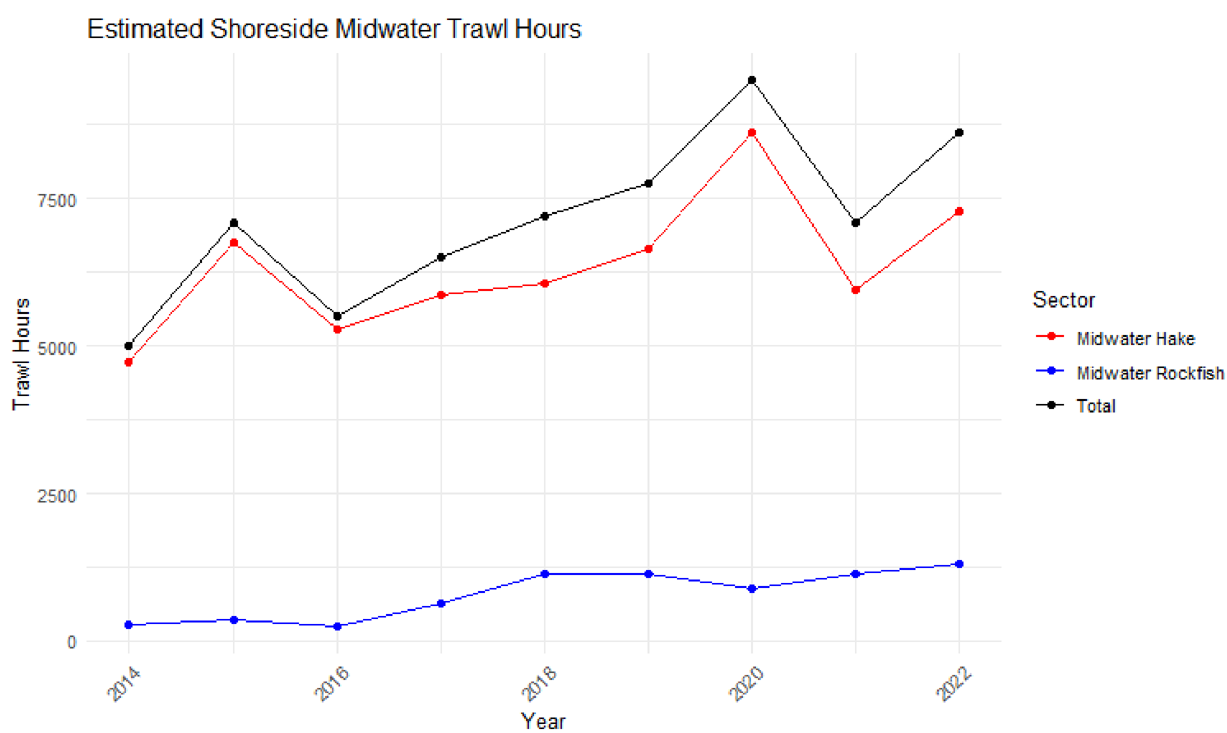

Figure 1: Line plot representing shoreside (SS) trawl hours by sector, which includes the estimated midwater trawl hours for the years 2014-2023. Lines are colored by sector and the

black line represents the total sets summed for all sectors.

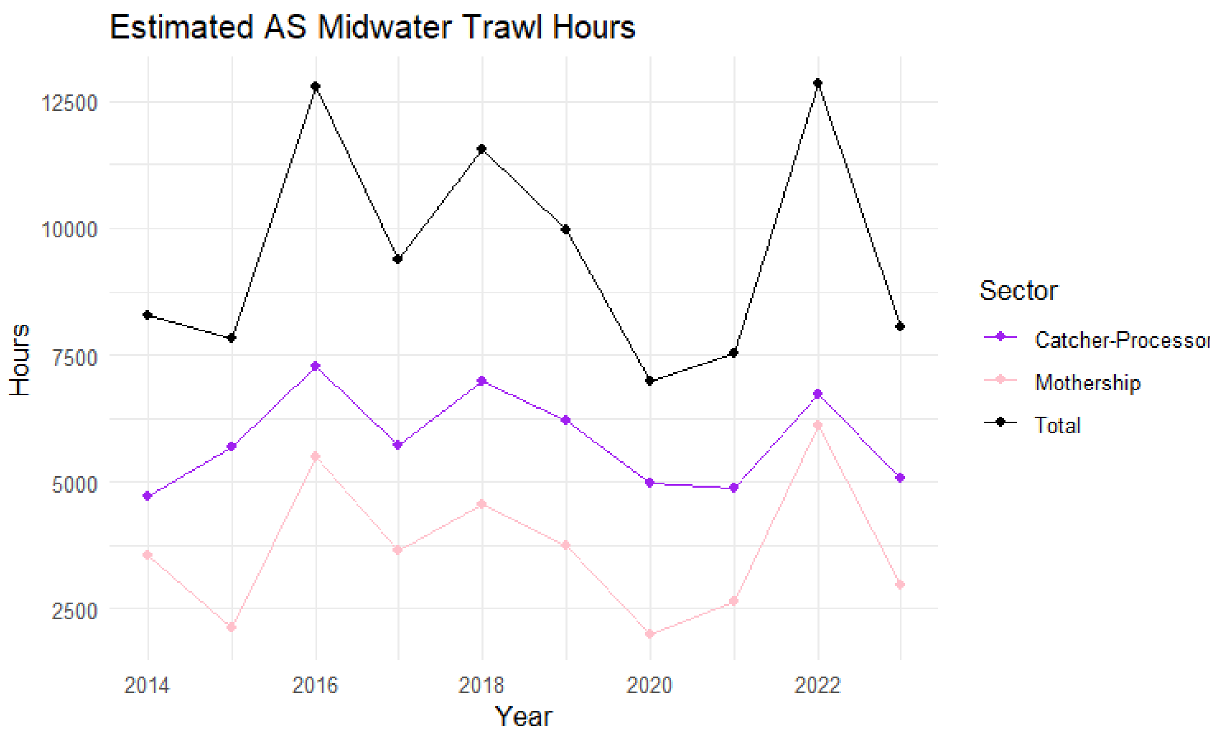

Figure 2: Line plot representing at-sea (AS) trawl hours by sector, which includes the estimated midwater trawl hours for the years 2014-2023. Lines are colored by sector and the black line represents the total sets summed for all sectors.

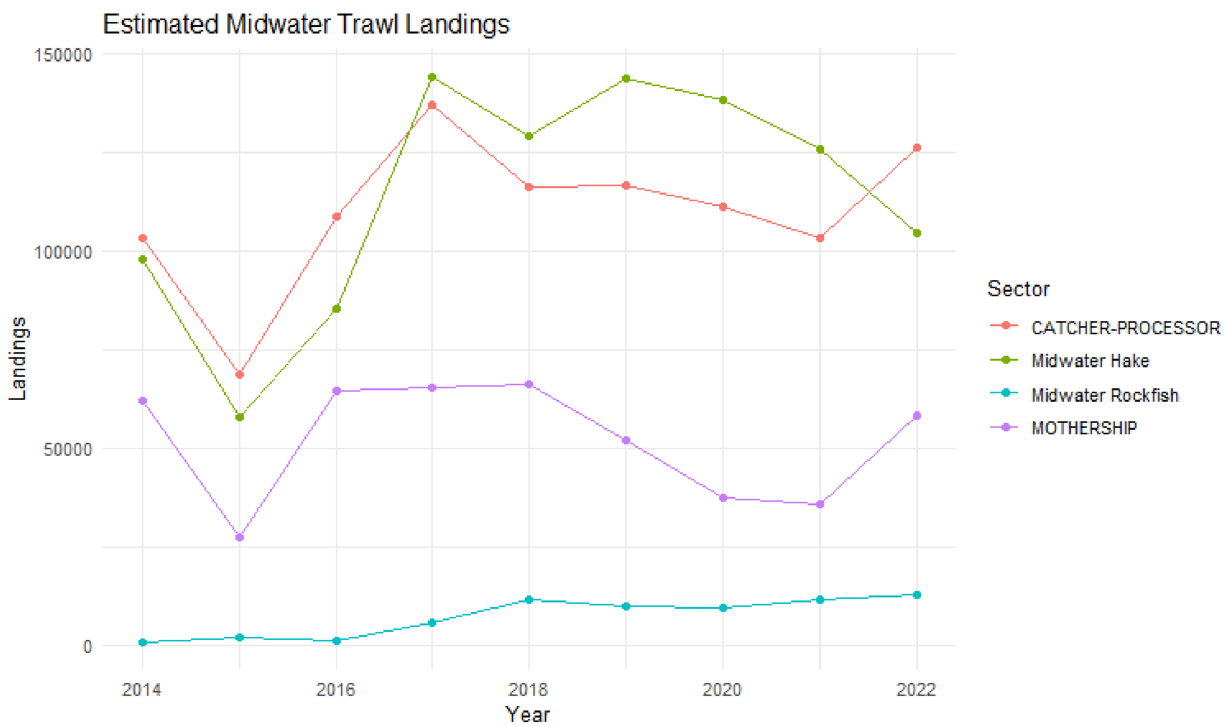

Figure 3: Observed PCGF midwater trawl landings from 2014-2023. Lines and points are colored by the sector in which fishing occurs and landings are represented in metric tons.

1.3.2.1 Limited Entry - At-Sea Pacific Whiting Cooperatives

The Pacific whiting trawl fishery is divided into a number of sectors for management purposes. Harvesting vessels include vessels that both harvest and process catch (CPs), and those that catch and deliver to at-sea processors (MS). For the at-sea trawl fishery, the Pacific whiting primary season runs from May 1 to December 31, or until the sector allocations are taken. Much of the participation in the Pacific whiting fishery occurs in two separate timeframes: a spring season before vessels move into fisheries in other regions, and a fall season. Most of the CP activity occurs from May to early June, and late September to late November. Most of the MS activity occurs from May to early June and mid-September to mid-November. Generally, there is little or no fishing activity in the Pacific whiting at-sea fishery during July and August. Since 1992, CP and MS processing vessels have been prohibited from processing south of 42° N, therefore no at-sea sector catch has occurred south of 40°19’ N. in recent years.

Landings in the CP trawl fleet increased from 2015 through 2017, but saw an overall decrease in landings until 2021. The MS fleet had constant landings from 2016 through 2018 then decreased from 2018 to 2021. The 2021 effort of the MS fleet was concentrated between 47°N, 42°N, and 41°N latitudinal bins (Somers et al., 2023). Fishing effort in both at-sea fleets have varied since 2014 but reached historic highs in 2022 (Table A-6).

1.3.2.2 Limited Entry - Shorebased IFQ Program

The Shorebased IFQ fishery season for Pacific whiting is set using a framework for the area north of 40°30’ N lat. Under the framework, the fishery opens on May 1 north of 42°30’ N lat. and on April 15 south of 40°30' N lat. The fishery harvests most of its Pacific whiting from mid-June through September, with smaller amounts being taken after September. The Pacific whiting shorebased IFQ fishery start date is aligned with the at-sea sector start date. Vessels in the shorebased IFQ fishery can fish whiting as well as other groundfish species they have IFQ for, or for non-IFQ species under trip limits (see Table 1, North and South, to 50 CFR Part 660, Subpart D).

The bottom trawl fishery, a component of the shorebased IFQ program, operates year-round and targets non-whiting species in a wide range of depths which are then delivered to shoreside processors. Catch for this fishery, peaks in the spring, in either March or April; with a secondary, lower peak happening in October. Two important and valuable species in this fishery are sablefish and petrale sole. Sablefish catch peaks in September and October, and petrale sole catch peaks in December and January. Amendment 28 eliminated the trawl RCA off Oregon and California, and established block area closures, a series of areas that span the West Coast seaward of the state territorial seas out to 200 nm that can be closed as needed by NMFS.

The Shorebased IFQ program allows LE trawl permit holders to switch from trawl to fixed gears (hook and line or pot gear) to fish their individual quota. From 2011-2018, 39 different LE trawl vessels landed sablefish north of 36° N. latitude with fixed gear. From 2016 to 2018, 16 vessels landed sablefish north of 36° N. latitude with fixed gear. The greatest amount of gear switching participation (referred to as the CS fixed gear sector throughout the rest of this biological opinion) was seen in 2012 and the least in 2013 (PFMC 2019). Fixed gears targeting sablefish are more selective than trawl gear and have less potential impact to benthic habitat. In recent years, gear switchers have exclusively used pot gear. The CS pot fleet showed a slight but generally increasing trend in total effort (in metric tons (mt) of landings) from 2013-2019, but has since decreased in 2021. The number of pots per set in the non-catch share (NCS) fleet in 2020 and 2021 reached an all-time high of approximately 50 pots in 2020 and 2021, two of the only years in which pots per set was greater in CS than in non-catch share (Somers et al., 2023). CS pot effort was greatest and increasingly concentrated off of WA and OR although there were some concentrated effort areas off of Morro Bay, San Francisco, and Fort Bragg, CA (Somers et al., 2023). The CS hook-and-line fleet has generally decreased from 2011-2021, and occurs between 48°N and 32°N with fairly even distribution (Somers et al., 2023).

1.3.3 Overview of Limited Entry Fixed Gear Fisheries (Non-Catch Shares)

LEFG vessels fishing in the primary, OA, and TL sectors make up part of the NCS fishery; they primarily target high-value sablefish with most landings historically occurring in Oregon and Washington. However, landings of sablefish vary depending on environmental conditions, and they have recently shown a southerly trend.

The LEFG fishery consists of vessels fishing in the primary fishery –also referred to as the sablefish-endorsed tier fishery– and the trip limit (TL) fishery. The TL fishery targets nearshore and non-nearshore species, and also includes the TL fishery for sablefish. In the primary fishery, which is a limited access privilege program, the permit holder of a sablefish-endorsed permit receives an annual share of the sablefish catch or "tier limits." Regulations allow for up to three sablefish-endorsed permits to be stacked[2] on a single vessel. The number of vessels in the LE fisheries varies between years based on permits being transferred to multiple vessels, vessels in the sablefish tier fishery stacking or unstacking permits, and permit owners removing their permits from vessels so that the permits are unused for some period (i.e., unidentified status). Vessels that are sablefish-endorsed generally fish deeper than 80 fathoms, and they land catch composed mostly of sablefish, with groundfish bycatch or incidental catch consisting primarily of spiny dogfish shark, Pacific halibut, rockfish species, and skates.

Like the LE trawl fleet, LEFG vessels deliver their catch to ports along the Washington, Oregon, and California coasts. The primary season takes place from April 1 to December 31. Permit holders land their tier limits at any time during the nine-month season. Once the primary season opens, all sablefish landed by a sablefish-endorsed permit is counted toward attainment of its tier limit. Approximately 29% of the sablefish annual catch limit is allocated to the tier fishery (for both longline and pot gear permits). California ports have had the greatest amount of LE trip-limit landings of sablefish in recent years, while Oregon had the most LE primary fishery landings. Pot gear is used for targeting sablefish, and the majority of the pot gear used in the PCGF is traditional pot gear. This gear may be conical, trapezoidal, or rectangular. Pot gear for sablefish is typically long-lined so that between 15 and 50 pots are connected together on a single groundline. The average soak time for traditional pots is 36-48 hours.

In 2024, there were 227 fixed gear permits, including 164 sablefish-endorsed and 59 non-sablefish endorsed permits. All LE fixed gear permits have gear endorsements (longline, pot/trap, or both), and those endorsements cannot currently be changed. Of the sablefish-endorsed permits, 132 were associated with longline gear only, 28 were associated with pot/trap gear only, and four were associated with both longline and pot/trap gear. The remaining 59 non-sablefish-endorsed permits were all associated with longline gear[3].

Recent changes to this sector include a new allowance for vessels assigned to a LE permit to use non-bottom contact gear (stationary vertical hook-and-line, troll gear) inside the non-trawl RCA (87 FR 77007, December 16, 2022). Additionally, some vessels are now using slinky pots

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[2] Stacking is the practice of registering more than one LE permit for use with a single vessel.

[3] NMFS West Coast Region Pacific Coast Fisheries Permit System, queried January 1st, 2024

(collapsible pots) which are a newer type of pot gear originally developed in Alaska as an alternative for bottom longline boats dealing with significant depredation issues from toothed whales. The pots are much lighter and can be fished using a lighter groundline. Multiple slinky pots are typically attached to a groundline, so that there is a vertical line to surface gear on the end of a string of slinky pots, rather than a vertical line for each slinky pot. Slinky pots are left to soak, but cannot be left on the grounds as long as traditional pots due to their being more lightweight. Slinky pots would be more likely to be used by boats that would otherwise use bottom longline gear because they don't require heavy machinery onboard the boat to haul pots up. Currently, only some vessels can use slinky pots but the PFMC is currently evaluating a change to the gear endorsements to allow longline-endorsed permits to use pots. This change is being evaluated because some longline gear users are experiencing depredation of longlines by toothed whales, primarily killer whales. Currently, there is not explicit tracking of slinky pot gear use on landings. The recent non-trawl logbook will provide information on slinky pot gear use in the future.

Vessels in the LEFG TL fishery fish under trip limits generally targeting sablefish, thornyheads, and other groundfish species. A total of 60-80 vessels annually participated in this sector over the past five years, predominantly using longlines (70-80% of effort) and pots/traps (20-30% of effort). These vessels fish primarily out of California ports. Fixed gear vessels are more prone to catching yelloweye rockfish than trawl vessels, and therefore have greater fishing restrictions on the continental shelf. The LE TL fishery operates year-round (January to December) with most fishing activity occurring in the summer months. Landings have been highest from August through October, followed by the April to July period. The lowest number of landings occurs between December and March. Approximately 5% of the sablefish annual catch limit is allocated to the TL fishery (for both longline and pot gear permits).

In 2005, LEFG fishing opportunity was constrained by measures needed to reduce the catch of overfished species, including canary rockfish, yelloweye rockfish, bocaccio, and cowcod. Landing limits for the LEFG fleet north of 40°10' N. latitude provided vessels with access to continental slope and nearshore species, but less access to continental shelf species. For waters south of 40°10′ N. latitude, landing limits were intended to draw vessels away from continental shelf species. The CCAs off the Southern California Bight were closed to the PCGF to prevent vessels from fishing in areas of higher cowcod abundance. As all of those rockfish species have been rebuilt, with the exception of yelloweye rockfish (which is projected to rebuild by 2028), areas of the non-trawl RCA and the CCA have been reopened to fixed gear fishing. Starting in 2024, the non-trawl RCA was reduced in size by moving the seaward boundary shoreward to 75 fathoms from 100 or 125 fathoms, depending on the area along the coast (88 FR 83830). Additionally, the CCA was opened to non-trawl commercial fishing and recreational fishing in 2024.

Estimated total annual landings by the various sectors of PCGF pot fishing and hook-and-line fishing over time are shown in Figures 4 and 5, respectively. Pot landings have decreased for the CS sector from 2014-2021, but in 2022 and 2023 began to increase in total landings again. LE has steadily increased in landings since 2014, and OA has remained relatively consistent (Figure 4). For the hook-and-line sector of the PCGF, LE TL and OA have remained consistent from 2014-2023. The CS sector has ceased landings using hook-and-line gear since 2019, leaving LE the dominant sector for hook-and-line PCGF landings. The estimated landings shown in Figure 4 are less than the pot landings presented in Somers et al. 2023 due to the different datasets utilized; Figure 4 solely relies on the West Coast Groundfish Observer Program (WCGOP) data that are scaled up based on observer coverage rates, whereas Somers et al. 2023 presents higher landings numbers due to the incorporation of fish ticket data. Somers et al. 2023 is likely a more exact estimate of landings, but both datasets show the same overall linear trends.

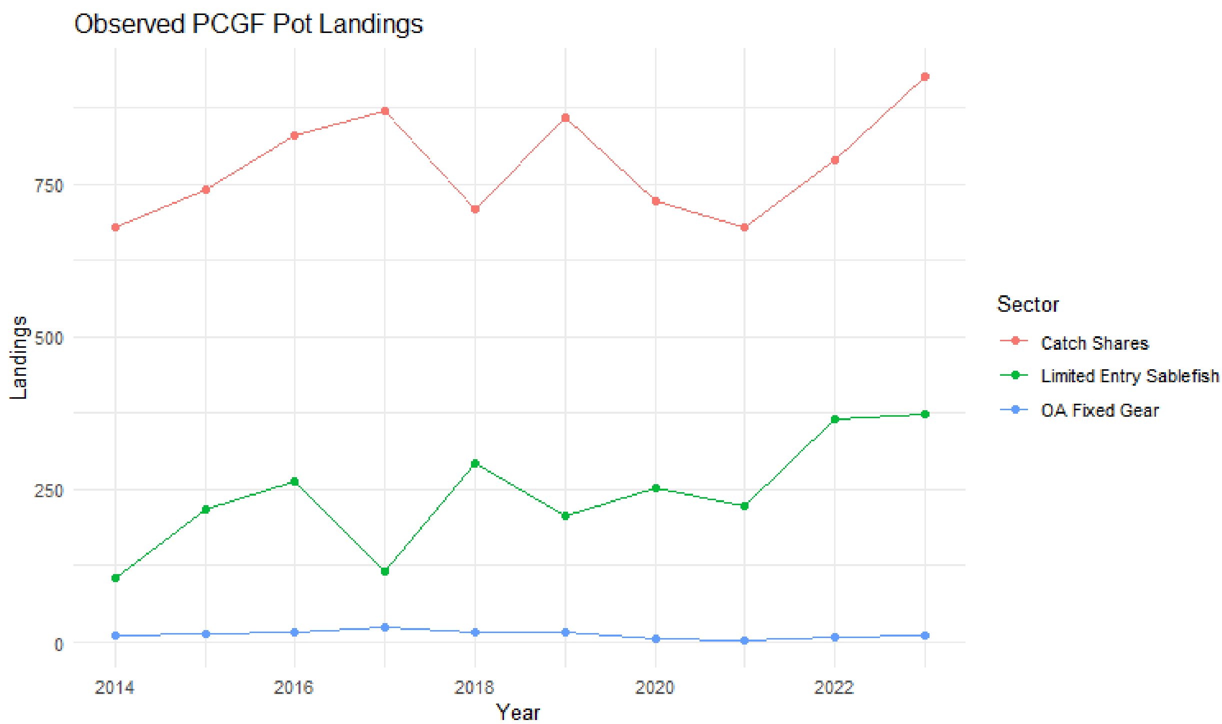

Figure 4: Observed PCGF pot landings in metric tons from 2014-2023. Each line is colored by the sector within the pot fishery. Landings were estimated by dividing the observed landings by the observation coverage rate provided for the unique year, sector, and gear type (WCGOP).

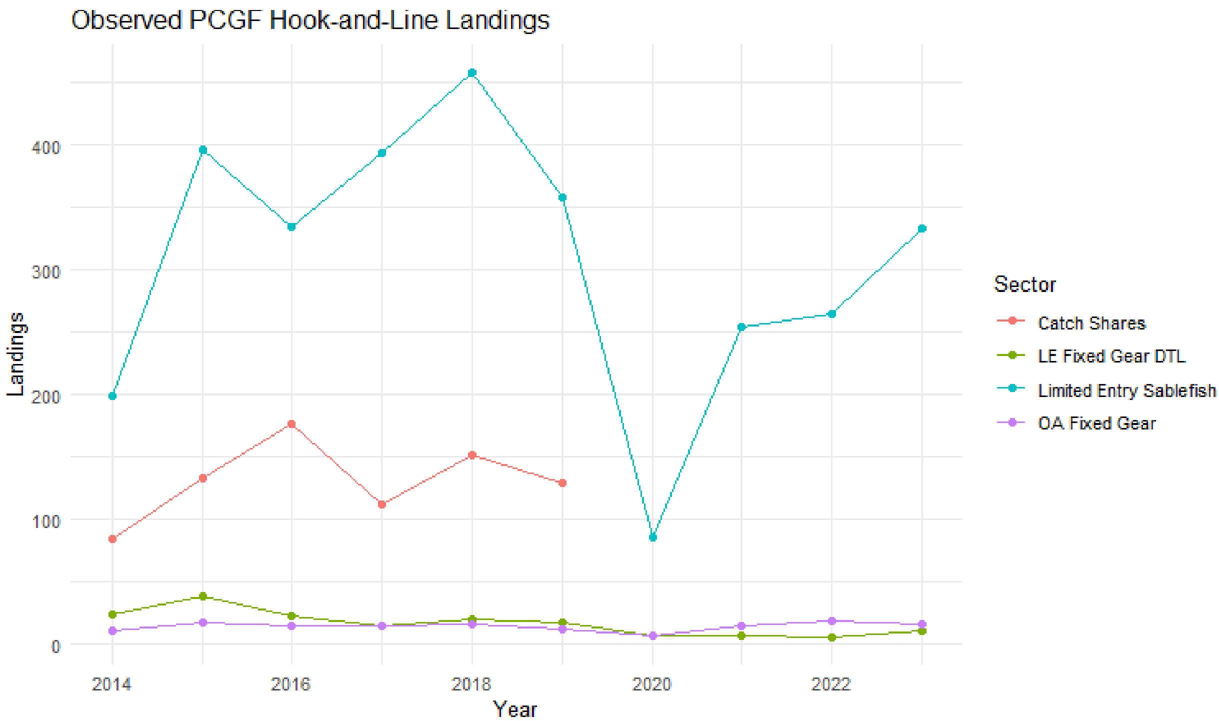

Figure 5: Observed PCGF hook-and-line landings in metric tons from 2014-2023. Each line is colored by the sector within the hook-and-line fishery. Landings were estimated by dividing the observed landings by the observation coverage rate provided for the unique year, sector, and gear type (WCGOP).

1.3.4 Open Access Fixed Gear Fishery (Non-Catch Shares)

The OA sector consists of vessels that do not hold a Federal groundfish LE permit. They target groundfish (OA directed fisheries) or catch them incidentally (OA incidental fisheries) using a variety of gears. OA vessels must comply with cumulative trip limits established for the OA sector, and are subject to the other operational restrictions imposed in the regulations, including general compliance with RCA restrictions.

OA fishermen use various non-trawl gears (including longline, trap or pot, stationary hook-and-line, vertical hook-and-line, jig, and troll) to target particular groundfish species or species groups. Longline and other hook-and-line gear are the most common OA gear types used by vessels directly targeting groundfish, and they are generally used to target sablefish, rockfish, and lingcod. The majority of hook-and-line catch in the PCGF is with bottom longline gear. In recent years, though, there is a growing component of the commercial hook-and-line sector that utilizes variations on vertical line gear, rod and reel gear, and stick gear. In 2023, NMFS began to allow non-trawl vessels to use select non-bottom contact hook-and-line gear configurations within the non-trawl RCA. This provided opportunities for commercial non-trawl fisheries to target healthy stocks, relieve pressure on overfished or constrained nearshore stocks, and to limit impacts to sensitive habitats. Vessels targeting groundfish may operate inside the non-trawl RCA from the Washington/Oregon border to the U.S./Mexico border with non-bottom contact hook-and-line gear only, and while vessels can fish both inside and outside the non-trawl RCA on the same trip, they may only carry one type of legal non-bottom contact hook-and-line gear (vertical jig and troll) on board when fishing occurs within the non-trawl RCA. The directed OA fishery is further grouped into “dead” or “live” fish fisheries. In the live-fish fishery, groundfish are primarily caught with hook-and-line gear (rod-and reel, stationary vertical hook-and-line), LE longline gear, and a variety of other hook gears (e.g. stick gear). The fish are kept alive in a seawater tank onboard the vessel which are primarily composed of nearshore rockfish species.

For vessels targeting non-groundfish species, the groundfish catch is incidental to the target species. Only the groundfish catch is regulated under the Groundfish FMP and federal groundfish regulations. The fixed gear fisheries that take incidental amounts of groundfish include the following fisheries managed by the states or under other Federal FMPs: California halibut, coastal pelagic species, crab pot, fish pot, highly migratory species, Pacific halibut, salmon, sea urchin, and setnet fisheries. In summary, the incidental retention of groundfish in the EEZ is part of the OA fishery and is therefore included in the proposed action. The target fisheries listed above are not themselves part of the proposed action.

The OA sector is made up of many different gear types involved in directed and incidental catch, which makes it difficult to discern the location of effort. However, based on the diversity of this sector, we assume that effort is widespread across the West Coast. OA groundfish landings vary according to which non-groundfish fisheries are landing groundfish as bycatch. The number of OA vessels that land groundfish also varies with the changes in the non-groundfish fisheries, and participation varies between years. There is limited historical information on the distribution of effort by OA vessels beyond state-level data.

The OA fishery operates year-round (January to December). Assuming that landed catch represents directed OA fisheries, and that landed catch is a function of effort, more OA-related fishing activity occurs in the spring, summer, and fall months than during winter months, although seasonal patterns have varied considerably among years, especially since 2011. Incidental fisheries vary with fishing seasons for intended target species. Approximately 8% of the sablefish annual catch limit is allocated to the OA fishery (all gear types).

1.3.5 Tribal Groundfish Fisheries

Washington coastal tribes (Makah, Quileute, Hoh, and Quinault) possess treaty rights to harvest Federally managed groundfish in their usual and accustomed fishing areas (U&As) within the EEZ, as described in decisions in *United States v. Washington* and associated cases. The U&As for Pacific Coast treaty Indian tribes are defined at 50 CFR 660.4. Under treaty arrangements, each tribe manages the fisheries carried out by its members. The Groundfish FMP and its implementing regulations provide for allocations or set-asides of specific amounts of some species for the tribal fisheries to ensure implementation of treaty fishing rights. Those allocations and set-asides are developed annually or biennially (depending on the species) in consultation with the tribes.

The individual tribes manage their fisheries, coordinating with NMFS and the Council. Treaty tribes participating in the groundfish fishery off Washington have formal allocations for a number of species, including sablefish, and Pacific whiting, established through the Council. For other groundfish species without formal allocations, the tribes propose set-aside tribal limits to the Council. The Council tries to accommodate the requested limits by setting aside a portion of the catch limit for specific species, while ensuring that catch limits for all groundfish species are not exceeded.

All four coastal treaty tribes have longline vessels in their fleets; only the Makah Tribe has trawl vessels. The Makah trawl vessels use both midwater and bottom trawl gear to target groundfish. Since 1996, a portion of the U.S. Pacific whiting TAC has been allocated to the West Coast treaty tribes fishing in the groundfish fishery. Tribal allocations have been based on discussions with the tribes regarding their intent for a specific fishing year. For 2024, the interim tribal whiting allocation was 17.5% of the U.S. Pacific whiting TAC.

The tribal Pacific whiting annual allocation percentage is not intended to set precedent for future allocations. Although the Quinault, Quileute, and Makah Tribes have expressed interest in the Pacific whiting fishery, to date, only the Makah Tribe has participated in the Pacific whiting fishery. Since 2012, whiting migration patterns have resulted in minimal tribal fisheries, in part because whiting distribution has been south of tribal U&A areas.

In addition to its participation in the Pacific whiting fishery, the Makah Tribe has a midwater trawl fishery that primarily targets yellowtail rockfish and a bottom trawl fishery that targets petrale sole. In developing its trawl fisheries, the Makah Tribe has implemented management practices that include test fishing to show tribal managers that the fishery can be conducted with gear and in areas without harming tribal fisheries. In the Makah bottom trawl fishery, the Tribe adopted small footrope gear restrictions to reduce rockfish bycatch and avoid areas where higher numbers of rockfish occur. In addition, the bottom trawl fishery is limited by overall footrope length to conduct a more controlled fishery. Harvest is restricted by time and area to focus on harvestable species while avoiding bycatch of other species. If bycatch of rockfish is above a set amount, the fishery is modified to stay within the bycatch limit. The midwater trawl fishery has similar control measures. A trawl area must first be tested to determine the incidence of overfished rockfish species before opening the area to harvest. Vessels receive guidelines for fishing techniques and operation of their net.

The tribal non-whiting groundfish fishery typically takes on a dome-shaped seasonal pattern, generally peaking between May and September. Historically the Pacific whiting tribal fishery tended to occur between June and September. However, there has been little activity in the tribal

Pacific whiting fishery since 2011, so the pattern in recent years may not reflect what would occur under broader tribal participation.

Tribes are allocated 10% of the annual catch limit of sablefish north of 36°N. Approximately one-third of the tribal sablefish allocation is taken during an open competition fishery, where vessels from all four tribes have access to the overall tribal sablefish allocation. The open competition portion of the fishery tends to be taken in March and April. The remaining two-thirds of the tribal sablefish allocation is split between the tribes according to a mutually agreed-upon allocation scheme. The individual tribes manage specific sablefish allocations. Participants in the halibut and sablefish fisheries tend to use hook-and-line gear, as required by the International Pacific Halibut Commission. In recent years, some small amount of pot gear has been in use for sablefish fishing due to killer whale depredation of longlines.

1.3.6 Recreational Fisheries

Recreational fisheries include charter vessels (commercial passenger fishing vessels) and private party recreational vessels (individuals fishing from their own or rented boats). Federal and state management measures have been designed to limit catch of overfished species and provide fishing opportunities for anglers targeting nearshore groundfish species. The primary management tools have been seasons, bag limits, and closed areas. The most common gear used in recreational groundfish fisheries are hook-and-line variations. In Oregon, starting in 2018, a longleader gear opportunity became available in waters seaward of 40 fathoms (fm) during months in which fishing deeper than 40 fm is prohibited. Longleader gear has a minimum of 30 feet between the weight and the lowest hook. The gear is designed to target midwater rockfish species such as yellowtail and widow rockfish to move fishing pressure off nearshore rockfish species and to provide increased recreational fishing opportunities.

Recreational fisheries in Washington and California have shifted from year-round fisheries to seasonal fisheries with different open periods, depending on the target species. Recreational fishing in Oregon is open year-round, except when in-season closures are needed. Coastwide, the number of marine angler trips peak in the July-to-August period, but seasonal concentrations are more pronounced in Oregon and Washington where weather is more variable. However, only recreational groundfish fishing that occurs in the EEZ is included in this proposed action. Recreational groundfish fishing that occurs in state waters is not included.

1.3.7 Catch Monitoring

Vessel monitoring systems (VMS) that automatically transmit position reports to NMFS are the primary management tool used to monitor commercial vessel compliance with time and area restrictions. All non-tribal commercial vessels are required to have an operational VMS to fish in the PCGF. In addition, each vessel operator is required to submit declaration reports to NOAA's

Office of Law Enforcement that allows the vessel's position data to be linked to the type(s) of fishing gear, and in some cases a target strategy. The CS and at-sea Pacific whiting fisheries are subject to full observer coverage, although the SS and MS participants can elect to use Electronic Monitoring (EM) in lieu of human observers. The EM program has 100% coverage (i.e., cameras are required to be operational throughout fishing activity), and a target of 25% human observation for scientific data collection. EM video review rates vary by sector. All other observed fisheries have less than 100% observer coverage. Total catch data for groundfish species are available approximately 11-12 months following the end of the fishing year.

The monitoring of fishing mortality varies between sectors based on effort and prevalence of bycatch. The greatest amount of monitoring occurs in the trawl fisheries, and the least in the OA and recreational fisheries.

1.3.7.1 At-Sea Pacific Whiting Sector

In the at-sea Pacific whiting sectors, catch composition is closely monitored through the WCGOP's on-board observer program on processing vessels and EM (video) on MS sector catcher vessels. Each processing vessel 125 feet and longer must carry two observers that subsample close to 100% of all hauls in order to estimate catch composition. Processing vessels under 125 feet must carry one observer. Currently, there are no processing vessels under 125 feet. Each MS vessel has one observer to account for discards or uses electronic video monitoring to verify full retention of catch. In addition, the observers collect biological data from groundfish, protected species, and prohibited species. Catch data by species are generally available within 24 hours during the season and will continue to be available into the future for use in management decisions.

1.3.7.2 Shorebased IFQ Sector

The Shorebased IFQ Sector is subject to 100% observer coverage or electronic monitoring. Nearly 100% of the hauls are sampled, with discards being accounted for at the haul level. The exception is the Pacific whiting Shorebased IFQ fishery, where most vessels retain nearly all their catch and do not sort and discard at sea. In the Pacific whiting shorebased IFQ fishery, observers primarily monitor the retention of catch. Catch composition data are gathered on shore by catch monitors. Pacific whiting vessels may voluntarily use electronic monitoring to monitor catch retention. Observers collect valuable fisheries data, including fishing effort and location, estimates of retained and discarded catch, species composition, biological data, and protected species interactions. Stock-specific information on Chinook salmon bycatch is not available until the following year. The data informs fisheries managers and stock assessment scientists, as well as other fisheries researchers. WCGOP catch data informs the vessel accounting system used for quota management.

Shorebased IFQ vessels are required to land catch at IFQ first receivers where the landed catch is sorted and weighed. Catch monitors are individuals who collect data to verify that the catch is correctly sorted, weighed, and reported. Landings data and at-sea discards are later combined for total catch estimation. Prohibited species catch data for the IFQ fishery is available in season to fishery participants. However, the full dataset at the haul level for all species is not available until the summer of the following year.

1.3.7.3 Fixed Gear Sector

The WCGOP provides observer coverage for the NCS and CS fisheries. Observers collect discard data at sea as well as biological data from groundfish, protected, and prohibited species. Groundfish total catch data are available approximately nine months following the end of the fishing year after sample data are extrapolated and combined with landings data. Table 2 provides observer coverage rates by sector and gear (Somers et al., 2024).

Table 2. Median observer coverage rates, defined as the percentage of total groundfish landings monitored by human observers in the sector of the fishery 2015-2023. Sector name abbreviations: CS EM = catch shares electronic monitoring, LE = limited entry, TWL = trawl, TL = trip limit, HKL = hook-and-line, OA = open access. (WCGOP - FOS)

Year	CS EM – Pot	EM - CS	LE TL HKL	OA-HKL	OA - Pot	LE - HKL	LE - Pot
2015	30	33	7	5	7	41	61
2016	34	28	4	5	7	33	72
2017	37	16	3	4	12	37	32
2018	40	30	4	5	10	43	72
2019	26	25	4	4	11	38	47
2020	14	8	2	3	6	13	47
2021	35	11	2	5	5	30	39
2022	39	18	2	4	4	28	62
2023	27	33	4	3	5	30	53

Starting in 2023, the non-trawl sector is also subject to logbook requirements. Vessels fishing for groundfish in the EEZ must complete logbook entries for every trip, and the data collected include fishing location, gear used, catch and discards. This data will allow for calculation of comprehensive effort metrics and a better understanding of where fishing is occurring, beyond just observed vessels. The percentage of observed effort in the fixed gear sectors of these fisheries from 2015-2023 are outlined in Table 2.

1.3.7.4 Tribal Sector

Tribal-directed groundfish fisheries are subject to full rockfish retention. Tribes also use shorebased sampling and observers to monitor their fisheries.

1.3.7.5 Recreational Sector

Recreational catch is generally monitored by the states as it is landed in port. However, there may also be on-the-water effort estimates as well. The Pacific States Marine Fisheries Commission (PSMFC) compiles these data in the Recreational Fisheries Information Network (RecFIN) database. The types of data compiled in RecFIN include sampled biological data, estimates of landed catch plus discards, and economic data. Data are generally available within three months. Descriptions of the RecFIN program, state recreational fishery sampling programs, and the most recent data available to managers, assessment scientists, and the public, can be found on the PSMFC website at http://www.psmfc.org/program/prog-3. The majority of recreational groundfish fishing occurs in state waters due to both natural limitations of how far offshore small vessels can safely go, and because most recreational groundfish fishing targets are found closer to shore. Currently, there is inconsistent spatial fishing location data collection across the three states, which complicates quantitative summaries of the location of recreational fishing activity from shore. However, only recreational groundfish fishing that occurs in the EEZ is included in this proposed action. Recreational groundfish fishing that occurs in state waters is not included.

1.3.8 Fixed Gear Marking and Entanglement Risk Reduction

In the 2020 biological opinion for humpback whales (NMFS, 2020c), Term and Condition #1 required a pot gear marking feasibility study to “consider whether additional gear marking would increase NMFS’ ability to attribute humpback whale entanglements to specific fisheries and assist in identifying take of humpback whales.” NMFS conducted the study in collaboration with Oregon Sea Grant, engaging industry members in workshops, and sourcing various ideas on changes to the fishery that may reduce whale entanglements.

The feasibility report was presented by NMFS to the Council at the March 2023 meeting, which identified line marking and additional markings on buoys/surface gear as having the greatest potential to improve identifiability of sablefish pot gear. This action also included a LEFG follow-on action that aimed to encourage efficient use of the LEFG sablefish quota through slinky pot gear switching in the longline sector. Entanglement risk reduction and the follow-on action were initially considered under one package for the PFMC, but were later divided into two projects at the June 2023 Council meeting. A work plan for each project was presented at the September 2023 meeting with a “Purpose and Need” and “Range of Alternatives.” During the March 2024 meeting, the Council adopted preliminary preferred alternatives, then adopted final recommendations in June 2024 for PCGF pot and longline gear marking and entanglement risk reduction. Final preferred alternatives included:

- Each surface buoy must be marked with a tag (e.g. cattle ear tag) with the vessel ID on it.

- Each vertical line must be marked over at least the top 20 fathoms (120 ft) by a manufactured line in a two-color combination unique to each gear type. With the exception of the first three years, temporary marking methods are allowed. Specific colors used are not yet known but are currently being discussed.
- During a phase-in period of three years from the effective date, vertical lines must be marked over the top 20 fathoms, but the marking may consist of continuous alternating bands of the same two-color combinations.
- Surface buoys will be required on at least one end of the groundline, rather than both.
- Surface lines will be limited to no more than 10 fathoms (60 ft) from the main buoy to the last trailing buoy.

The final rule is expected in spring of 2025, and the above regulations effective by January 1, 2026. The proposed action includes these gear marking requirements and risk reduction measures.

1.3.9 Closed Areas That Apply To All Groundfish Fisheries

1.3.9.1 Groundfish Conservation Areas (GCAs)

GCAs are depth-based management areas closed to commercial and, in some cases, recreational vessels. The use of these areas applies to all groundfish fisheries. The GCAs are used to control catch of overfished groundfish species or protected species and prohibit fishing in areas where the catch is likely to be high for a particular gear type. The boundaries are defined by a series of latitude/longitude coordinates that are intended to approximate particular depth contours. Depth contours are a series of coordinates expressed in degrees of latitude and longitude. Federal regulations at 50 CFR 660.60 state that depth-based closed areas may be used: to protect and rebuild overfished stocks; to prevent the overfishing of any groundfish species by minimizing the direct or incidental catch of that species; to minimize the incidental harvest of any protected or prohibited species taken in the groundfish fishery; to extend the fishing season in areas outside the closed zones; to minimize disruption of traditional fishing and marketing patterns for the commercial fisheries; to spread the available catch over a large number of anglers for the recreational fisheries; to discourage target fishing while allowing small incidental catches to be landed; and to allow small fisheries to operate outside the normal season. Specific GCAs include: Rockfish Conservation Areas (RCAs), Cowcod Conservation Areas (CCAs), Yelloweye Rockfish Conservation Areas (YRCAs) and Bycatch Reduction Areas (BRAs). Amendment 28 also added new protections for deep sea coral areas by closing the portion of the EEZ deeper than 3,500 m to all bottom contact gear, including bottom trawl gear, bottom long line gear, and pot/trap gear.

1.3.9.2 Rockfish Conservation Areas

RCAs are large-scale closed areas that extend along the entire length of the West Coast, from the Mexican border to the Canadian border. Commercial RCAs are specified for a particular gear group (trawl, non-trawl, and non-groundfish trawl) and can differ north and south of 40°10' N. latitude. Recreational RCAs may either have boundaries defined by general depth contours or boundaries defined by specific latitude and longitude coordinates that are intended to approximate particular depth contours.

1.3.9.3 Cowcod Conservation Areas

The CCAs are two areas off the southern California coast that are intended to reduce the catch of cowcod. These areas have been in place since 2001 and are expected to remain in effect in the near future. Fishing is prohibited in CCAs with the following exceptions: Fishing for "Other Flatfish" when using no more than 12 hooks, #2 or smaller and fishing for rockfish and lingcod shoreward of 20 fm. Fishing is expected to resume in these areas more broadly in the future as cowcod was rebuilt in 2020.

NMFS published a final rule for Amendment 32 to the FMP in December 2023. Amendment 32 removed the cowcod conservation area closures off of California for several sectors, opening roughly 4,600 square miles of historical fishing grounds to non-trawl groundfish commercial and recreational fisheries.

1.3.9.4 Essential Fish Habitat Conservation Areas

In March 2006, NMFS approved a plan to establish and protect more than 130,000 square miles off the United States West Coast as Essential Fish Habitat (EFH) for groundfish (72 FR 27408; Amendment 19 to the Groundfish FMP). EFH conservation areas (EFHCAs) are geographic areas defined by coordinates expressed in degrees of latitude and longitude, wherein fishing by a particular gear type or types may be prohibited. EFHCAs are created and enforced to contribute to protection of West Coast groundfish EFH. NMFS works with the Council to review EFH components of the fishery management plans periodically and to revise these provisions based on available information.

The EFHCAs are geographic areas defined by coordinates expressed in degrees latitude and longitude, wherein fishing by a particular gear type or types may be prohibited. EFHCAs are created and enforced for the purpose of contributing to the protection of West Coast groundfish EFH. The EFHCAs include the closure of waters deeper than 700 fm to bottom trawl; the prohibition of large footrope trawl shoreward of the 100 fm depth contour; and the specification of closed areas where bottom trawl gear and bottom contact gears are prohibited.

Amendment 28 made revisions to EFHCAs, including closure of most of the Southern California Bight to bottom trawl gear, as well as other changes, including re-opening of areas off Washington, Oregon and California. Areas that re-opened no longer have EFHCA or trawl RCA-related prohibitions, but may be closed by other restrictions (e.g. state rules, other groundfish conservation areas). EFHCAs that are closed prohibit bottom trawling (except demersal seine gear in areas off California). Nearshore areas (inside a boundary line approximating the 100 fm depth contour, formerly "shoreward of the trawl RCA") would remain closed to large footrope trawl gear.

Additionally, Amendment 32 established new EFHCAs off of Oregon (Nehalem Bank East, Bandon High Spot East, Arago Reef West, Garibaldi Reef North, Garibaldi Reef South).

1.3.10 Closed Areas That Apply Only to Trawl Fisheries

Closed areas that apply to the trawl fisheries differ for bottom trawl and midwater trawl. Midwater trawl is generally less geographically restricted than bottom trawl. In addition, vessels targeting Pacific whiting have fishery-specific area restrictions and practical constraints related to fishery operation. Vessels delivering catch to first receivers tend to fish in waters closer to the ports where first receivers are located. Shoreside hauls have generally occurred within 120 fathoms or shallower, compared to 140 fathoms in the MS sector and 175 fathoms in the CP sector.

1.3.10.1 Trawl Rockfish Conservation Areas

The operation of a vessel with bottom trawl gear onboard is currently prohibited in a trawl RCA, except for the purpose of continuous transiting. Fishing with midwater trawl gear within the RCAs north of 40°10' N. latitude is allowed during the Pacific whiting season. Since 2005, midwater trawling has been allowed in the area south of 40°10' N. latitude for all groundfish species when fishing seaward of the trawl RCA. The type of trawl gear type can be restricted within the RCA.

Amendment 28 eliminated the trawl RCA off Oregon and California. It also established "block area closures," a series of areas that, taken together span the entire West Coast seaward of the state territorial seas out to 200 nautical miles. The individual block areas, or groups of blocks, could be closed as needed, by the PFMC or NMFS, to protect PFMC-managed or other protected species.

1.3.10.2 Bycatch Reduction Areas

Federal regulations at 50 CFR § 660.131 for the Pacific whiting fishery include closed areas referred to as Bycatch Reduction Areas (BRAs). BRAs may be implemented in season under automatic action authority when NMFS projects that a whiting sector will exceed an allocation for a non-whiting groundfish species specified for that sector before the sector's whiting allocation is projected to be reached. The BRAs are depth closures that use the 75-fm (137-m), 100-fm (183-m) or 150-fm (274-m) depth contours to shift the Pacific whiting fishery into deeper waters. Because the Pacific whiting fishery is exempt from the RCA restrictions north of 40°10' N. latitude, the BRAs allow depth-based management in the Pacific whiting fishery when needed (§ 660.11). Like RCAs, the BRAs are areas closed to fishing by particular gear types, bounded by lines approximating particular depth contours (660.11). Federal regulations at §660.55 (c)(3)(i) continue to allow BRAs to be implemented through automatic action to prevent a Pacific whiting sector allocation from being exceeded. BRAs can also be implemented through routine in-season action to address broader conservation concerns.

1.3.10.3 Salmon Conservation Zones - Closed Areas Specific to the Pacific Whiting Fisheries

Vessels fishing in the Pacific whiting primary seasons for the Shorebased IFQ Program, MS Cooperative Program, or CP Cooperative Program are prohibited from targeting Pacific whiting in the following areas in order to reduce salmon bycatch:

Klamath River Salmon Conservation Zone

The targeting of Pacific whiting with midwater trawl is prohibited in the ocean area surrounding the Klamath River mouth bounded on the north by 41°38.80′ N. latitude (approximately 6 nautical miles (nm) north of the Klamath River mouth), on the west by 124°23′ W. longitude (approximately 12 nm from shore), and on the south by 41°26.80′ N. latitude (approximately 6 nm south of the Klamath River mouth). The Klamath River conservation zone was established in 1993 because of the concentrations of Chinook salmon in the area.

Columbia River Salmon Conservation Zone

The targeting of Pacific whiting with midwater trawl is prohibited in the ocean area surrounding the Columbia River mouth bounded by a line extending for 6 nm due west from North Head along 46°18′ N. latitude to 124°13.30′ W. longitude, then southerly along a line of 167 True to 46°11.10′ N. latitude and 124°11′ W. longitude (Columbia River Buoy), then northeast along Red Buoy Line to the tip of the south jetty. The Columbia River conservation zone was established in 1993 because of the concentrations of Chinook salmon in the area.

Eureka Area 100 fm Limit

Regulations at 50 CFR § 660.131 for the Pacific whiting fishery (any vessels with a valid "Limited entry midwater trawl, Pacific whiting shorebased IFQ fishing" declaration) state that unless otherwise specified, no more than 10,000-lb of whiting may be taken and retained, possessed, or landed by a vessel that, at any time during a fishing trip, fished in the fishery management area shoreward of the 100 fm contour in the Eureka management area. In 1992, this was one of several management actions taken to limit salmon bycatch. The continental shelf in the Eureka area is narrow and the 100-fathom contour generally occurs 6 to 10 nm offshore. Because a depth effect with higher salmon bycatch rates had also been observed in the bottom trawl fishery in the Eureka area, a year-round trip limit for Pacific whiting taken with bottom trawl was also established. Before the primary whiting season, there is a 20,000 lb/trip limit and during and after the primary season there is a 10,000 lb/trip limit.

1.3.10.4 At-sea Processing South of 42° N. Latitude

Since 1992, CP and MS vessels have been prohibited from processing south of 42° N. latitude in order to reduce salmon interception in those sectors (PFMC 1997). Therefore, no at-sea sector catch has occurred south of 40°10’ N. latitude in recent years.

1.3.11 Closed Areas that Apply to the Limited Entry and Open Access Fixed Gear Fisheries

This section discusses closed areas that apply to the non-trawl gears which primarily include: bottom longline, hook and line gear, and pot or trap. Fixed gear vessels may use one or more of these gears on a single fishing trip.

1.3.11.1 Non-trawl Rockfish Conservation Areas

Vessels with LE permits are prohibited to take and retain, possess, or land groundfish taken with non-trawl gear within the non-trawl gear RCA. LE fixed gear and incidental OA non-trawl gear vessels may transit through the non-trawl gear RCA, with or without groundfish on board. If a vessel fishes in an RCA, it may not participate in any fishing on that trip that is inconsistent with the restrictions that apply within the RCA. These restrictions do not apply to vessels fishing for species other than groundfish with non-trawl gear (i.e. Dungeness crab), and as a new management measure in the 2023-2024 Harvest Specifications, these restrictions do not apply to a subset of vessels using certain gear types in the *Directed Open Access* sector.[4]

NMFS published a final rule for Amendment 32 to the FMP in December 2023. Amendment 32 reduces the seaward extent of the non-trawl RCA, which opens up approximately 2,400 square miles off of Oregon and California to non-trawl fishing.

1.3.12 Closed Areas That Apply to Recreational Fisheries

Closed Areas (e.g. GCAs, RCAs, CCAs, and YRCAs) have been used to control fishing effort in the recreational fishery. The recreational RCAs are defined by a seaward boundary with shoreward areas being open. Recently, the recreational RCAs have also been used to restrict fishing shoreward of a boundary line (an “offshore” fishery). Each state has used recreational RCAs for all or a portion of the year to limit catch of overfished groundfish species. The RCAs have remained relatively stable off of Washington and Oregon in recent years. In 2017, midwater long-leader gear became allowed in waters seaward of 40 fm off the coast of Oregon during months in which fishing deeper than 40 fm is prohibited. The recreational groundfish fishery off Oregon is currently restricted to fishing shoreward of the 30 fm curve from April 1 through September 30. The RCAs for the recreational sector off California have changed recently to move effort out of the nearshore where quillback rockfish (a depleted stock) are found.

YRCAs are a type of Groundfish Closed Area that are intended to reduce the catch of yelloweye

[4] Directed open access means that a fishing vessel is target fishing for groundfish under the requirements of 50 CFR 550 Subpart F and is only declared into an open access groundfish gear type or sector as defined at 50 CFR 660. 13(d)(4)(iv)(A) and has not declared into any other gear type or sector.

rockfish. Although there are a number of YRCAs defined for waters off Washington, Oregon, and California, the following are those that are currently in use: the North Coast Recreational YRCA off Washington, the South coast recreational YRCA off Washington, and the Westport Offshore Recreational YRCA off Washington.

2.ENDANGERED SPECIES ACT: BIOLOGICAL AND CONFERENCE OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This opinion includes both a jeopardy analysis and a not likely to adversely affect determination (NLAA) for designated critical habitat. The analytical approach for the NLAA analysis is presented in Section 2.12. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion also relies on the regulatory definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designations of critical habitat for leatherback sea turtles uses the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414) that revised the critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification” analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The ESA Section 7 implementing regulations define effects of the action using the term “consequences” (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977), that revision does not change the scope of our analysis, and in this opinion we use the terms “effects” and “consequences” interchangeably.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species:

- Evaluate the rangewide status of the species.
- Evaluate the environmental baseline of the species.
- Evaluate the effects of the proposed action on species and their critical habitat using an exposure-response approach. This multi-step process includes:
    - Evaluation of the risk of humpback whale and leatherback sea turtle bycatch (entanglement/hooking/capture) in fishing gear
        - Review of available information on humpback whale and leatherback bycatch
        - Evaluation and application of available bycatch estimates for sectors of the PCGF in which there have been observed interactions with humpbacks or leatherbacks
        - Evaluation of the spatial and temporal trends in fishing effort by individual gear type
        - Evaluation of the spatial and temporal trends in species distribution models (density distribution for humpbacks and habitat suitability for leatherbacks)
        - Co-occurrence analysis: Overlay of PCGF fishing effort by gear type with a humpback whale density distribution model and a leatherback sea turtle habitat suitability model
        - Quantitative and qualitative evaluation of bycatch risk for sectors of the PCGF that do not have bycatch estimates, utilizing spatial fishing distribution and co-occurrence overlap analysis
        - Incorporation of entanglement history and associated mortality and serious injury (M/SI) rates
        - Use of information on the distribution of humpback whale DPSs along the U.S. West Coast to apportion anticipated effects to the different ESA-listed DPSs
    - Evaluation of other effects associated with the proposed action
        - Quantifying removal of humpback whale and leatherback sea turtle

primary prey items (i.e. PBFs that define critical habitat designations) by the PCGF

- Evaluation of impacts of pollution from PCGF vessels
- Evaluation of impacts from PCGF vessel traffic

- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

For this proposed action, NMFS relies on data provided by fisheries observers deployed in the WCGOP, marine mammal and turtle stranding network, and species density and habitat suitability models from the Southwest Fisheries Science Center (SWFSC) to evaluate the effects of the PCGF on ESA-listed humpback whales and leatherback sea turtles. Estimates of bycatch rates for humpback whales and leatherback sea turtles were generated by the NWFSC (Somers et al., 2024), M/SI values were taken from marine mammal stock assessment reports (Carretta et al., 2023b), and entanglement record information was provided by the West Coast Marine Mammal Stranding Network and West Coast Marine Turtle Stranding Network. Information on the *Status of the Species and Critical Habitat* and relevant *Environmental Baseline* of humpbacks and leatherbacks was gathered from the most recent stock assessment reports (SARs), recovery plans, status reviews, published scientific literature, other publicly available information, and unpublished data available to NMFS.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that is likely to be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the coastal and marine environments that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species.

2.2.1 Climate Change

Climate change significantly influences the status of species listed under the ESA and broader aquatic habitats. It can alter habitats, impact prey abundance and distribution, and fluctuate factors such as ocean currents and water temperature, rendering current habitats unsuitable, and affect migration, feeding, and breeding behaviors. Marine species generally respond to climate change through redistribution, adaptation, or extinction (IPCC, 2019), with specialized diets, restricted ranges, or reliance on specific foraging sites making many marine mammal populations particularly vulnerable (Silber et al., 2017). Humpback whales are more likely to redistribute as a result of climate change. MacLeod (2009) estimated that 88% of cetaceans would be affected by climate change, with 47% negatively affected, and 21% at risk of extinction due to shifts in water temperature.

Both humpbacks and leatherbacks migrate to Central America, a region predicted to become significantly warmer and drier by 2100 (Saba, 2013). In the Pacific Ocean, phenomena like the Pacific Decadal Oscillation (PDO), El Niño, or La Niña can impact productivity, affecting species dependent on specific prey types (Mackas et al., 1998; Quinn & Niebauer, 1995). These climatic and oceanographic processes can decrease organism productivity, forcing species like whales and sea turtles into unsuitable or non-existent habitats.

Rising atmospheric carbon and changing temperatures can influence marine ecosystems through changes in ocean acidity, altered precipitation patterns, sea level rise, and ocean currents. Global average sea level has risen by about seven to eight inches since 1900, with almost half of that rise occurring since 1993, likely due to anthropogenic climate change. Average global sea levels are expected to rise by at least several inches in the next 15 years, and by one to four feet by 2100 (Wuebbles et al. 2017). Sea level rise and coastal encroachment threatens nearshore habitat, potentially degrading ecosystems and nesting beaches for leatherbacks sea turtles, significantly altering reproductive success. Climate change can also influence major basin-wide currents, impacting nutrient availability and phytoplankton and zooplankton distribution (Van Gennip et al., 2017). Marine mammals and sea turtles may be indirectly impacted by ocean acidification through changes in foraging opportunities. Nearshore waters off California have already shown a persistent drop in pH (as low as 7.43; Chan et al., 2017), which can affect the distribution, abundance and migration of baleen whales via the same changes in prey patches (e.g. copepods, euphausiids or krill, amphipods, and shrimp), via climatic changes in oceanographic processes (Learmonth et al., 2006).

Numerous studies have documented changes in the abundance, quality, and distribution of humpback whale prey species due to climate shifts, particularly ocean warming (Thompson et al. 2019, Leising et al. 2024). Shifts in prey distribution and abundance due to climate change and other environmental conditions can lead to corresponding shifts in marine mammal distributions (King et al., 2011), and may lead to corresponding shifts in humpback whale distribution. For example, in Monterey Bay, California, the densities of blue, fin, and humpback whales declined with El Niño-associated declines in euphausiids (Benson et al., 2002). Later, the 2014-2016 marine heatwave altered humpback whale prey distribution and abundance by compressing habitat coastward (Santora et al., 2020). While these changes can occur regionally or across ocean basins, and may occur more frequently under future climate change conditions, the precise magnitude and impacts remain uncertain.

Sea turtles are similarly affected by climate change, as evidenced by shifts in the distribution and abundance of jellyfish, degradation of nesting beaches, nesting success, and the alterations in temperature-dependent sex ratios. Jellyfish, a primary prey for leatherbacks, experience diverse effects due to changes in climate that can potentially disrupt leatherback foraging ecology. Jellyfish populations are expected to increase under warmer conditions brought on by climate change which could suggest more available prey for leatherbacks, but jellyfish species expected to increase under warmer conditions are less energetically dense for nutritional value (Purcell et al., 2007; Brotz et al., 2012; Hazen et al., 2012; Gomes et al., 2024). A switch to a less energetically dense resource could have impacts on the reproduction and survivability of the leatherback population. Temperature changes can also reorganize prey distribution, likely poleward and into deeper waters, further disrupting leatherback foraging ecology (Nordstrom et al., 2019). Climate change is expected to draw leatherback turtles northward and offshore and into Oregon and Washington by 2070, but this expansion may draw them away from their main prey that occurs in coastal areas (Lezama-Ochoa et al. 2024). Additionally, if prey distribution shifts as a result of climate change, there is no guarantee the ranges of prey and leatherback turtles will overlap. Changes in oceanographic conditions, such as currents and upwelling patterns, can disrupt nutrient cycling and primary productivity, reducing trophic efficiency from the bottom-up (Polovina et al., 2008; Ullah et al., 2018). These alterations can lead to mismatches between leatherback distribution and prey availability throughout their range, resulting in reduced foraging success and potential nutritional stress.

Climate change also has implications for sea turtle migratory behavior as they travel within specific isotherms and utilize ocean temperatures to navigate. Changes in ocean temperatures may impact their bioenergetics, thermoregulation, and foraging success. It is believed that leatherbacks rely on current and temperature cues for timing foraging and migrations (Gaspar et al. 2006; Wilis-Norton et al. 2015). However, different populations of leatherbacks respond differently to these changes (Bailey et al. 2012). Western Pacific turtles prefer to forage in areas with warmer sea surface temperatures (SSTs) and depart when water temperatures drop (Graham et al. 2001; Benson et al. 2011). Eastern Pacific leatherbacks utilize foraging habitats with low SSTs and leave foraging grounds later when temperatures increase (Shillinger et al. 2011; Willis-Norton et al. 2015; Neeman et al. 2015; Patricio et al. 2021). This may have implications for reproductive success as arriving to nesting sites later may expose eggs to different incubation temperatures and precipitation, which may affect sex ratios (Hays et al. 2010; Katselidis et al. 2012; Neeman et al. 2015). Although warmer ocean temperatures are associated with more jellyfish, changes in temperatures can affect seasonal chlorophyll levels (productivity), prey distribution, and ocean currents. However, migratory clues are also highly complex and variable between sites and populations, making it difficult to accurately determine how a changing climate will affect leatherback movement and migratory behaviors.

Nesting and hatching success is crucial for leatherback sea turtle conservation, but climatic variations, including changes in rainfall patterns, sea levels, and temperature, have diminished nesting success in the Pacific Ocean. Leatherbacks prefer nesting beaches with specific characteristics, but sea level rise and increased erosion due to changes in precipitation patterns threaten these sites, particularly on island nations such as Indonesia, Papua New Guinea, and the Solomon Islands (Hitipeuw et al., 2007; Pilcher & Chaloupka, 2013). While leatherback turtles can adapt to some habitat changes, the increasing frequency of storms and high water events poses significant risk for nest loss (NMFS & USFWS, 2020). Temperature-dependent sex determination makes leatherbacks vulnerable to climatic variations. Climate change is anticipated to alter the duration, frequency, and intensity of El Niño and La Niña, thus possibly skewing sex ratios and create a bias for female hatchlings, leading to decreased overall reproductive success (Chan & Liew, 1995; Kaska et al., 2006; Saba, 2013; Santidrián Tomillo et al., 2014; Blechschmidt et al., 2020). More frequent and more intense El Niño events may further increase temperatures on nesting beaches and the duration for high beach temperatures, resulting in higher embryonic mortality (Matsuzawa et al., 2002; Kobayashi et al., 2017). Reduced vegetation cover resulting from more intense storms on nesting beaches can also increase sand temperatures, further exacerbating these effects (Santidrián Tomillo et al., 2012). Changes in beach conditions are expected to reduce hatchling success and emergence rates by 50-60% over the next 100 years (Santidrián Tomillo et al., 2012). Furthermore, heightened storm frequency and intensity can render nesting sites unsuitable and destroy existing nests, exacerbating climate change impacts (Patrício et al., 2021).

Considering the ongoing implications of climate change are essential when assessing the status of ESA-listed species. It is crucial to evaluate whether the impacts of the proposed action could affect the resiliency or adaptability of these species to cope with anticipated climate changes in the foreseeable future. Although understanding how climate change may impact marine organisms is improving, there remains uncertainty and limitations in predicting effects 50 years or more into the future. The ongoing implementation of the proposed action adds to the challenge of analyzing the potential influence of the changing climate far into the future.

2.2.2 Status of the Species

In this section, we describe the species, including the specific DPSs that are the subject of this consultation, as well as species' population structure, abundance, and distribution, which inform their associated extinction risk.

2.2.2.1 Humpback whales

Humpback whales are large baleen whales with long pectoral flippers, distinct ventral fluke patterns, dark dorsal coloration, highly varied acoustic call (termed "song"), and a diverse repertoire of surface behaviors. Their body coloration is primarily dark gray with variable white patterns on their pectoral fins, flukes, and belly. These pigmentation patterns on the undersides of their flukes are used to identify individual whales. Coloring of the ventral surface varies from white to marbled to fully black. Dorsal surfaces of humpback whale pectoral flippers are typically white in the North Atlantic and black in the North Pacific (Perrin et al., 2009), and are one-third of the total body length. Similar to all baleen whales, body lengths differ between the sexes, with adult females being approximately 1-1.5 m longer than males. Humpback whales reach a maximum of 16-17 m, although lengths of 14-15 m are more typical. Adult body weights in excess of 40 tons make them one of the largest mammals on earth (Ohsumi, 1966).

Humpback whales were listed as endangered globally under the Endangered Species Conservation Act in June 1970 (35 FR 18319) and remained listed under the ESA of 1973 (35 FR 8491). In November 1991, NMFS released a recovery plan for humpback whales (NMFS, 1991). In 2016, NMFS divided the global humpback whale population into 14 DPSs, with four categorized as endangered and one as threatened (81 FR 62259). NMFS identified three humpback whale DPSs that may be found off the coasts of Washington (WA), Oregon (OR), California (CA), and southern British Columbia (SBC) and within the range of the PCGF - the Hawaii DPS (not ESA-listed; found predominantly off WA and SBC), the Mexico DPS (ESA-listed threatened), and the Central America DPS (ESA-listed endangered). A recovery plan for humpbacks was issued in November of 1991 (NMFS, 1991). Given the change in status of humpback whales globally, NMFS is currently updating a DPS-specific recovery plan for three ESA-listed DPSs found in U.S. waters of the Pacific Ocean: Central America, Mexico, and the Western North Pacific. This includes an outline for the recovery of both Central America and Mexico DPSs was created in 2022 which does highlight fishery entanglement, vessel strikes, and low abundance as the primary threats to the Central America DPS (NMFS 2022e).

The final rule designating critical habitat for the Central America and Mexico DPSs became effective on May 21st, 2021 which contained ~59,411 square nautical miles of marine habitat in the Northern Pacific Ocean (86 FR 21082). Specific areas designated as critical habitat for the Central America DPS contains ~48,521nm^2 of marine habitat in the Northern Pacific within the portions of the California Current Ecosystem (CCE) off the coasts of California, Oregon, and Washington (Figure 30; Section 2.12.1). Specific areas designated for the Mexico DPS contain ~116,098 nmi^2 of marine habitat in areas including the eastern Bering Sea, Gulf of Alaska, and the CCE (Figure 29; Section 2.12.1).

The 2015 status review relied heavily on the Structure of Populations, Levels of Abundance and Status of Humpbacks (SPLASH) study on all known winter breeding and summer feeding areas for humpback whales in the North Pacific from 2004-2006. This study provided data on abundance, trends, movements, population structure, and human impacts on North Pacific humpback whales (Calambokidis et al., 2008). Results from the SPLASH study continue to be sources for abundance estimates and movement proportions between breeding and foraging grounds, even though the field efforts took place nearly twenty years ago (Wade et al., 2021; Cheeseman et al., 2024).

Under the MMPA, marine mammals are conserved and managed as population stocks, hereafter referred to as "stocks", which are groups of marine mammals of the same species in a common spatial arrangement that interbreed. It is important to note, stock delineations for humpbacks have changed since the 2020 Opinion on humpback whale effects from the PCGF, when NMFS has previously designated three stocks of humpback whales in the North Pacific: the California-Oregon-Washington (CA/OR/WA) stock, the Central North Pacific stock, and the Western North Pacific stock. In 2023, NMFS designated five new Pacific humpback whale stocks under the MMPA (Carretta et al. 2023b; Young et al. 2023; 88 FR 4162) to better align with humpback whale DPS under the ESA. The three new humpback whale stocks that occur off the mainland U.S. West Coast (CA, OR, and WA) include: the Central America/Southern Mexico-CA/OR/WA stock and the Mainland Mexico-CA/OR/WA stock. The Hawai'i stock also occurs off Washington and southern British Columbia.

In terms of relating the humpback stock designated under the MMPA to the DPS defined under the ESA, two of the five designated stocks, the Mainland Mexico - CA/OR/WA stock and the Mexico - North Pacific stock, fall within the Mexico DPSs. The Central America/Southern Mexico - CA/OR/WA stock encompasses the entire Central America DPS, given that all the individuals from this DPS forage off the U.S. West Coast. Individuals from the Hawai'i stock that occur off the U.S. West Coast are associated with the Hawai'i DPS, which is not ESA-listed. While NMFS will continue to evaluate the relationship between the humpback whale DPSs and designated stocks, we rely heavily on the most recent SAR and the most recent publicly available information in assessing the status (including abundance and trends) of the two listed DPSs, and in considering the proportional risk of anthropogenic activities on humpbacks found within the action area.

The calculated potential biological removal (PBR) for the Mainland Mexico - CA/OR/WA stock is 65 whales/year (Carretta et al., 2023b). Humpbacks are present in U.S. waters at least 8 months annually, with the beginning half of December and the ending half of April representing "transition months," where whales are moving in/out of the region (Ryan et al., 2019). Assuming 8 months of residency time in U.S. West Coast waters, or two thirds of the year, this yields a PBR in U.S. waters of 43 whales per year for this stock (Carretta et al. 2023b). For the Central America/Southern Mexico - CA/OR/WA stock (synonymous with the Central America DPS), PBR was calculated to be 5.2 animals. Assuming an 8 month residency time in U.S. waters, the total PBR for this stock is prorated by two-thirds (8/12), to yield a PBR in U.S. waters of 3.5 whales per year (Carretta et al., 2023b). NMFS will continue to evaluate the relationship between the humpback whale DPSs and recognized stocks.

Humpback whales found along the U.S. West Coast spend the winter primarily in coastal waters of Mexico and Central America, and the summer along the U.S. West Coast from California to

British Columbia. As a result, both the endangered Central America DPS and the threatened Mexico DPS at times travel and feed off the U.S. West Coast and may be exposed to the PCGF. Based on the best available information, all of the whales from the Central America DPS appear to migrate to feed only off the west coast of the United States. Conversely, whales from the Mexico DPS migrate in varying proportions to the U.S. West Coast, British Columbia, and various areas off Alaska. In July 2021, NMFS WCR updated a memo outlining evaluation of the distribution and relative abundance of ESA-listed DPSs that occur in the waters off the U.S. West Coast using the best available scientific information, which included genetic analyses (Lizewski et al. 2021; Martien et al. 2020; 2021), photo-identification analyses, (Calambokidis and Barlow 2020; Wade 2017; 2021) and species distribution models (Becker et al. 2020; NMFS 2021c). NMFS (2021c) recommended that for ESA Section 7 analyses, the WCR should apply a proportional approach based on the most recent abundance information on the CA/OR/WA stock from Calambokidis and Barlow (2020) and the proportions of the various DPSs feeding off CA/OR and WA/Southern British Columbia in Wade (2021). NMFS recommended considering that for actions occurring off the coast of California or Oregon, 42.3% of the humpback whales that could be affected by a proposed action would be members of the endangered Central America DPS and 57.7% would be members of the threatened Mexico DPS (Table 3). For actions off the coast of Washington, NMFS recommended considering that 5.9% of humpback whales would be from the Central America DPS, 25.4% would be from the Mexico DPS, and 68.8% would be from the non-listed Hawai'i DPS (Table 3). In addition, the most recent SARs for humpback whales uses the same underlying information for apportioning human impacts among the newly designated humpback stock delineations (Carretta et al. 2023a). We will use these recommended proportions in our analysis of the relative threats to each of the two listed DPSs, both with respect to the proposed action and other impacts that occur in the action area.

Table 3: Central America, Mexico, and Hawai'i humpback whale DPSs' migratory pathway probabilities to known feeding areas off the U.S. West Coast based on Wade (2021).[5]

	Feeding Grounds	
Population	**California or Oregon (CA/OR)**	**Washington (SBC/WA)**
Central America	0.423 (CV=0.23)	0.059 (CV=0.935)
Mexico	0.577 (CV=0.169)	0.254 (CV=0.278)
Hawai'i	0.00	0.688 (CV = 0.13)

[5] The 2022 SAR uses these same percentages to apportion human-caused impacts to the MMPA stocks that are associated with these DPSs that occur off the U.S. West Coast.

Population Status and Trends

NMFS reviewed the best available scientific information on the distribution and abundance of the two DPSs foraging off the U.S. West Coast. There are two primary lines of evidence for the origin of humpback whales found off the U.S. West Coast: photo identification catalogs and genetic identification of sampled individuals.

Wade et al. (2016) estimated abundance within all sampled winter breeding and summer feeding areas in the North Pacific and estimated migration rates between these areas using a comprehensive photo-identification study of humpback whales in 2004-2006 during the SPLASH project. Subsequently, Wade (2017) reanalyzed the Wade et al. (2016) data because "the multistrata model analyses were not necessarily converging to the correct answer," as stated in Wade (2017). Further revisions and refinements were made in Wade (2021) as part of the ongoing comprehensive assessment of humpback whales by the International Whaling Commission (IWC). The revised results led to different estimates of abundance for both the breeding (winter) and feeding (summer) grounds and different estimates of the proportional representation of animals from the different breeding grounds that forage off areas of the U.S. West Coast. We note that the SPLASH surveys were conducted around 15 years ago, which indicates that those abundance estimates are outdated; specifically, they are greater than eight years old, which is not considered a reliable estimate of current abundance, as summarized in NMFS' Guidelines for Preparing Stock Assessment Reports (NMFS 2016b; NMFS 2023e). For the 2004-2006 humpback populations, the Wade (2021) revised abundance estimate for the Central America DPS is 755 (CV=0.242) animals, and the revised abundance estimate for the Mexico DPS is 2,913 (CV=0.066) animals, using the multistrata model (Nmulti) (which uses both winter and summer data; Table 4 in Wade 2021).

Recent analyses by Calambokidis and Barlow (2020) updated the humpback whale abundance estimate for the previous CA/OR/WA stock of humpbacks, which included 2018 survey data. Capture-recapture models for humpback whales off CA/OR showed a dramatic increase in recent years, with a trend for the population starting in 1989 (~500 animals) through 2018 increasing an average 8.2% per year, with a higher rate of increase in the late 2000s. While multiple abundance estimates for humpbacks along the U.S. West Coast were reported, the most recent (i.e., 2018) estimate of 4,973 whales (with a standard error of 239 and lower and upper 20th percentile values of 4,776 to 5,178 whales) was produced for CA/OR based on the Chao model using rolling 4-year periods for the last four most recent available years (2015-2018; Table 3 in Calambokidis and Barlow 2020). While the estimates of humpback whale abundance for WA/SBC were also presented (1,593 animals, standard error of 108) and showed increases, particularly in recent years and extending into the Salish Sea[6], the abundance estimate for the

[6] Photographs of humpback whales in the inland waters of Washington (Strait of Juan de Fuca, Haro Strait and Puget Sound) are currently being analyzed by Cascadia Research Collective to match individuals to the breeding

U.S. West Coast only included CA/OR. There are two main reasons why the authors did not add the two estimates from both foraging areas. First, the WA/SBC estimate included a fairly large number of animals that would be outside U.S. waters, since some of the major areas of concentration were just north of the U.S. border. Secondly, there is some interchange between the CA/OR and the WA/SBC areas, which would mean that each individual estimate is to some degree including a portion of animals from the other area (J. Calambokidis, Cascadia Research Collective, personal communication, September 2020).

The final 2022 SAR (Caretta et al. 2023) relied on photo-identification data collected in the wintering area of the Central America/Southern Mexico - CA/OR/WA stock from 2019-2021, and fit a one-dimensional spatial capture-recapture model to annual capture histories using a Bayesian framework (Curtis et al. 2022). Curtis et al. (2022) estimates the Central America/Southern Mexico stock - CA/OR/WA at 1,496 (CV=0.171) whales and represents the best estimate of abundance for this stock. Given this estimate and a recent estimate of total abundance in the U.S. West Coast EEZ of 4,973 (CV=0.048) whales from a mark-recapture (Calambokidis and Barlow 2020), Curtis et al. (2022) also estimated the abundance of the whales from the Mainland Mexico - CA/OR/WA stock as the difference, or 3,477 animals (CV = 0.101). This may be an underestimate, because the authors state their estimates likely includes whales from Washington waters, since there is movement of whales between WA, OR, and CA. Another estimate, based on a species distribution model from 2018 line-transect data, resulted in a lower abundance of 4,784 whales (CV=0.31) (Becker et al. 2020). Of these two estimates, Calambokidis and Barlow (2020)'s has been used previously to represent U.S. West Coast abundance of humpback whales as it is more precise, while Becker et al. (2020)'s estimate reflects only whale densities and oceanographic conditions within the study area during summer and autumn, thus presenting a seasonal bias.

Threats

The Recovery Plan (NMFS, 1991), 2015 status review (Bettridge et al. 2015), and 2022 Recovery Outline identify the general threats to humpback whales in the North Pacific Ocean. These threats include habitat loss, prey depletion, underwater noise, pollutants, vessel collisions, and entanglement in fishing gear. Substantial coastal development occurs throughout the range of the two listed DPSs, and noise associated with construction (e.g., pile driving, blasting or explosives) or moving vessels has the potential to affect humpbacks by generating sound levels that may disturb humpback whales or adversely affect their hearing (Bailey et al., 2010; Houghton et al., 2015; Rossi-Santos, 2015). Contaminants such as heavy metals, persistent organic pollutants, effluent airborne contaminants, plastics and other marine debris pose risks to humpback whales by accumulating in their blubber (e.g., pesticides such as DDT) and causing

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ground photo identification catalogs. Until that analysis is complete, we will use the same proportions in inland waters as for the outer coast of Washington.

health issues like disease susceptibility, neurotoxicity, and reproductive and immune impairment (Aguilar et al., 2002; Bachman et al., 2014; Baugh et al., 2023). Entanglement or ingestion of marine debris, particularly derelict fishing gear, is also a concern. Whale watching and scientific research may also disturb or harm humpback whales by disrupting essential biological functions via harassment or injury from inadvertent close approaches. Anthropogenic sound has increased in all oceans over the last 50 years, and is thought to have doubled each decade in some areas over the last 30 years. Low-frequency sound comprises a large proportion of this increase, from sources like shipping, oil and gas exploration and military activities. Detrimental effects associated with anthropogenic sound include hearing loss, masking, and temporary threshold shifts, impacts to social communication, stress hormone fluctuations, departure from prime foraging areas, or alteration in migratory routes or timing. Given the sensitivities of humpbacks to low and mid-frequency sounds, researchers may be able to detect changes and adverse effects to individuals; however, population-level and long-term impacts on cetaceans has not been confirmed.

Little is known of the anthropogenic threats to the two listed humpback whale DPSs while they are outside of U.S. waters. When we do have reports of injured or dead whales reported off Canada and Mexico entangled in U.S. fishing gear, these reports are included in the SAR. The Mexico population of humpbacks has one of the highest scar rates from nets and lines in the North Pacific, indicating a high entanglement rate (Bettridge et al., 2015). Given their long migrations between feeding and breeding grounds, we assume both DPSs are subject to the anthropogenic threats summarized above.

Entanglement in fishing gear poses a significant threat to individual humpback whales throughout the Pacific Ocean. The estimated impact of fisheries on the Central America and Mexico DPSs is likely underestimated, since the M/SI of large whales due to entanglement in gear may go unobserved because whales swim away with a portion of the net, line, buoys, or pots and these whales frequent areas of the ocean not typically visited by human observers. Non-commercial fisheries may include tribal and recreational fisheries and marine debris, but are likely responsible for a small fraction of all entanglements. Details of the interactions are summarized in the Environmental Baseline section, since the action area includes most of the U.S. West Coast, including the EEZ and state waters.

Humpback whales, especially calves and juveniles, are highly vulnerable to ship strikes (Stevick, 1999) and other interactions with non-fishing vessels. Off the U.S. West Coast, humpback whale distribution overlaps significantly with the transit routes of large commercial vessels, including cruise ships, large tug and barge transport vessels, and oil tankers in the action area (Rockwood et al., 2017; Greig et al., 2020; Redfern et al., 2020). Ship speeds greater than 10 knots are likely to be fatal (Vanderlaan & Taggart, 2007), and Currie et al. (2021) found swimming speeds of humpback whales increased as whale-watching vessels approached. Whale watching boats and research activities directed toward whales may have direct or indirect impacts as harassment may occur, preferred habitats may be abandoned, and fitness and survivability may be compromised if disturbance levels are too high (Schuyler et al., 2019; Amrein et al., 2020). Over the past 30 years, our known (and considered minimum) estimate of vessel strikes of large whales is considered low. More details of interactions between vessels and humpback whales is provided in the *Environmental Baseline*.

Conservation:

Numerous international agreements are in place to safeguard humpback whales. The IWC has enforced no catch from commercial whaling since 1985, with North Pacific humpback whales enjoying nominal protection since 1966. Despite continued illegal catches, substantial captures ceased in 1968 (IUCN, 2018). The IWC's Scientific Committee has since developed a stock assessment and catch limit methodology to determine catch limits to maintain sustainable populations. While some aboriginal whaling has been permitted, it is not allowed within the North Pacific Ocean. The ban on commercial whaling has been pivotal in humpback whale conservation, facilitating their recovery and population growth across most areas of the North Pacific. Humpback whales are listed under Appendix I of the Convention of International Trade in Endangered Species (CITES), which severely restricts trade except under exceptional circumstances. The International Union for Conservation of Nature (IUCN) Red List classifies humpback whales as "least concern", indicating no immediate threat of extinction (IUCN, 2018).

2.2.2.1.1 Mexico DPS

The Mexico DPS breeds along the Pacific coast of mainland Mexico, the Baja California Peninsula, and the Revillagigedos Islands. Its feeding range extends from California to the Aleutian Islands, with significant concentrations in California, Oregon, Washington, Southern British Columbia, northern and western Gulf of Alaska, and the Bering Sea. Genetic analysis and sighting data indicate significant genetic differentiation and low rates of movement among breeding areas, leading to this discrete DPS. This DPS was determined to be discrete due to the gap in breeding grounds that would occur if this DPS were to go extinct and the marked degree of genetic divergence to other populations (Bettridge et al. 2015).

Population Status and Trends

The Mexico DPS along the U.S. West Coast was estimated to consist of 6,000 to 7,000 animals based on the SPLASH project (2004-2006; Calambokidis et al., 2008) and in the most recent status review (Bettridge et al., 2015). Wade (2021) revised this estimate to 2,913 whales (CV=0.242) based on the SPLASH data from 2004-2006. Recognizing the outdated nature of the SPLASH project data, NMFS (2021c) utilized more recent data from Calambokidis and Barlow (2020) to estimate a minimum abundance estimate of 6,981 whales for the entire Mexico DPS, with a potential higher abundance of 9,000 animals or more based on recent growth rate estimates used for humpback whale populations off the U.S. West Coast used in the SARs.

The estimated abundance of the Mainland Mexico-CA/OR/WA stock (which only includes a portion of the Mexico DPS) is 3,477 animals (CV=0.101) using an estimate from Curtis et al. (2022) of 1,496 whales wintering in southern Mexico and Central America, and the recent estimate of humpback whales foraging off the U.S. West Coast (4,973; Calambokidis & Barlow, 2020). While the stock trend remains undetermined due to the presence of multiple humpback stocks off the U.S. West Coast, it can be inferred that the Mainland Mexico-CA/OR/WA stock (only a portion of the Mexico DPS) is likely experiencing growth around 8% annually, given the cumulative annual 8.2% growth rate for all humpback whales off of the U.S. West Coast, and information that suggests the Central America/Southern Mexico-CA/OR/WA stock (includes all of the Central America DPS) is only growing ~1.6% annually (Curtis et al. 2022)

A recent study estimated Pacific basin-wide abundances for humpbacks from 2002-2021 using mark-recapture methods on the largest individual photo-identification dataset ever assembled for cetaceans, which included estimates for humpback whales that winter in mainland Mexico (HappyWhale; Cheeseman et al. 2024). After bias-corrections in their model, the mainland Mexico abundance (including most, but not all of the Mexico DPS) is estimated to have grown an average of 7.1% per year from 2002 to 2015, before appearing to stabilize with an average of 0.9% per year growth from 2016 to 2021. Cheeseman et al. (2024) estimated humpbacks wintering in the mainland Mexico region grew on average 7.1% annually from 2002-2015 to about 7,500, before stabilizing with an average 0.9% annual growth from 2016-2021 (Cheeseman et al. 2024). This estimate of growth rate roughly matches the growth of the total abundance of humpback whales off the U.S. West Coast from Calambokidis and Barlow (2020). Based on all the available information, we conclude that 7,500 is the best current assessment of the abundance of the Mexico DPS. The threats faced by the Mexico DPS have been broadly summarized above with further details impacting the population in the action area provided in the further section 2.4 *Environmental Baseline*.

2.2.2.1.2 Central America DPS

The Central America DPS breeds along the Pacific Coast of Costa Rica, Panama, Guatemala, El Salvador, Honduras, and Nicaragua (Bettridge et al., 2015). Recent evidence indicates that this DPSs' wintering grounds extend north into southern Mexico, reaching as far as Guerrero, Michoacan, and Colima (Taylor et al., 2021). The whales utilize a migratory corridor along mainland Mexico to the mouth of the Gulf of California along the Baja California Peninsula (Martinez-Loustalot et al. 2022). Designated as discrete, this DPS displays significant genetic differentiation from other North Pacific populations and includes mitochondrial DNA (mtDNA) haplotypes shared with certain Southern Hemisphere DPSs, suggesting a potential conduit for gene flow between the North Pacific and Southern Hemisphere. Therefore, the loss of this population would create a significant gap in the species' range (Bettridge et al., 2015).

Occupying a unique ecological setting, this DPS differs in both its breeding and feeding grounds from other populations. The wintering ground extends into southern Mexico, leading to the classification as the Central America/Southern Mexico-CA/OR/WA stock under the MMPA (Taylor et al., 2021). Therefore, while the Central America DPS is defined by Bettridge et al. (2015) and the final rule identifying the 14 DPSs of humpbacks (81 FR 62260; September 16, 2016) under the ESA, we consider the inclusion of southern Mexico humpbacks in the abundance estimate recently published by Curtis et al. (2022), as reflective of the status of the Central America DPS. The threats for the Central America DPS have been generally summarized above, and more information from activities that affect this population in the action area will be described further in section 2.4 *Environmental Baseline*.

Population Status and Trends

The Central America DPS occurs along the U.S. West Coast, with individuals more likely to be found off the coast of California and Oregon. Previous estimates of abundance for the population in 2004-2006 ranged from 400 to 600 individuals (Bettridge et al., 2015; Wade et al., 2016). Wade (2021) reanalyzed SPLASH data to estimate an abundance at 755 whales (CV=0.242), although this data is nearly 20 years old.

Curtis et al. (2022) provided new abundance estimates of the Central America-CA/OR/WA stock, which is essentially synonymous with the Central America DPS. Curtis et al. (2022) estimated this stock's abundance at 1,496 individuals (CV = 0.171) using spatial capture-recapture models of photographic data collected from 2019 and 2021. This is considered the best estimate of the Central America DPS abundance. The inclusion of whales from Southern Mexico in the most recent estimate for the Central America/Southern Mexico-CA/OR/WA stock yielded a population growth rate of 4.8% (SD=2.0%), compared to previous estimates of the Central America DPS (Curtis et al., 2022). After correcting for the inclusion of whales from Southern Mexico, Curtis et al. (2022) estimated an increase of 1.6% per year (SD = 2.0%) for whales from Central America, although this estimate has high uncertainty.

2.2.2.2 Leatherback sea turtle

Description and Geographic Range

The leatherback sea turtle has been listed as endangered since the Endangered Species Conservation Act of 1969 (35 FR 8491), and remains endangered throughout its global range under the ESA (50 CFR 17.11). A recovery plan for the U.S. Pacific populations of leatherbacks was completed over 20 years ago (NMFS & USFWS, 1998), and in 2012 NMFS revised critical habitat for leatherbacks to include additional areas of the Pacific Ocean (77 FR 4170; Figure 31 in Section 2.12.2). It is the only remaining species in the family Dermochelyidae, with all other extant sea turtles belonging to the family Cheloniidae. Leatherbacks are the largest marine turtle, with a curved carapace length often exceeding 150 cm and front flippers that can span 270 cm (NMFS & USFWS, 1998; Davenport et al., 2011). Unlike other sea turtles, leatherbacks have a slightly flexible, rubber-like carapace composed of oil-saturated connective tissue, raised into seven prominent ridges covered in horny scutes that taper to a blunt point posteriorly. The carapace and plastron are barrel-shaped and streamlined. Their unique physiological and behavioral adaptations, such as a countercurrent circulatory system (Greer et al., 1973), a thick layer of insulating fat (Goff & Stenson, 1988; Davenport et al., 1990), gigantothermy (Paladino et al., 1990), and the ability to elevate body temperature through increased metabolic activity (Southwood et al., 2005; Bostrom & Jones, 2007) enable them to inhabit colder waters, extending their geographic range further than other sea turtle species.

Leatherback turtles are found in all oceans, making them the most widely dispersed reptile species. They spend much of their lives in the ocean undertaking extensive journeys while developing, foraging, and migrating. They typically travel within 15 feet of the surface to maximize swimming efficiency during migrations (Eckert, 2002), but can dive as deep as 3,937 feet (1,200 m), although most dives are less than 262 feet (80 m) (Shillinger et al., 2011). Leatherbacks nest on beaches on every continent except Europe and Antarctica (K. L. Eckert & Eckert, 2012; NMFS & USFWS, 2020). Currently, seven populations are recognized: (1) Northwest Atlantic; (2) Southeast Atlantic; (3) Southwest Atlantic; (4) Northeast Indian; (5) Southwest Indian; (6) West Pacific; and (7) East Pacific Ocean populations, all listed as endangered under the ESA (NMFS & USFWS, 2020). For the purposes of this Opinion, we focus on the two populations (i.e. West Pacific and East Pacific) occurring within the Pacific Ocean, often referred to as Pacific leatherbacks. Their distribution extends from the Sea of Japan, across the North Pacific to North America’s West Coast, the South China Sea, Indonesian Seas, and high-latitude waters of the western South Pacific Ocean and Tasman Sea (Benson et al., 2011).

Genetic analyses reveal fine-scale population structure among Pacific leatherbacks. While mtDNA studies did not detect genetic differentiations among nesting sites in Indonesia, Papua New Guinea, and the Solomon Islands (Dutton et al., 2007), microsatellite DNA analyses indicate genetic structure (Dutton et al., 1999; NMFS SWFSC unpublished data). Hence, we treat these nesting aggregations as subpopulations. Migration and foraging strategies vary based on life history traits, influenced by prevailing offshore currents and seasonal monsoon-related effects experienced as hatchlings (Benson et al., 2011; Gaspar et al., 2012). Leatherbacks display fidelity to specific foraging regions likely based on juvenile dispersal patterns (Benson et al., 2011; Gaspar et al., 2012; Gaspar & Lalire, 2017). Stable isotopes analysis confirms this fidelity (Seminoff et al., 2012).

The Western Pacific population is defined by boundaries south of 71°N, north of 47°S, east of 120°E, and west of 117.124°W (NMFS & USFWS, 2020). This population exhibits a dichotomy of summer and winter nesting behaviors, influencing their foraging destinations, dictated by offshore currents and monsoon seasons (Benson et al., 2011; Gaspar et al., 2012). Summer nesters typically forage in Asia and the North Pacific, while winter nesters favor the Southern Hemisphere's tropical waters (Benson et al., 2011; Harrison et al., 2018). A noteworthy subset of the Western Pacific population comprises summer nesters or individuals foraging in CCE (Benson et al., 2011). These individuals primarily forage in northern and central California, Southern Washington, and Northern Oregon, with approximately 30-60% of Jamursba-Medi summer nesting females foraging off California (Seminoff et al., 2012). Summer nesting females from Indonesia and the Solomon Islands migrate towards Central California (Benson et al., 2011), and winter nesters migrate to the tropics of the southern hemisphere and South Pacific Ocean (Benson et al., 2011; Harrison et al., 2018). Figure 6 displays the various migratory pathways described for the Western Pacific population of leatherbacks based on satellite tracks of 126 leatherbacks from Benson et al. (2011). This map displays the seasonal differences in migratory pathways and the primary foraging and breeding grounds for the Western Pacific population and emphasizes the summer nesters that migrate to the U.S. West Coast within the action area.

The Eastern Pacific population is delineated north of 47°S, south of 32.531°N, east of 117.124°W, and west of the Americas. This population exhibits somewhat continuous but low-density nesting along the coasts of Mexico and Central America (NMFS & USFWS, 2020). The Eastern Pacific population forages primarily along the coastlines and pelagic waters of the southeastern Pacific Ocean (NMFS & USFWS, 2020). One study found a small presence of Western Pacific individuals within the fisheries off of Peru and Chile, which are primary feeding grounds for the Eastern Pacific population (Donoso & Dutton, 2010; NMFS & USFWS, 2013). During the nesting season, they stay within shallow, highly productive, continental shelf waters (Shillinger et al., 2011). Adult females from both populations exhibit site fidelity to specific foraging regions, (Benson et al., 2011; Gaspar et al., 2012; Gaspar & Lalire, 2017) displaying limited movement, and even stationary behavior for extended periods upon reaching their foraging habitats (Benson et al., 2011).

While East and West Pacific populations can overlap, such as south of Hawaii, genetic analyses indicate a low probability of East Pacific leatherbacks occurring off the U.S. West Coast. No leatherbacks sampled off the U.S. West Coast have ever been genetically assigned to the East Pacific nesting beach subpopulation, with a majority of them being boreal summer western Pacific nesting females. Approximately 38%-57% of summer-nesting females from Papua Barat migrate to distant foraging grounds off the U.S. West Coast, including the neritic waters off central California. Researchers recently assessed the abundance and trend of leatherbacks foraging off central California using 28 years (1990-2017) of aerial survey data from coast-wide and adaptive fine-scale surveys, indicating abundance declined at an annual rate of -5.6% (95% credible interval; -9.8% to -1.5%) to less than 200 individuals (Benson et al., 2020).

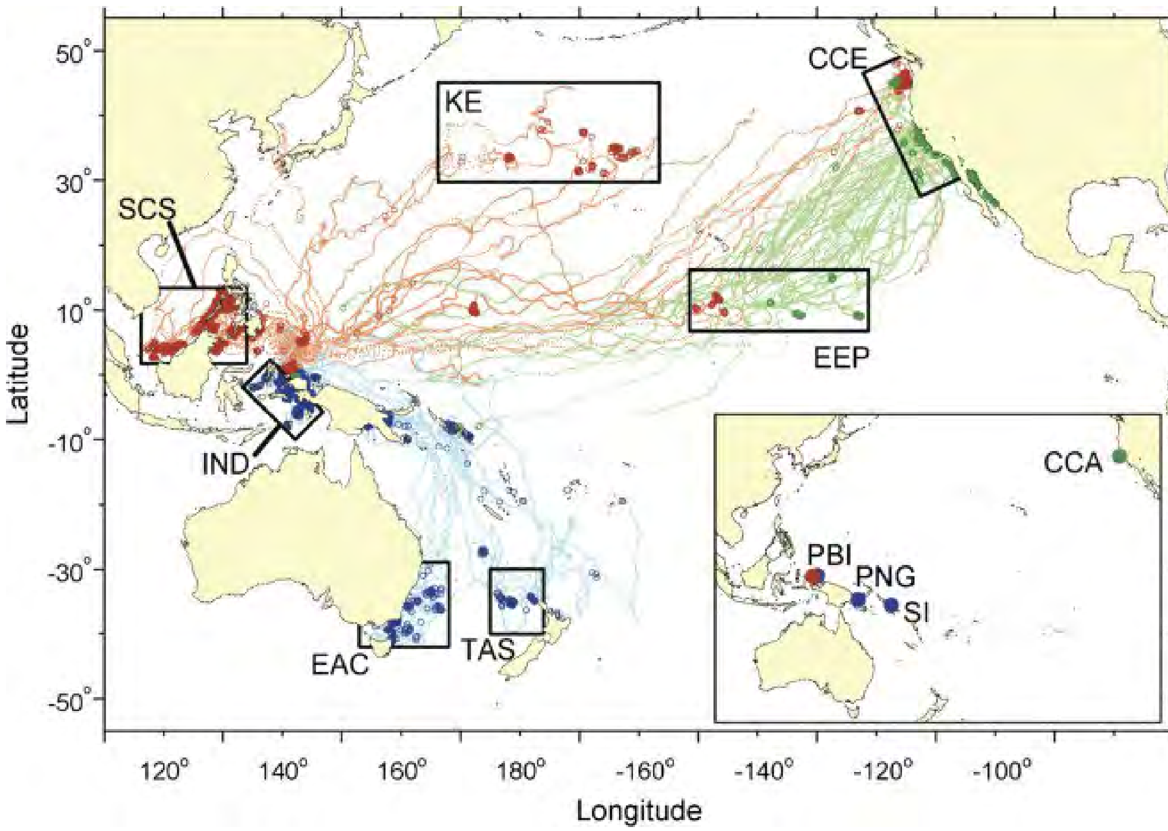


Figure 6: Satellite tracks from 126 West Pacific leatherbacks. Color of track indicates deployment season: red = summer nesters, blue = winter nesters, green = deployments at central California foraging grounds. Inset shows deployment locations; PBI = Papua Barat, Indonesia, PNG = Papua New Guinea, SI = Solomon Islands, CCA = central California. Black boxes represent ecoregions for which habitat associations were quantitatively examined: SCS = South China, Sulu and Sulawesi Seas, IND = Indonesian Seas, EAC = East Australia Current Extension, TAS = Tasman Front, KE = Kuroshio Extension, EEP = equatorial eastern Pacific, and CCE = California Current Ecosystem (Benson et al., 2011).

Feeding

Leatherback turtles primarily feed on gelatinous zooplankton such as cnidarians (jellyfish and siphonophores) and tunicates (salps and pyrosomas) typically near the ocean's surface, but will also dive more than 1,000 m to forage on tunicate colonies within the deep scattering layer (NMFS & USFWS, 1998; Spotila, 2004). Although capable of deep dives, most foraging dives are less than 80 m (Shillinger et al., 2011). Due to their specialization on gelatinous zooplankton, any substantial changes to the distribution, abundance or density of these prey items could significantly impact the population as a whole. Due to their prey's low nutrient content, leatherbacks must consume large quantities to support their energetic needs (Heaslip et al., 2012;

Jones et al., 2012; Wallace et al., 2018). Estimates suggest the Pacific population consumes approximately 2.1 million tons of jellyfish annually, with individuals consuming upwards of 1,000 metric tons in their lifetime (Jones et al., 2012). Leatherbacks exhibit continual diving behavior during migrations, indicating foraging along the entire depth profile (K. L. Eckert et al., 1989). Typical average dive durations range from 6.9 to 14.5 minutes per dive, with a maximum of 42 minutes (S. A. Eckert et al., 1986).

Foraging areas are often characterized by zones of upwelling, major currents convergences, and deep-water eddies (Saba, 2013). Western Pacific winter-nesting females travel southward to waters off Australia and New Zealand or remain in Indonesian waters post-nesting. Southeast Australia is a crucial foraging area for Pacific leatherbacks (Hays et al., 2023). Western Pacific summer-nesting females either move to the Sulawesi, Sulu, and South China Seas to forage in Indonesian, Malaysian and Philippine waters or travel to the temperate North Pacific.

Post-nesting Eastern Pacific females forage broadly along the coasts of Central and South America, specifically Peru and Chile (Donoso & Dutton, 2010; Shillinger et al., 2011; NMFS & USFWS, 2013). Their feeding locations vary based on upwelling locations and El Niño-Southern Oscillation (ENSO) events, but have less diversity than the Western Pacific population, making them more vulnerable to environmental changes. Adult female leatherbacks weigh about 33%more in their foraging grounds than nesting grounds, indicating they probably catabolize fat reserves to fuel migration and subsequent reproduction (James et al., 2005). Adult female sea turtles must replenish their energy stores after nesting, therefore, their remigration intervals are dependent upon foraging success and duration (Hays, 2000; Price et al., 2004).

Population Status and Trends

Estimating leatherback population abundance is challenging due to their complex life history. Data from nesting beaches, although valuable, do not capture all life stages (i.e., immature and mature males and immature females) and the spatial structure of male leatherback sea turtles and their fidelity to specific coastal areas is unknown. Additionally, standardized nesting surveys are difficult to maintain over many consecutive years at all nesting beaches. The best available data for leatherback turtles, however, is based on surveys conducted at nesting beaches females return to when they mature. The below data have been consistently collected using a standardized monitoring approach over a recent remigration interval, providing reasonable certainty that such data are representative of recent nesting at the identified beach. Although some data may have been collected at other nesting beaches, monitoring has not been recent, consistent, or standardized, thus limiting our certainty of these data; therefore, data from those nesting beaches cannot be used to calculate abundance. Here we will make inferences about the growth or decline of leatherback populations based on numbers of nests and trends in numbers of nests.

Leatherbacks occur globally with variable populations in different regions and nesting beaches. In 1980, the global leatherback population was approximately 115,000 adult females (Pritchard

1982). By 1995, one estimate claimed this global population of adult females had declined to 34,500 (Spotila et al. 1996). Abundance and trend estimates of nesting females for five of the DPSs not located in the Pacific Ocean indicated that all were at risk of extinction in 2020 (NOAA & USFWS 2020). The Northwest Atlantic DPS has a total index of nesting female abundance of 20,659 females (moderate confidence), and has decreasing nesting activity at a nesting beach with the greatest known nesting female abundance. There are an estimated 27 females in the Southwest Atlantic DPS, with most nesting occurring in Brazil and exhibiting an increasing, although variable nest trend (NOAA & USFWS 2020). The Southeast Atlantic DPS was estimated to have 9,198 nesting females, with most nesting in Gabon where a declining nest trend has been observed. The Southwest Indian Ocean DPS was estimated to have 149 nesting females with an overall nesting trend to be slightly decreasing. Lastly, the Northeast Indian DPS was estimated to be 109 nesting females with a declining trend, particularly with the extirpation of its largest nesting aggregation in Malaysia (NOAA and USFWS 2020).

Western Pacific Leatherback

The Western Pacific leatherback population that nests in Indonesia, Papua New Guinea, Solomon Islands, and Vanuatu harbors is the last remaining nesting aggregation of significant size in the Pacific. A recent discovery of a previously undocumented nesting area on Buru Island, Indonesia and relatively new sites in the Solomon Islands, suggests that additional undocumented nesting habitats may exist on other remote or infrequently surveyed islands of the Western Pacific Ocean (WPO) (NMFS and USFWS 2020). Low levels of nesting are also reported in Vanuatu (Petro et al. 2007; Wan Smolbag 2010). The leatherback status review (NMFS and USFWS 2020) conservatively estimated adult female abundance at 1,277 individuals in 2017. This value is based only on nesting at Jamursba-Medi and Wermon beaches in Papua Barat, Indonesia, as these are the only beaches with long-term monitoring. Despite a slight uptrend in the most recent data, NMFS and USFWS (2020) estimated the long-term trend in annual nest counts for Jamursba Medi (data collected from 2001 to 2017) at -5.7% annually. These two beaches likely represent between 50% and 75% of all nesting for this population (NMFS and USFWS 2020).

The index of total nesting females in Jamursba Medi and Wermon (1,277 females) provided in the status review of the species (NMFS and USFWS 2020b) was based on a simple calculation that does not provide confidence or credible intervals. While NMFS and USFWS (2020) determined that this index was a suitable representation of total nesting female abundance for their purposes (i.e., evaluating extinction risk), they acknowledged that the degree to which the index represents the actual abundance of nesting females is unknown. We consider the values from Martin et al. (2020b) using the median values for nest counts to be the best available estimates for abundance for two reasons. First, Martin et al. (2020b) imputed missing data for months during which data were not collected, providing a more accurate estimate of total nesting. Second, their model evaluated variation due to natural causes (i.e., changes in nesting over time due to environmental or demographic factors) and observational error (i.e., imperfect data collection; Martin et al. 2020b).

To estimate the total number of nesting females from all nesting beaches in the WPO, we considered nesting at unmonitored or irregularly monitored beaches. Approximately 50% to 75% of West Pacific leatherback nesting occurs at Jamursba Medi and Wermon beaches (Dutton et al. 2007; NMFS and USFWS 2020b). Applying the conservative estimate of 75% to the Martin et al. (2020b) estimate of 790 females in the index beaches leads to an estimate of 1,054 females for the West Pacific population, with an overall 95% CI of 888 to 1,256 females. It should be noted that this estimate (i.e., 1,054) of nesting females for the West Pacific population based on more recent available information is an update of the NMFS and USFWS (2020) estimate (i.e., 1,277).

Based on 2004 estimates, the total Pacific population was around 250,000 individuals (i.e., juveniles and adults, 95% confidence interval 97,000 to 535,000) (Jones et al., 2012). Current estimates suggest the West Pacific leatherback population is about 100,000 sea turtles (95% confidence interval 47,000 to 195,000 individuals) (Martin et al., 2020b). Despite stable nest numbers from 2017 to 2021 (Lontoh et al. in prep), data are not yet available in sufficient detail to update the model of (Martin et al., 2020b). Because nesting numbers have been stable since 2017, we assume the 1,054 estimate from 2017 to be the best estimate of current (2024) adult females for the index beaches.

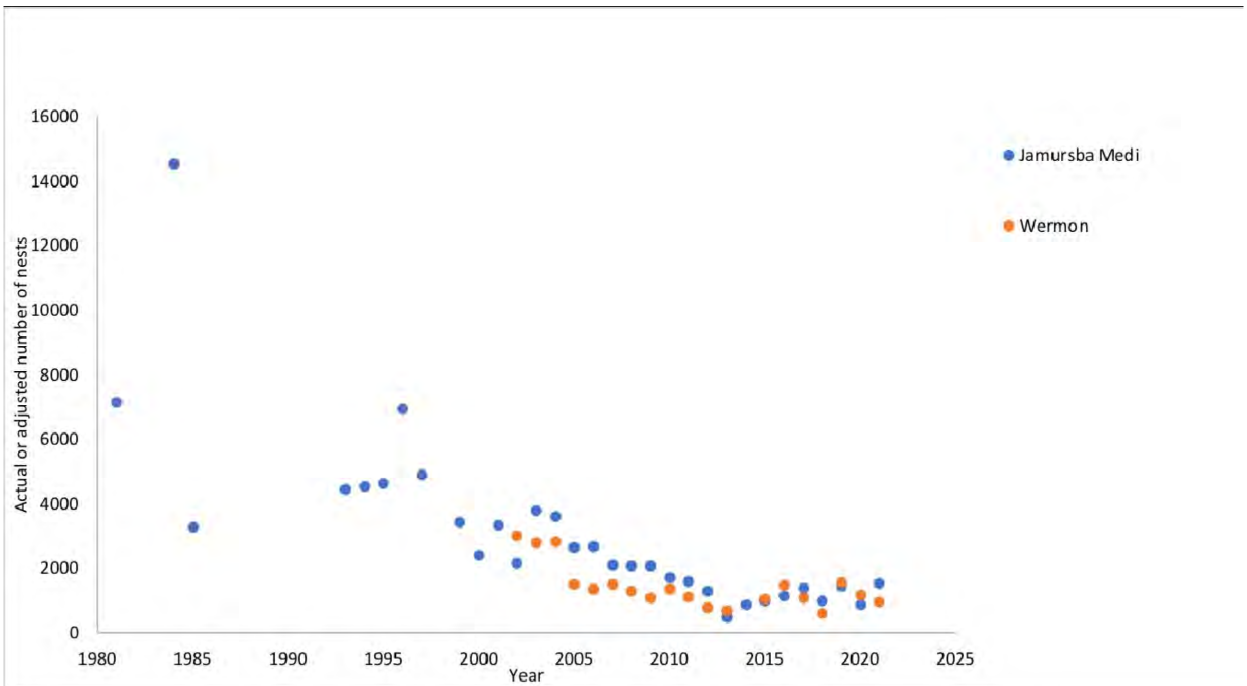


Figure 7. Actual and adjusted number of leatherback nests between 1981 and 2021 at Jamursba-Medi and Wermon. Each year represents nests laid from April of one year to March

of the following year (Lontoh et al. in prep).

The Western Pacific population has been exhibiting low hatching success and decreasing nesting population trends due to past and current threats (NMFS & USFWS, 2020). The low estimated nesting female abundance of the West Pacific population places it at elevated risk for environmental variation, genetic complications, demographic stochasticity, negative ecological feedback, and catastrophes (NMFS & USFWS, 2020). Site fidelity results in the dispersal of nests among various beaches which may help to reduce population level impacts disproportionately affecting one area over another, but may also place nests in locations that are likely unmonitored and not protected from human poaching or predation, thereby increasing threats to the population (NMFS & USFWS, 2020). Nest success rates increased from about 35% prior to 2017 to over 50% from 2017 to 2019, due to increased conservation efforts to protect nests from predation, tidal inundation, erosion and high sand temperatures (Pakiding et al., 2020).

Based on NMFS's Population Viability Analysis (PVA) model (Martin et al., 2020b; Siders et al., 2023), leatherback abundance in the West Pacific population has been declining ~6% per year from 2001-2017 (95% CI: -23.8% to 12.2%). Leatherback abundance in the CCE foraging area declined by a mean of 5.6% per year (95% CI: -9.8% to -1.5%) over a similar timeframe (1990 to 2017) (Benson et al., 2020). This indicates the 6.0% per year decline (Martin et al., 2020) may be mirrored in the large juvenile and male portions of the North Pacific population. Therefore, we consider the Martin et al. (2020b) trend in annual nest counts an accurate index of the population's growth rate through 2017, although we acknowledge that these declines may not have occurred or continued in recent years given some of the recent nesting data. Monitoring at most other sites (i.e., not Jamursba-Medi or Wermon) has not been going on long enough to establish trends or abundance. However, six years of data from a newly established monitoring program on Buru Island, Indonesia estimates about 103 adult female nesters, which indicates an increasing trend of 10.1% per year (95% Confidence Interval: -26.1% to 46.3%) (NMFS 2023d).

We note that the nesting data from 2018 to 2021 in Figure 7 are preliminary and only provided to NMFS from the authors (Lontoh et al. in prep) as the figure shown in Figure 7. Until we receive the detailed raw monthly data from the nesting beaches, the growth trend analysis of Martin et al. (2020a, 2020b) cannot be updated. Therefore, since we do not have any updated modeled estimates of future growth rates based on this new information, we rely on the estimates of Martin et al. (2020a, 2020b) for current population growth rates. In addition, given the substantial declines in the population from 1984 to 2012, the data from 2012 to 2021 are likely not of long enough duration to definitely state that the population is now at least stable, but this may be reevaluated when raw data are available for analysis. NMFS (2023d) notes that New Zealand shallow-set longline fishery has shown a marked increase in leatherback interactions, from a low of one in 2008 to a high of 50 in 2022, which indicates a 19.9 % increase in interactions per year from 2008-2022 (CI: 8.4% to 31.3%). While fishery captures can be influenced by numerous environmental factors that can disconnect them from population trends, NMFS postulates that the strength of the trend suggests the potential for more leatherback turtles in the water in recent years.

Martin et al. (2020b) estimated the mean and median time until the West Pacific population declines to 50%, 25%, and 12.5% of its 2017 estimated abundance, and Siders et al. (2023) updated these results to 2021, assuming the population declined at a rate of 6% per year from the 2017 estimates. Results of updated modeling from Siders et al. (2023) indicate the adult female portion of West Pacific leatherbacks nesting at Jamursba-Medi and Wermon beaches are predicted to decline to 50% of their 2017 abundance in approximately 9 years starting in 2021 (or by 2030; 95% CI from 1 to 22 years) and to 25% of their 2017 abundance in approximately 20 years (or by 2041; 95% CI from 8 to 37 years).

Table 4: Estimated total number of nesting females for Jamursba-Medi and Wermon beaches from Martin et al. (2020b). L95% = lower 95% credible limit and U95% = upper 95% limit. Median, Low and High correspond to the median and lower and upper limits of the annual estimated number of nests from the imputation process.

	L95%	**Median**	**U95%**
Median	666	790	942
Low	425	515	634
High	1,052	1,224	1,425

East Pacific Leatherbacks

NMFS and USFWS (2020) estimated a minimum index of total nesting females in the Eastern Pacific population at 755 females based on monitoring data with 76% of nesting occurring on beaches in Mexico (572 females), 22% (165 females) in Costa Rica and 2% (18 females) in Nicaragua (Santidrian et al., 2017; Swiggs et al., 2018). This calculation considers the most recent 4-year remigration interval data from monitored nesting beaches in Costa Rica, Nicaragua, and approximately 70-75% of the total nesting areas in Mexico, equating to ~75% of all nesting for this population (NMFS & USFWS 2020). Considering a sex ratio of 79% female (Santidrián Tomillo et al., 2014), the total adult population is estimated at 1,274 individuals, both male and female in 2020. Though total population size data is lacking, extrapolations based on juvenile to adult ratios (Jones et al., 2012), estimates suggest a total population size of 60,611 individuals in 2020.

Historically, this population in Mexico alone possessed an estimated 75,000 adult leatherback females (Pritchard, 1982), yet has experienced a substantial decline over recent decades. The

East Pacific leatherback population has undergone dramatic declines over the last three generations (Wallace et al. 2013; NMFS and USFWS 2020), and to date there is no sign of recovery. In Costa Rica, a 15.5% annual rate of decline in nesting females has been documented at Las Baulas from 1988/1989 through 2015/2016 (NMFS and USFWS 2020). In Mexico, a positive trend has been recorded at some nesting beaches (i.e., Barra de la Cruz/Playa Grande +9.5% annually), but a negative trend has been recorded in other areas (i.e., Cahuitan -4.3% annually over the same period). Based on high nest numbers and mean trends across four index beaches (i.e., Tierra Colorada, Barra Cruz/Grande, Cahuitan, and Las Baulas), NMFS (2023d) estimate a weighted average trend of -8.1% for the East Pacific leatherback population.

Pacific leatherback recovery is partially defined by each population averaging an annual 5,000 females nesting over 6 years, and all nesting populations stable or increasing over a 25-year monitoring period (NMFS & USFWS, 1998). However, both Pacific populations are not on track to meet these criteria and are deemed at high risk of extinction due to reduced female nesting abundance, declining nest trends, and other compounded threats.

Reproduction

Leatherback turtles reproduce by depositing eggs on beaches and hatchlings developing and self-releasing into nearby oceanic waters. Pregnant individuals prefer nesting beaches with minimal abrasive material, wide and lengthy banks, soft bottoms, deep water approaches to minimize energy expenditure, and proximity to ocean currents to facilitate hatchling dispersal (Eckert et al., 2015). Adult females typically attain maturity on average at 17 years (range = 12-28) and display variations in clutch numbers and frequencies (Avens et al., 2020). In Indonesia, the mean size of nesting females is 161 cm curved carapace length (CCL) with an observed minimum of 138 cm CCL (Hitipeuw & Maturbongs, 2002; Lontoh, 2014). Productivity levels can vary across populations with certain studies indicating individuals foraging in the northeast Pacific Ocean display greater body size and longer remigration intervals than those foraging in the South China Sea or North Pacific Transition Zone (Benson et al., 2011; Lontoh, 2014). The range of remigration intervals is 1-6 years, and the mean remigration interval was greater for the Northeast Pacific foraging group (4 ± 0.3 years) than the North Pacific Transition Zone foraging group (2.3 ± 0.4 years) and the South China Sea foraging group (2.9 ± 0.4 years) (Lontoh 2014). Mean clutch frequency varied, but was higher for the North Pacific Transition Zone foraging group (6.1) than the Northeast Pacific (5.6) and South China Sea (4.8) foraging groups and increased with turtle size (Lontoh 2014).

The Western Pacific population engages in nesting activities year-round, with a subset nesting from November to February (winter) and other nesting from May to September (summer) (NMFS & USFWS 2020). Females typically remain within 300 km of their respective beaches during nesting season (Benson et al., 2007a; Benson et al., 2007b; Benson et al., 2011). Tapilatu et al. (2013)t indicate an average clutch frequency of 5.5 (3-10 range) for individuals from

Jamursba-Medi and Wermon beaches, with mean clutch sizes across the West Pacific population ranging from 76-94 eggs per nest (Tapilatu and Tiwari 2007; Pilcher 2011; Jino et al. 2018) (Tapilatu & Tiwari, 2007; Pilcher & Chaloupka, 2013; Jino et al., 2018). The mean hatchling emergence success ranges from 25-60%(NMFS and USFWS 2020).

The Eastern Pacific population predominantly nests along the beaches of Mexico, Nicaragua, and Costa Rica with sporadic occurrences reported in Guatemala, El Salvador, Panama, Colombia, and Ecuador (IAC, 2012). Crucial nesting beaches include: Tierra Colorada, Cahuitan, and Mexiquillo in Mexico and Las Baulas National Park, Playa Grande, Playa Langosta, and Playa Ventanas, Naranjo, Ostinonal, Cabuyal, and Caleta beaches in Costa Rica (NMFS and USFWS 2020). Nesting activities occur from October to March. Mean remigration intervals range from 3 to 3.7 years, with clutch size ranging from 62 to 65 eggs (NMFS & USFWS 2020). Mean sizes of nesting females in this population range from 144 to 147 cm CCL with a minimum observed size of 125 cm CCL at Playa Langosta, Costa Rica (NMFS & USFWS 2020). The mean hatchling emergence success ranges between 25 and 60% in the West Pacific and 35 to 52% in the East Pacific (NMFS & USFWS 2020).

Limiting Factors and Threats:

The primary ongoing threats to leatherback sea turtles worldwide are fisheries bycatch, legal and illegal directed harvest, alteration of nesting habitat, predation, interactions with pollutants and marine debris, and entanglements with marine debris (NMFS & USFWS 2020). Other threats include changing environmental conditions due to climate change (land change use resulting in hotter beaches without ample shade, sand temperatures resulting in egg or hatchling mortality or changes in sex ratios, erosion of nesting beaches due to rising sea levels and/or increased storm frequency and magnitude), and vessel strikes (Tiwari et al. 2013; NMFS and USFWS 2020). Below, we summarize the main anthropogenic threats facing both the West and East populations including climate change, illegal and legal harvest, and inadequate regulatory mechanisms.

Climate change poses a threat to both the East and West Pacific leatherback populations. For leatherbacks during their pelagic life phase, impacts include increased temperatures in the ocean possibly leading to changes in oceanographic regimes, currents, and prey distribution. Leatherbacks are known to travel within specific isotherms and a changing ocean may affect environmental cues these turtles use to navigate to these isotherms. This can influence thermoregulation, bioenergetics, prey availability and foraging success during migration. A warming ocean may also affect the environmental variables of their foraging habitat and, subsequently, prey distribution, which may further exacerbate population declines (NMFS and USFWS 2020).

On nesting beaches, climate change can increase sea levels and the rate of coastal erosion and increase the frequency and intensity of storms. Leatherback nests and eggs will be affected by the resulting changes in beach morphology and sand temperatures, impacting nesting and hatchling success (Benson et al. 2015, Tapilatu & Tiwari 207; Bellagio Steering Committee 2008; NMFS & USFWS 2013). Sand temperatures fluctuate between 28.6° and 34.9 °C at Jamursba-Medi and between 27.0° and 32.7 °C at Wermon (Tapilatu and Tiwari 2007). Despite black sand at Wermon beaches, sand temperatures during nesting season are lower, perhaps because peak nesting coincides with the monsoon season (Tapilatu and Tiwari 2007). Similar to other sea turtles, leatherback hatchling success is determined by nest incubation temperature and higher incubation temperatures skew the hatchling sex ratio to favor females, producing a greater proportion of females (Mrosovsky 1994). There was evidence of this bias for the West Pacific population at Jamursba-Medi nesting beaches (Tapilatu and Tiwari 2007; Tapilatu et al. 2013) and for the East Pacific population at the Playa Grande nesting beach in Costa Rica (Plotkin 1995, Binckley et al. 1998). West Pacific leatherbacks have evolved to sustain changes in beach habitats to select highly dynamic and narrow beach habitats, allowing the population to sustain a certain level of nest loss (NMFS & USFWS 2020). Despite these adaptations, the increasing frequency and magnitude of storms and flooding events predicted to come with climate change can exacerbate nest loss. Saba et al. (2012) predicted the Playa Grande, Costa Rica nesting population would decline 7% per decade over the 21st century. Changes in beach conditions and the resulting reduced hatchling success and emergence rates contribute to this expected decline. Natural factors, including the 2004 tsunami in the Indian Ocean (see detailed report by Hamann et al. 2006) and the tsunami that affected Japan in 2011, may have impacted leatherback nesting beach habitat through encroachment and erosion (2004 tsunami) or may have resulted in increased debris into leatherback marine habitat (e.g., impacting migratory routes and foraging hotspots). Shifting mudflats in the Guianas have also made nesting habitat unsuitable (Crossland 2003; Goverse and Hilterman 2003).

Climate change prediction models, coupled with leatherback movements (through satellite telemetry) showed slightly favorable habitat conditions by expanding adult leatherback range and creating new foraging areas in the eastern Pacific over the same time period. Climate change may also contribute to shifts in the distribution and abundance of jellyfish, which is a primary prey resource for leatherbacks. Jellyfish abundance and distribution can vary due to

climate-induced changes, potentially disrupting leatherback foraging ecology. Some studies suggest rising temperatures increase jellyfish abundance, consequently enhancing metabolic accessibility to leatherbacks (Brotz et al. 2012). Results from Gomes et al. (2024) indicate elevated sea surface temperatures in the CCE prompt decreases in more energetically dense jellyfish populations and increases in energetically poor pyrosomes. Given leatherbacks' specialized diet of jellyfish, however, researchers found it difficult to determine how potential changes in prey distribution due to climate change would affect leatherback population (Hazen et al. 2012), particularly since increased jellyfish populations are often associated with warming caused by climate change (Purcell et al. 2007). Although leatherbacks are known to consume both jellyfish and pyrosomes, the switch to a less energetically dense resource could have impacts on the reproduction and survivability of the species. Temperature can also reorganize the distribution of important prey items, typically poleward and into deeper waters, which can further disrupt the foraging ecology of leatherback sea turtles given their high degree of overlap with jellyfish hotspots (Nordstrom et al. 2020). Changes in oceanographic conditions, such as currents and upwelling patterns, can disrupt nutrient cycling and primary productivity, reducing trophic efficiency from the bottom up (Polovina et al. 2008; Ullah et al. 2018). These alterations in prey items can lead to mismatches between leatherback distribution and prey availability, resulting in reduced foraging success and potential nutritional stress.

Currently, we cannot reliably predict the magnitude of future climate change and the impacts on leatherback sea turtles. The existing data and current scientific methods and analysis are not able to predict the future effects of climate change on this species or allow us to predict or quantify this threat to the species (Hawkes et al. 2009). Uncertainty remains related to leatherback nesting beach trend forecasts and correlations with climate indices.

The destruction or modification of habitat is a threat at many nesting beaches used by the East Pacific leatherback population. In Costa Rica, coastal development along the northern and southern ends of the nesting beach at Playa Grande in Las Baulas National Park and in the town of Tamarindo has resulted in the loss of nesting beach habitat in addition to the removal of much of the natural beach vegetation. In addition to the loss and degradation of nesting beach habitat, stressors associated with development include pollution from artificial light, solid and chemical wastes, beach erosion, unsustainable water consumption, and deforestation. In Mexico, the extent of development near nesting beaches is generally low, given the remoteness of the beaches in Baja California and on the mainland (NMFS and USFWS 2020).

Leatherbacks are vulnerable to bycatch in a variety of fisheries, including longline, drift gillnet, set gillnet, bottom trawling, dredge, and pot/trap fisheries that are operated on the high seas or in coastal areas throughout the Pacific Ocean. Bycatch of leatherback turtles has been documented for a variety of gillnet and longline fisheries in the Pacific Ocean, but little is known about the total magnitude or full geographic extent of mortality (NMFS and USFWS 2020). Detailed bycatch data are available for U.S.-managed pelagic fisheries operating in the central and eastern Pacific Ocean due to regulatory mandates and high levels of observer coverage. Off the U.S. West Coast, a large time/area closure was implemented in 2001 to protect Pacific leatherbacks by restricting the federal large mesh drift gillnet (DGN) fishery, which significantly (at least 80%) reduced bycatch of leatherbacks in that fishery. On the high seas, bycatch in longline fisheries is considered a major threat to leatherbacks (Lewison et al. 2004).

The summer nesting component of the population exhibits strong site fidelity to the central California foraging area (Benson et al. 2011), which puts migrating leatherbacks at risk of interacting with U.S. and international pelagic longline fleets operating throughout the Central and North Pacific oceans. Fishery observer data collected between 1989 and 2015 from 34 purse seine and longline fleets across the Pacific documented a total of 2,323 sea turtle interactions, of which 331 were leatherback turtles (Clarke 2017). Two bycatch hotspot areas were identified: one in central North Pacific (which likely reflects the 100% observer coverage in the Hawaii SSLL fishery) and a second hotspot in eastern Australia (Hays et al. 2023). These data are unlikely to be representative of all bycatch hotspots as the data are driven by the presence of fishery observer programs, which are not extensive and are concentrated in certain nations' fishing fleets.

There are interactions between leatherbacks and domestic longline fishing for tuna and swordfish based out of Hawaii. Prior to 2001, an estimated 110 leatherback turtles were captured annually in all Hawaii longline fisheries combined, resulting in approximately nine annual mortalities (McCracken 2000). Under requirements established in 2004 to minimize sea turtle bycatch (69 FR 17329), vessel operators in the Hawaii-based shallow-set longline (SSLL) swordfish fishery must use large (sized 18/0 or larger) circle hooks with a maximum of 10 degrees offset and mackerel-type bait. In addition, NMFS requires 100% observer coverage in this fishery, so every interaction is observed. The 2004 management measures introduced to the Hawaii longline fisheries have demonstrably reduced leatherback sea turtle interaction rates by 83% (Gilman et al. 2007a; Swimmer et al. 2017). Between 2004 and 2017, there have been 99 total leatherback turtle interactions in the SSLL fishery (or approximately eight leatherback turtles annually), based on 100% observer coverage (WPFMC 2018). From 2012-2017, the incidental take statement for the Hawaii-based SSLL fishery was 26 leatherback sea turtles per year, which served as the "hard cap" for the fishery that requires closure of the entire fishery during any year if reached. Recently, the hard cap for leatherback sea turtle bycatch was reset to 16 per year, with the expectations that up to 16 may be caught and 3 may be killed each year, and that vessels would be restricted to no more than 2 leatherbacks taken during any one trip (NMFS 2019b). Between 2004 and 2022, there were a total of 121 leatherback sea turtles captured in the Hawaii-based SSLL fishery, with zero leatherback sea turtles observed killed as a result, but an estimated 21% of those killed given post-interaction mortality estimates (NMFS 2019b; updated in NMFS 2023c). From 2004-2018, NMFS estimated that the Hawaii-based SSLL fishery annually interacted with around 21 leatherbacks/year, with an estimated 3 dead per year (given also post-interaction mortality) (NMFS 2019b).

Between 2002 and 2016, an estimated 166 leatherback interactions have occurred in the Hawaii-based deep-set longline (DSLL) fishery (or approximately 11 annually) (McCracken 2019). From the 2014 biological opinion for the Hawaii DSLL fishery (NMFS 2014), the estimated future interactions for leatherbacks is 24 annual interactions resulting in 9 mortalities. From 2004-2022, the Hawaii DSLL fishery (~20% observer coverage) was observed to interact with 46 leatherbacks, with an estimated 246 taken (around 13/year). On average, a mean of 17 (95th percentile: 43) were anticipated to be captured. When at-vessel and post-release mortality rates are combined, the effective mortality rate in this fishery is 35%, resulting in a mortality rate of 6 turtles to die each year. The current anticipated take level (incidental take statement) over a 5-year period (running sum) is 92 leatherbacks (interactions, injuries and/or mortalities) (NMFS

2023c). Based on updated fishery interaction, take distribution, and population benchmark data, Siders et al. (2023) used a probability of maturity approach to estimate an expected mortality from the Hawaii DSLL fishery of 0.37 annual nesters per year.

In the current West Coast DSLL fishery operating outside of the U.S. West Coast EEZ, NMFS has anticipated that four leatherbacks could be taken every 10 years, with two of those resulting in mortality (NMFS 2016a). Up to this point, no leatherback interactions have been reported in the West Coast DSLL fishery since 2005.

Observer coverage of the American Samoa longline fishery has varied over time from 5% to 40% and has had an estimated 55 leatherback interactions between 2010 and 2017 (McCracken 2019). From the 2023 American Samoa longline fishery biological opinion (NMFS 2023b), the mean number of leatherback sea turtles from the West Pacific population that are likely to be captured by this fishery in any given year is 10 (95th Percentile: 30), given observer data from 2010 to 2019. With an estimated total mortality rate (at-vessel and post release) of 65%, approximately 7 leatherbacks (95th percentile: 20) would be killed per year. Over the next 10 years, NMFS anticipates that the fishery will interact with 17 adult leatherback turtles resulting in the mortality of 4 adults, 3 of which would be females (NMFS 2023b).

Estimating the total number of sea turtle interactions in other Pacific fisheries that interact with the same sea turtle populations as U.S. fisheries is difficult because of low observer coverage and inconsistent reporting from international fleets. Lewison et al. (2004) estimated 1,000 – 3,200 leatherback mortalities from pelagic longlining in the Pacific in 2000. Beverly and Chapman (2007) more recently estimated leatherback longline bycatch in the Pacific to be approximately 20% of that estimated by Lewison et al. (2004), which would equate to 200 – 640 leatherbacks during that time period. Chan and Pan (2012) estimated that there were approximately 1,866 total sea turtle interactions of all species in 2009 in the Central and North Pacific by comparing swordfish production and turtle bycatch rates from fleets fishing in the Central and North Pacific area. In 2015, a workshop convened to analyze the effectiveness of sea turtle mitigation measures in the tuna regional fishery management organizations and 16 countries (including the United States, which reported 27% of the interactions) provided data on observed sea turtle interactions and gear configurations in the Western Central Pacific Ocean. Based on the information gathered there, 331 leatherback sea turtles were reported, leading to a total estimate of 6,620 leatherbacks caught in the region from 1989-2015 in these countries (mortality rates were not reported (Common Oceans (ABNJ) Tuna Project 2017). Most recently, Peatman et al. (2018) estimated that 24,006 leatherbacks were captured in longline fisheries operating in the North Pacific from 2003-2017. Finally, bycatch estimates of sea turtles were summarized from annual reports by the Western and Central Pacific Fisheries Commission (WCPFC) (2021). Sea turtle data included U.S. fishery data, with the Hawaii-based DSLL fishery representing 5 to 6% of the total hooks set by Western Central Pacific Ocean longline fisheries. From 2013 to 2020, an average of 722 leatherbacks (CI: 468 – 976) were caught annually, with an estimated 76 leatherbacks (CI: 16 – 136) killed per year. With low observer coverage in these international fleets (~3%), confidence in these estimates are low. Nonetheless, we have more confidence in understanding the effects of our domestic longline fisheries, given 100% observer coverage in the Hawaii-based SSLL fishery and approximately 20% observer coverage in the Hawaii-based DSLL fishery, and variable coverage in the American Samoa longline fishery.

The U.S. tuna purse seine fishery operating in the Western and Central Pacific Ocean interacted with approximately 16 leatherback turtles between 2008 and 2015 based on observer coverage ranging from 20 to 100 percent (NMFS and USFWS 2020). The anticipated future interactions of leatherbacks for this fishery is estimated to be 11 sub-lethal interactions per year, and mortalities are not anticipated from this fishery.

Historically, significant leatherback bycatch was documented in the North Pacific high seas driftnet fishery, which expanded rapidly during the late 1970s, and was banned in 1992 by a United Nations resolution (summarized in Benson et al. 2015). High seas driftnet fishery bycatch was likely a significant contributor to the population declines observed at nesting beaches during the 1980s and 1990s (Benson et al. 2015). Bycatch in small-scale coastal fisheries has also been a significant contributor to leatherback population declines in many regions (Kaplan 2005; Alfaro-Shigueto et al. 2011), yet there is a significant lack of information from coastal and small-scale fisheries, especially from the Indian Ocean and Southeast Asian region (Lewison et al. 2014).

In summary, West Pacific leatherbacks are exposed to high fishing effort throughout their foraging range, nesting range, and migratory pathways, though very little fisheries data are available for coastal areas (NMFS and USFWS 2020). Bycatch rates in international pelagic and coastal fisheries are thought to be high, and these fisheries have limited management regulations despite hotspots of high interactions (Lewison et al. 2004; Alfaro-Shigueto et al. 2011; Wallace et al. 2013a; Clarke et al. 2014; Lewison et al. 2014; Clarke 2017). Annual interaction and mortality estimates are only available for U.S.-managed pelagic fisheries, which operate under fisheries regulations that are designed to minimize interactions with and mortalities of endangered and threatened sea turtles (NMFS and USFWS 2013; Swimmer et al. 2017; NMFS and USFWS 2020).

Bycatch in commercial and recreational fisheries, both on the high seas and nearshore, is considered the primary threat to the East Pacific leatherback population (NMFS and USFWS 2020). Juvenile and adult leatherbacks are exposed to high fishing effort throughout their foraging and nesting ranges. Mortality is also high in some fisheries, with reported mortality rates of up to 58% due in part to gillnet use and consumption of bycaught turtles in Peru (NMFS and USFWS 2020). While efforts by individual nations and regional fishery management organizations have, to some extent, mitigated and reduced bycatch, this stressor remains a major threat to the East Pacific leatherback population (NMFS and USFWS 2020).

Given that recent developments to reduce sea turtle bycatch in fisheries have been working their way into some international fisheries, and the incomplete datasets and reporting that exists, the exact level of current sea turtle bycatch internationally is not clear. However, given the information that is available, we believe that international bycatch of sea turtles in fisheries throughout the Pacific Ocean continues to occur at significant rates several orders of magnitude greater than what NMFS documents or anticipates in domestic U.S. Pacific Ocean fisheries.

In an attempt to develop a tool for managers to use locally (e.g. in an EEZ) to reduce threats in a particular area of interest, Curtis et al. (2015) developed biological "limit reference points" for western Pacific leatherback turtles in the U.S. West Coast EEZ, similar to a PBR approach calculated for marine mammal stocks. Depending on the model used, various objectives sought, and incorporation of conservative assumptions accounting for broad uncertainty in abundance and productivity estimates, the limit reference point estimate for human-caused removals in the

U.S. West Coast EEZ ranged from 0.8 to 7.7 leatherbacks over 5 years. Although these results are useful for consideration, NMFS is not currently using this approach to manage threats to sea turtles foraging within the U.S. EEZ pending further discussion of how this approach or other approaches relate to the standards of the ESA. We anticipate that the management tool presented by Curtis et al. (2015) and other approaches to managing threats to sea turtles will continue to be subject to future discussion by scientific and policy experts.

Marine debris represents a potential stressor for the East and West Pacific leatherback populations, although the impacts remain unquantified. Leatherback turtles can ingest marine debris, causing internal damage and/or blockages. Larger debris can entangle animals, leading to reduced mobility, starvation, and death. Given the amount of floating debris in the Pacific Ocean within the range of the West Pacific population, marine debris has the potential to be a significant threat, however the impact is unquantified (NMFS and USFWS 2020). Lebreton et al. (2018) estimated plastic debris accumulation to be at least 79,000 tons in the Great Pacific Garbage Patch, a 1.6 million km^2 area between California and Hawaii. Leatherback turtles feed exclusively on jellyfish and other gelatinous organisms and as a result may be prone to ingesting plastic items resembling their food source (Schuyler et al. 2014; Schuyler 2014). Few studies have addressed the susceptibility of West Pacific leatherbacks to plastic marine debris ingestion, or the magnitude of the risk this potential stressor represents. Entanglement in ghost fishing gear is also a concern (Gilman et al. 2016), and derelict nets account for approximately 46% by piece, and 86% by weight, of debris floating in the Great Pacific Garbage Patch (Lebreton et al. 2018).

The South Pacific Garbage Patch, discovered in 2011 and confirmed in mid-2017, contains an area of elevated levels of marine debris and plastic particle pollution, most of which is concentrated within the ocean's pelagic zone and in areas where East Pacific leatherbacks forage for many years of their life (NMFS and USFWS 2020). This garbage patch is located within the South Pacific Gyre, which spans from east of Australia to the South American continent and as far north as the equator. Entanglement in, and ingestion of marine debris and plastics is a threat that likely kills or injures individuals from this population each year; however, data are not available because most affected turtles are not observed.

Inadequate International Regulatory Mechanisms: Legal and Illegal Harvest

One threat to the West Pacific population outside of the U.S. is the legal and illegal harvest of leatherback turtles and their eggs. The removal of nesting females from the population reduces both abundance and productivity; egg harvest reduces productivity and recruitment. Regulatory mechanisms exist in all four nations (Indonesia, Papua New Guinea, Solomon Islands, and Vanuatu) where this population nests, but enforcement is often lacking due to remote nesting beaches, customary ownership of natural resources, and limited institutional capacity and funding for enforcement (Kinch, 2006; Gjertsen & Pakiding, 2011; NMFS & USFWS, 2020).

Directed killing of juvenile and adult leatherbacks has been documented in all four countries where this population nests (Suarez & Starbird, 1995; Dutton et al., 2007; Steering Committee, 2008; Kinch et al., 2009; Jino et al., 2018). Efforts to quantify and reduce directed take are ongoing, but past and current threats from egg and turtle harvest remain widespread throughout the West Pacific leatherback range (Steering Committee, 2008; NMFS & USFWS, 2013; Tiwari et al., 2013; Tapilatu et al., 2017). In Indonesia, the direct harvest of turtles and eggs likely persists, although this threat has been minimized at Jamursba-Medi, Wermon, and Buru Island beaches due to the presence of monitoring programs and associated educational outreach activities (NMFS & USFWS, 2020). In the Maluku islands of Indonesia, several villages of the Kei islands have engaged in an indigenous hunt (directed fishery) of juvenile and adult leatherback turtles foraging in coastal habitats for decades. While recent programmatic efforts are working to monitor and reduce this impact, the hunt was historically estimated to take over 100 leatherback turtles annually (Suarez & Starbird, 1995; NMFS & USFWS, 2020). Since 2017, the harvest has declined significantly from the high of over 100 leatherbacks in 2017, to less than 25 in 2019-2021, including only 9 turtles in 2021 (92% reduction; J. Wang, NMFS-PIFSC, personal communication, 2022). In Papua New Guinea, egg harvest and killing of nesting females is still a major threat despite the fact that leatherback turtles have been protected since the 1976 Fauna (Protection and Control) Act. The killing of nesting females and directed harvest of eggs in Vanuatu and the Solomon Islands is also well documented (Steering Committee, 2008; NMFS & USFWS, 2013, 2020).

The conservation of leatherback sea turtles internationally is hampered by inadequate regulatory mechanisms, which ultimately contribute to mortality of these endangered creatures. Legal and illegal harvest of turtles and their eggs persist despite existing laws, which are often poorly enforced or outright ignored (Kinch, 2006; Gjertsen & Pakiding, 2011). While relocation of nests is a common mitigation strategy, it has not been sufficient to counteract the nearly 90% decline in egg harvest over two decades, severely depleting certain leatherback populations (Martínez et al., 2007; Santidrián-Tomillo et al., 2008; B. Wallace & Saba, 2009). Traditional rights are sometimes perceived as superseding conservation laws, further complicating enforcement efforts. Leatherbacks face overutilization for various purposes including commercial trade, recreation, scientific research, and education, exacerbating their decline.

In Mexico, the harvest of turtles and eggs is now prohibited as a result of national legislation. In Costa Rica, establishment of Parque Nacional Marino Las Baulas in 1991 ensured increased protection at three nesting beaches (Playa Grande, Playa Ventanas, and Playa Langosta), greatly reducing egg poaching in the area. Though conservation efforts have reduced the levels of both, egg poaching remains high and affects a large proportion of the East Pacific breeding population. Despite international efforts such as the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) and CITES, regulatory mechanisms remain inadequate. The Eastern Pacific Leatherback Network and regulations imposed by the Inter-American Tropical Tuna Commission (IATTC), such as requiring longline vessels to carry observers since 2015 and promoting the use of circle hooks, aim to mitigate threats, yet challenges persist. Illegal, unreported and unregulated (IUU) fishing, particularly rampant in countries like Mexico, further exacerbates the issue. Moreover, a lack of institutional capacity and funding for enforcement, coupled with the remoteness of nesting beaches and government-led legislation that may clash with traditional practices, complicate conservation efforts. These systemic shortcomings underscore the urgent need for strengthened regulatory frameworks and increased community engagement to effectively protect leatherback sea turtles from human-induced mortality. Despite best efforts from governmental organizations, international regulatory mechanisms can fall short of conservation goals. Many fisheries (pelagic longline, shallow-set longline, gillnet) with known interactions with leatherback sea turtles require observers to be onboard during fishing activity to monitor and quantify fishery interactions with turtles and other bycatch species. Due to spatially limited coverage and a reduced observer coverage rate (Panizza et al. 2022, Peatman et al. 2023), available observer data doesn't create an accurate representation of overall fishing effort across international fisheries. Although there are some requirements for observer coverage in how much effort is observed in international fisheries, coverage is lower than mandated and varies across international fleets and gear types (Lewison et al. 2014, Mace et al. 2014, Panizza et al. 2022). With gaps in the data, it is difficult to accurately describe how often leatherback sea turtles are interacting with international fisheries as bycatch and how lethal these interactions may be.

In response to decreasing numbers of leatherback turtles, governments have put in efforts to discourage harvest of leatherbacks and their eggs. The take of turtle eggs is tied to cultural demand or because it is an accessible source of protein for locals. In Costa Rica, poachers removed 90% of eggs each nesting season for 15-20 years until Las Baulas Marine National Park was established in 1991 (Santidrian Tomillo et al. 2017, 2008). Beach protections and enforcement has reduced poaching to less than 1% each year at Las Baulas but such a large reduction in poaching is not always the case for other nesting beaches worldwide

(Mejias-Balsalobre et al. 2021). Continued poaching of eggs despite beach protections may also be due to lack of funding, personnel or other resources needed to patrol large stretches of nesting beaches or the extreme remoteness of beaches (Kinch 2006, Santidrian Tomillo et al. 2008, Gjertsen and Pakiding 2011, Tapilatu 2014, Von Essen et al. 2014, NMFS & USFWS 2020). A 2017 survey in Costa Rica at Tortuguero found 28.6% of leatherback nests were poached (Restrepo et al. 2018, Mejias-Balsalobre et al. 2021). Despite protections in place and the promotion of sea turtles as a source of income via ecotourism, those who do not benefit from the tourism industry may still poach sea turtles and their eggs (Hart et al. 2013, Mejias-Balsalobre et al. 2021). This consumptive use of turtles and their products has been identified as a major challenge to marine turtle conservation in the Caribbean Basin (Barrios-Garrido et al. 2020, Mejias-Balsalobre et al. 2021).

Conservation:

Considerable effort has been made since the 1980s to document and address leatherback sea turtle bycatch in fisheries around the world. Observer programs have been implemented in most U.S. federally managed fisheries to collect bycatch data and several strategies have been pursued to reduce both bycatch and post-interaction mortality. Some of these methods include gear solutions to prevent or reduce capture (e.g. circle hooks, fin-fish bait), turtle exclusion devices, seasonal time-area closures, and developing and promoting sea turtle handling guidelines. For example, switching to large circle hooks and mackerel-type bait in 2004 with complimentary fishery-based outreach and education resulted in an 84% reduction in the leatherback sea turtle interaction rate in the Hawaii SSLL fishery (Swimmer at al. 2017, NMFS 2024d). In addition, in 2020, NMFS issued a final rule for the SSLL fishery that reduced the annual interaction limit from 26 to 16 for leatherbacks, and included trip (not more than 2 leatherbacks per vessel trip) and vessel (vessels that reach the trip limit twice in a calendar year are prohibited from the fishery for the remainder of the year) limits (85 FR 57988).

NMFS developed a 5-year action plan (2016-2020) identifying the top five recovery actions to support leatherbacks: reduce fishery interactions, improve nesting beach protection and increase reproductive output, international cooperation, monitoring and research, and public engagement (NMFS 2016c). This initiative was recently renewed in 2021 to be implemented from 2021-2025 and is called the Species in the Spotlight Action Plan (NMFS 2021b).

Community-based conservation projects in Wermon and Jamursba-Medi in Papua, Barat, Papua New Guinea, Solomon Islands, Vanuatu, Mexico, Costa Rica, Nicaragua have been developed to monitor and protect nests from harvest and predation, increasing the production of hatchlings from these nesting areas. Specifically, within Jamursba-Medi and Wermon, hatchling production increased from a mean of 21,966 hatchlings each year between 2005-2013, to 32,000-50,000 hatchlings per year from 2017-2019 (Tapilatu 2014; Pakiding et al. 2020). Nest success rates increased from about 35% prior to 2017 to over 50% since 2017. At Buru Island, a multi-year action plan developed with the involvement of local government agencies, local village elders, and community members continues to be implemented. When the plan was first implemented in 2017, over 60% of nests and even some nesting females were being poached or predated for local consumption partially fueled by cultural demand. By 2022, less than 1% of nests were being poached with no nesting females taken (NMFS 2023d). World Wildlife Fund (WWF)-Indonesia works to monitor and reduce the poaching of leatherbacks in the Kei Islands, Indonesia, and has documented an 86% reduction in leatherback take between 2017-2022 (NMFS 2023d). Recently, management and conservation practices have included relocating erosion-prone nests in Indonesia, Papua New Guinea, and the Solomon Islands to bolster hatchling production (NMFS and USFWS 2020).

The conservation and recovery of leatherbacks is facilitated by a number of regulatory mechanisms at international, regional, national, and local levels. The Food and Agriculture Organization (FAO) issues guidelines on how to reduce interactions between sea turtles and fishing gear then summarizes these interactions in formal reports. The IAC is an intergovernmental treaty providing a legal framework for countries in the American Continent to take actions benefiting sea turtles. Under CITES, sea turtles are prohibited from being commercially traded internationally. Despite a ban on global trade of leatherback turtles, the sale and trade of this species still occurs at local levels. Many non-profit organizations such as the WWF and the Nature Conservancy partner with government and local groups to support conservation efforts and discourage the consumption of these sea turtles. Local governments, particularly those with known nesting beaches for leatherback turtles, also implement conservation measures such as beach closures or marine protected areas to protect turtles, their nests, eggs and hatchlings from human interactions. The WCPFC has passed many conservation and management measures (CMMs) that have resulted in reducing the harvest of eggs and adults at several nesting areas, and promoting a number of community-based initiatives to help reduce the harvest of turtles.

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For the PCGF, the action area includes the U.S. EEZ of the northeast Pacific Ocean that lies between the U.S.-Canada border (as specified in Federal Register, Volume 42, Number 44, March 7, 1977, page 12938) and the U.S.-Mexico border (Figure 8), as fishing activity in the PCGF occurs throughout the entire U.S. West Coast EEZ. The action area also includes areas where PCGF vessels transit through state waters and land fish within ports scattered across the entire U.S. West Coast. These routes are not specifically defined given the variable nature of PCGF vessel traffic, and are assumed to include all state waters of Washington, Oregon, and California.

Several areas within the geographic extent of the action area are closed to PCGF activities. As described in Section 1.3.9 (*Closed Areas That Apply to All Groundfish Fisheries*), there are conservation areas defined by depth contours (or latitude/longitude coordinates that are intended to approximate particular depth contours) which are closed to all groundfish activities in order to protect rockfish, cowcod, and groundfish species from overfishing, as well as protect essential habitat for groundfish (Sections 1.3.9-1.3.9.10)

Although the state-managed groundfish fisheries in state waters are not part of the proposed action, vessels participating in Federally-managed fisheries transit through state waters and land fish within state waters. Thus, some effects of the Federally-managed PCGF could occur in state waters (e.g., marine pollution and collisions associated with vessel traffic from transiting), but deployment of fishing gear, harvest of groundfish, and bycatch of protected species or their prey associated with the proposed action would not occur in state waters.

Figure 8. The fishery management area, showing major communities and groundfish management areas within the EEZ; boundary lines do not accurately represent the boundaries of the U.S. West Coast EEZ and state waters that are included in the action area (PFMC 2023).

2.4. Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing federal agency activities or existing federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

As described in the Status of the Species sections, humpback whales and leatherback sea turtles are exposed to similar threats throughout their ranges. The action area for this proposed action represents only a portion of the relatively large ranges of these highly migratory and mobile species. In this section, we review the available information regarding impacts to humpbacks and leatherbacks within the action area, which includes biological opinions, current scientific research, current SARs, and other cited material.

A comprehensive list of general threats to humpback whales and their habitat is detailed in the Recovery Plan (NMFS, 1991) and the most recent Status Review (Bettridge et al., 2015). Similar to other large whales, humpback whales and their critical habitat are potentially affected by climate change, entanglement/entrapment in fishing gear, vessel collisions, coastal development, contaminants, energy exploration and development, harmful algal blooms, whale-watching, scientific research, habitat degradation, loss of prey, and anthropogenic underwater noise (Bettridge et al., 2015).

For leatherback sea turtles, a comprehensive list is detailed in the Recovery Plan (NMFS & USFWS, 1998) and the most recent Status Review (NMFS & USFWS, 2020). Potential threats include interactions with fisheries as bycatch, direct harvest of eggs and turtles, coastal development, climate change, vessel strikes, ingestion of plastics, and entanglement in marine debris.

2.4.1 Climate Change and Other Habitat Impacts

Given this proposed action is likely to continue into the future for an undetermined time, we anticipate that the environmental baseline and the effects of climate change will persist, similar to those impacts summarized throughout Section 2.2.

Temperature

Globally, annual surface air temperatures have increased by ~1.0°C over the last 115 years (1901 to 2016), primarily due to greenhouse gas emissions (Wuebbles et al., 2017). Without significant emission reductions, global temperatures relative to preindustrial times, could rise by 5°C or more by the end of this century. SST is also expected to increase due to climate change and the Intergovernmental Panel on Climate Change (IPCC) predicts an increase of 1-6°C by 2100 (IPCC 2007, Rosenzweig et al. 2008, Lezama-Ochoa et al. 2024). SST variation can affect ecological community composition and structure, alter migration and breeding patterns, and change the frequency and intensity of extreme weather events. Long term increases in SST can reduce nutrient supply from deep waters, leading to declines in fish populations, and consequently species that rely on fish. Rising SST can alter predator distributions, with leatherback sea turtles potentially gaining core habitat while loggerhead sea turtles and blue whales may lose habitat (Hazen et al., 2012). Such shifts could impact marine mammal and sea turtle foraging success and sea turtle reproductive periodicity (Kaschner et al., 2011). Sea turtles have temperature-dependent sex determination, and global warming is likely to exacerbate female-biased offspring sex ratios (Benson et al., 2015; Jensen et al., 2018). Increased temperatures in sea turtle nests can result in reduced incubation times, clutch size, and nesting success due to exceeded thermal tolerances (Fuentes et al., 2011) and increased frequency of natural disasters (Santidrián Tomillo et al., 2012). Even with current conservation efforts the chances of new nesting areas emerging with more ideal conditions is unlikely due to the global effect of warming (Santidrián Tomillo et al., 2012).

Temperature fluctuations and the concerns stated above, have occurred recently within the action area, specifically during the anomalous warming period from 2014–2016 in the CCE, known as the “warm blob”. Due to this warming, there were significant declines in euphausiid biomass, with decreases in both abundance and body length (Harvey et al., 2017; Peterson et al., 2017). Comparisons between cool, warm, and intermediate years in the Northern CCE indicated better body conditions for northern anchovy, Pacific herring, and Pacific sardine, particularly for anchovy and herring (Brodeur et al., 2019). During the marine heatwave, sardine spawned earlier and appeared further north within the Northern CCE than in previous years (Auth et al., 2018). Shifts in prey abundance and distributions can lead to corresponding shifts in marine mammal distributions (King et al., 2011). For example, in Monterey Bay, California, the densities of blue, fin, and humpback whales declined with El Niño-associated declines in euphausiids (Benson et al., 2002). The marine heatwave altered humpback whale prey distribution and abundance by compressing habitat coastward leading to increased coastal fisheries interactions and humpback whale entanglements (Santora et al., 2020).

Prey and Habitat Suitability

Species that undergo long migrations typically link their movements to prey availability or habitat suitability. Disruptions in prey availability due to climate change can alter migration pathways and timing or negatively impact population sustainability (Simmonds & Eliott, 2009). In the CCE, anomalous warming and weak upwelling from 2014-2016 led to declines in euphausiid biomass, potentially affecting humpback whale availability (Benson et al., 2002; Learmonth et al., 2006). Fish species targeted by humpback whales are included as an essential feature in the critical habitat designation, and may be negatively impacted by warming ocean conditions. For example, in the Northern CCE northern anchovy, Pacific herring, and Pacific sardine body conditions were better in cooler years (Brodeur et al., 2019). Sardines also spawned earlier and appeared further north (Auth et al., 2018). Changes in fish abundance and distribution may further impact humpback whale abundances and distributions within warmer oceans, increasing their vulnerability to threats such as interactions with fisheries. Humpbacks with their ability to use fat reserves for prolonged fasting, may adapt by seeking new habitats with sufficient prey resources. Although climate change poses uncertainties for northern hemisphere humpback whales, new feeding habitats may arise as ice sheets melt (although humpbacks generally do not feed in Arctic waters).

Commercial fisheries targeting Pacific sardine and northern anchovy are managed by NMFS and the PFMC under the Coastal Pelagic Species (CPS) FMP. The primary directed Pacific sardine fishery has been closed since 2015 (allowable catch set to zero) due to low biomass estimates (2022 Stock Assessment Report of Pacific Sardine Northern Subpopulation) A Pacific sardine rebuilding plan was approved by PFMC in September of 2020, and implemented by NMFS in June 2021 (CPS FMP 2024; 86 FR 33142). Despite the closure, fisheries are allowed some retention of Pacific sardine. CPS fisheries are allowed no more than 20% Pacific sardine per landing by weight and, when the annual catch target (ACT) of 3,800 is attained, vessels are restricted to a per-trip limit of 1 mt of Pacific sardines. Non-CPS fisheries are allowed an incidental per-landing amount of 2 mt until the annual catch limit (ACL) is reached. If landings in the live bait fishery attain 2,500 mt of sardine, a per-landing limit of 1 mt of sardine per trip will apply. These allowances are subject to other annual management measures the Council may recommend and NMFS may implement (CPS FMP 2024, CPS SAFE 2024). Fluctuations in biomass are common for Pacific sardine (Chavez et al., 2003) and the fishery will likely re-open with sufficient population increases. The anchovy fishery remains active, though it is landed in relatively low numbers. There are two subpopulations of northern anchovy found within U.S. waters, northern and central, while the third subpopulation–southern– is found only in Mexican waters (PFMC, 2023). The central subpopulation supports significant U.S. fisheries and has continually increased since 2015 (24,810 mt; 2021 Stock Assessment) with projections to reach a total biomass of 2.7 million mt in 2021 (Koenigstein et al., 2022, Kuriyama et al. 2022).

One of the main prey resources for leatherback sea turtles is jellyfish, displaying significant overlap in their species distributions (Nordstrom et al., 2020). Given cnidarians are a low energy food source, a single leatherback can consume upwards of 1000 mt of jellyfish in its lifetime with the Pacific population consuming 2.1×10^6 jellyfish annually (Jones et al., 2012). A climatic shift in jellyfish distribution would have a significant impact on leatherback critical habitat and distribution, as evidenced by leatherbacks in the northwest Atlantic shifting northward consistent with warming waters (Nordstrom et al., 2020). Jellyfish have been predicted to decrease in warming waters, facilitating an ecosystem with denser populations of energetically-poor pyrosomes (Gomes et al., 2024). This could influence and even decrease leatherback distribution and critical habitat, as they would need to travel to consume higher rates of pyrosomes to compensate for the energy deficiency between pyrosomes and jellyfish.

Environmental changes associated with climate change are occurring within the action area and are expected to continue into the future. Marine populations that are already at risk due to other threats are particularly vulnerable to the direct and indirect effects of climate change.

2.4.2. Human Interaction Threats for Humpback Whales

Off the U.S. West Coast, human-caused mortality and injuries are recorded through stranding reports, observer records, and at-sea sightings. The most recent SAR indicated the humpback whale stocks that represent ESA-listed DPSs off the U.S. West Coast are impacted by anthropogenic activities, including interactions with pot/trap and gillnet fisheries, unidentified fishery interactions, vessel strikes, and marine moorings. There were also entanglements involving "unidentified whales," reported from 2016-2020 (Carretta et al., 2023a), some unknown number of which were likely humpback whales. Humpback whales are also threatened by increasing levels of anthropogenic sound, such as those produced from shipping traffic, Navy sonar exercises, and explosives, which may interfere with communication, foraging, and hearing threshold levels (Carretta et al., 2023a). Although the humpback whale DPSs considered in this opinion are not exactly equivalent to stock definitions under the MMPA, we use information provided in the SARs for affected stocks of whales to understand what impacts are occurring that may affect the ESA-listed species of whales in the action area.

Along the U.S. West Coast, five national marine sanctuaries provide protection for both humpback whale DPSs: the Olympic Coast (3,188 mi^2), the Greater Farallones (3,295 mi^2), Cordell Bank (1,286 mi^2), Monterey Bay (6,094 mi^2), and the Channel Islands (1,470 mi^2). These sanctuaries provide additional protection that may restrict acoustic impacts, discharge of pollutants, cruise ships, fishing, offshore wind energy development, oil and gas development, vessel traffic, etc.

Fisheries Interactions

The impact of fisheries on U.S. West Coast humpback whales are likely underestimated since entanglements often go unobserved because whales swim away or occur in a remote area. Pot and trap fishery entanglements are the most prevalent source of M/SI off the West Coast, and reported entanglements increased considerably in 2014 (Saez et al. 2020). In the most recent decade (2014-2023), NMFS confirmed an average of 32.8 entangled whales per year across all species, for a total of 328 entanglements. Humpback whales constituted 66.8% of those reported entanglements (219 out of 328). The majority of entanglements (of all whale species) were reported from California, Washington, Oregon, and 1% were entanglements reported from Mexico and Canada that involved U.S. gear, with peak entanglement reporting occurring between April-November corresponding with humpback migration back to the West Coast. Many of the reports consist of unidentified gear, but for those entanglements with known fisheries/origins, a majority were attributed to traps/pots.

Here we will summarize the most recent years' whale entanglement summaries on the West Coast. It is important to note that throughout this opinion we will refer to entanglement locations. These locations are where the entanglements were first observed and reported by human observers, but does not necessarily mean that is where the entanglements originally occurred. Humpbacks can travel large distances despite entanglement in fishing gear, and observation of entanglements can be biased in areas where there is a larger density of people utilizing the water. In 2020, there were 10 confirmed humpback whale interactions involving U.S. gear; eight reported in California, one in Oregon, and one in Washington. Fishing gear that was able to be identified from those reported entanglements involved two in commercial Dungeness crab gear, two in unidentified gillnet, and one in commercial spot prawn gear (NMFS 2021a). In 2021, there were 17 confirmed humpback whale entanglements involving U.S. gear: 11 reported in California, one in Oregon, two in Washington, and three reported from Mexico. Fisheries identified in the entanglements include: five in commercial Dungeness crab gear, two in California large mesh drift gillnets, one in California experimental box crab gear, one in unidentified gillnet, one in California commercial spiny lobster gear, one in California commercial spot prawn gear, one in recreational hook-and-line, and five in unknown gear (NMFS, 2022a). In 2022, there were 18 confirmed humpback entanglements involving U.S. gear: 16 reported in California and two in Mexico. Fisheries identified include: seven in commercial Dungeness crab gear, two in unidentified gillnets, and nine in unknown gear (NMFS, 2023a). In 2023, there were 16 confirmed humpback entanglements off the West Coast: 12 reported in California (Central California predominantly), two in Oregon, one in Washington, and one in Mexico, all of which were found alive (NMFS, 2024a). Of these entanglements, seven involved Dungeness Crab gear, one in spot prawn gear, one in PCGF midwater trawl gear, one in both Pacific halibut longline and sablefish pot gear, one in unidentified gillnet, and five in unknown fishing gear. There were two additional alive unidentified whales observed entangled in 2023, and one live humpback in California documented with wounds consistent with previous entanglement. As of August 2024, there had been 14 confirmed entanglements of humpback whales in a variety of gear types in 2024, mostly reported from California and Oregon. All of the 2024 entanglements are still under review by NMFS at the time this opinion was written.

Considering the most recent SARs, and our assessment of the proportion of listed DPSs that may be found off California, Oregon, Washington, we can generate a proportional estimate of total entanglements (or other types of fisheries interactions) and human-caused M/SIs on the Mexico and Central America DPSs, following along the same proportions used for humpback whale stocks off the U.S. West Coast. This approach is used for both the DPSs and the stocks off the U.S. West Coast, because all members of the associated stock (e.g., Mainland Mexico - CA/OR/WA stock; Central America/So. Mexico - CA/OR/WA stock) are assumed to be associated with the respective DPSs, derived from the same movement probabilities described in Wade 2021. For humpback whale interactions with fishing gear that occur off the coast of California and Oregon, we assume that 57.7% would be representative of the Mexico DPS and 42.3% the Central America DPS. For interactions known to have come from Washington waters, the impacts are apportioned to the Central America DPS (5.9%), Mexico DPS (25.4%), and Hawai'i DPS (68.8%), respectively (NMFS, 2021a). The majority of historical confirmed entanglements were reported in southern California (Saez et al. 2021). Beginning in 2014, a much larger portion of entanglements have been reported in central California (NMFS, 2024a), likely due partially to increasing interactions with fixed gear fisheries and extensive use of vertical lines prominent outside of southern California (e.g. Dungeness crab fisheries), along with the popularity of Central California as a primary foraging and migratory route for many whale species along with well-developed whale-watching activities.

As shown in Table 5, of the documented 150 cases of human-related interactions with humpback whales between 2016-2020 that were not attributed to PCGF gear, the majority of those are attributed to fisheries interactions, with most of them attributed to unidentified fisheries, followed by interactions with the California Dungeness crab pot fishery. Other pot/trap fisheries also contribute to the majority of fishery interactions with humpback whales and this reflects much of the historic entanglements dating back to the early 1980s. However, recent analyses indicate that since 2000, the proportion of whales (all species) entangled in pot/trap gear has increased, whereas net entanglements have decreased in prevalence (through 2017; Saez et al. 2021).

Table 5: Humpback whale human-related injury and mortality sources (non-PCGF), number of cases, and total mortality and serious injury, 2016-2020, across California, Oregon, and Washington.

Source	**Number of Cases**	**Mortality/Serious Injury Total (and Annual Average), 2016-2020**
Unidentified Fishery Interaction (whales identified as humpbacks)	58	43.75 (8.75)
Dungeness Crab Pot Fishery (CA)	34	23.75 (4.75)

Vessel Strike	14	13.20 (2.64)
Unidentified Pot/Trap Fishery Entanglement	13	9.50 (1.9)
Dungeness Crab Pot Fishery (WA)	7	5.50 (1.1)
Gillnet Fishery	6	2.00 (0.4)
CA spot prawn trap fishery	5	3.25 (0.65)
Gillnet fishery, tribal	3	2.50 (0.5)
Dungeness crab pot fishery (commercial)	2	2.00 (0.4)
Dungeness crab pot fishery (OR)	2	1.75 (0.44)
Dungeness crab pot fishery (recreational)	2	1.00 (0.2)
Hook-and-line fishery	1	0.75 (0.15)
Marine debris	1	1.00 (0.2)
Pot fishery, tribal	1	1.00 (0.2)
Spot prawn trap/pot fishery (recreational)	1	0.00
Total	150	110.95 (22.2/year)

Table 6 provides a summary of estimated mortality and serious injury associated with different sources of interactions attributed to different stocks of humpback whales in U.S. West Coast commercial fisheries for the period 2016-2020, unless otherwise noted (Carretta 2022; Carretta et al. 2023a; Jannot et al. 2021). Records also include entanglements detected outside of U.S.

waters confirmed to involve U.S. West Coast commercial fisheries. Most cases are derived from opportunistic strandings and at-sea sightings of entangled whales. Also included are records of entangled *unidentified whales* prorated to humpback whales based on location, depth, and time of year (Carretta 2018). Sources derived from systematic observer programs with statistical estimates of bycatch and uncertainty are shown with coefficients of variation (CV). Totals in the first two numerical columns include whales from two stocks: the Central America / Southern Mexico – CA-OR-WA stock, and the Mainland Mexico – CA-OR-WA stock, which are synonymous with the respective Mexico and Central America DPSs, prorated using the same proportions as described earlier in the *Status of the Species* section 2.2.2, derived from Wade (2021).

Table 6: Sources of serious injury and mortality of humpback whale stocks in U.S. West Coast commercial fisheries (non-PCGF) for the period 2016-2020, unless noted otherwise (Jannot et al. 2021; Carretta 2022; Carretta et al. 2023a).

Fishery Source	**Observed Interactions (% observer coverage if applicable)**	Mean Annual M/SI all U.S. West Coast humpback whales	**Mean Annual M/SI** **Central America / Southern Mexico – CA-OR-WA stock prorated totals (0.42)**	**Mean Annual M/SI** **Mainland Mexico-CA/OR/ WA stock prorated totals** **(.58)**
Unidentified fishery	58	8.75	**3.52**	**4.89**
Dungeness crab pot (California)	34	4.75	**2.01**	**2.74**
Unidentified pot/trap fishery	13	1.9	**0.62**	**0.94**
Dungeness crab pot (Washington)	7	1.1	**0.07**	**0.28**

Unidentified fishery interactions involving *unidentified whales* prorated to humpback whale	7	1.05	**0.44**	**0.61**
Unidentified gillnet fishery	6	0.4	**0.17**	**0.23**
California spot prawn fishery	5	0.65	**0.28**	**0.38**
Dungeness crab pot fishery (Oregon)	2	0.35	**0.15**	**0.20**
Dungeness crab pot fishery (commercial, state unknown)	2	0.4	**0.17**	**0.23**
CA swordfish and thresher shark drift gillnet fishery (observer program)**	0 (21%)	0.02	**0.01 (CV>4.7)**	**0.01 (CV>4.7)**
Totals CA-OR-WA waters	136	19.38	**8.1**	**11.4**

† At-sea sightings of entangled whales in the WA/OR/CA sablefish pot fisheries that were not recorded in observer programs during 2016-2020 (2) are included in mean annual mortality and serious injury totals because observer data are used to estimate total entanglements for two separate sablefish pot fisheries in this category (Jannot et al. 2021). These two records are not included in 'Observed Interactions.'
* Jannot et al. (2021) report one humpback entanglement in the limited entry sector in 2014, over an observation period spanning 2002 – 2019 where 13% - 72% of landings were observed. Jannot et al. (2021) report one humpback entanglement in the open access sector in 2016, over an observation period spanning 2002 – 2019 where 2% - 12% of landings were observed. This estimate is based on 2015-2019 data.
** There were no observed entanglements during 2016-2020[7], the model-based estimate of bycatch is based on pooling 1990-2020 data, resulting in a small positive estimate (Carretta 2022).

Non-commercial sources of anthropogenic mortality and serious injury, including tribal fisheries, recreational fisheries, and marine debris (including research buoys) are responsible for a small fraction of all reported cases annually (Carretta et al. 2023a) (Table 7). The impact of recreational fisheries is presumed to be higher than documented due to the minimal mandated accounts of effort and entanglements. The same proportions are used as described earlier in the *Status of the Species* section 2.2.2 and this section.

Table 7. Non-commercial fishery sources of anthropogenic mortality and serious injury observed and reported during 2016-2020 in U.S. West Coast waters (Carretta et al. 2023a).

Source	**Observed Interactions**	**Mean Annual M/SI of all U.S. West Coast humpback whales**	**Mean Annual M/SI** Central America / Southern Mexico – CA-OR-WA stock prorated totals (0.42)	**Mean Annual M/SI** Mainland Mexico – CA/OR/WA stock prorated totals (0.58)
Gillnet fishery (tribal)	3	0.5	**0.03**	**0.13**
Dungeness crab pot fishery (recreational)	2	0.2	**0.09**	**0.12**
Hook-and-line fishery	1	0.15	**0.06**	**0.09**
Marine debris	1	0.2	**0.09**	**0.12**

[7] Carretta 2022 includes estimates of mortality and serious injury in the DGN fishery through 2021.

Pot fishery (tribal)	1	0.2	**0.09**	**0.12**
Spot prawn trap/pot fishery (recreational)	1	0	**0**	**0**
Totals CA-OR-WA waters	**9**	**1.25**	**0.35**	**0.56**

Some limited humpback whale bycatch is expected and has been analyzed in other federal U.S. West Coast fisheries. For example, in 2021 there were two documented humpback entanglements within the DGN fishery, despite the relatively low effort this fishery displays (NMFS 2023d However, this fishery, due to the Driftnet Modernization and Bycatch Reduction Act, will be phased out of operation by December of 2027. The 2023 DGN Biological Opinion estimated a maximum of one humpback whale would be entangled and potentially killed by the fishery over the next five years until the fishery ceases to exist, which amounts to an average of 0.2 individuals being removed from the population every year. Given we do not know what DPS these entangled humpbacks originate from, NMFS assumed that up to one individual could be taken from either DPS annually. NMFS concluded the DGN fishery would not jeopardize ESA-listed DPSs of humpback whales (NMFS 2023d).

There is currently no estimate of the total number of anthropogenic injuries and deaths to humpback whales that are undocumented in the U.S. West Coast.

Vessel Collisions

Vessel collisions are considered a serious and widespread threat to ESA-listed whales (especially large cetaceans) and are the most well-documented "marine road" interaction with large whales (Pirotta et al. 2019). This threat increases as commercial shipping lanes and other high traffic vessel areas overlap important breeding and feeding habitats, and as whale populations recover and populate new areas (Swingle et al. 1993; Wiley et al. 1995). Between 1995 and 2023, there were 40 confirmed or suspected ship strikes involving humpback whales along the West Coast (NMFS unpublished stranding data). In recent years (from 2016-2020), 14 confirmed humpback whale vessel strike cases were reported; eight in California, one in Oregon, and five in Washington, leading to a total estimate of 13.2 M/SI over 5 years, or an average of 2.6 whales seriously injured or killed per year (Carretta et al., 2023a). Whale carcasses can sink and ships may not detect a whale strike, although this is more likely to be the case with large container vessels and tankers. Additional mortality from ship strikes probably goes unreported because the whales do not necessarily or typically strand, or if they do, they do not always have obvious signs of trauma. As a result, most vessel strikes are likely undetected or unreported, and the true number of vessel collisions that occur is unknown.

Collisions of ships and marine mammals can cause major wounds, which may lead to the death of the animal. An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or an animal just below the surface could be cut by a vessel's propeller. In most cases, serious injuries are often assumed to result in death given the severity of the wounds and that animals are not adequately monitored to confirm they survived following such events (e.g. Vanderlaan and Taggart 2007). While any vessel has the potential to hit cetaceans, the severity of injuries typically depends on the size and speed of the vessel (Knowlton and Kraus 2001; Laist et al. 2001; Vanderlaan and Taggart 2007).

Vessel strike mortality has been estimated for several whale species (including humpback, fin, and blue whales) in the U.S. West Coast EEZ by Rockwood et al. (2017). This model estimated that the number of annual ship strike deaths along the U.S. West Coast was 43 fin whales, 22 humpback whales, and 18 blue whales in the California Current Ecosystem. We note that these estimates may not encompass all the potential risk of vessel collisions for humpback whales, since based on the 2016-2020 period, five out of 14 (36%) reported vessel strikes occurred off or within Washington waters, which were not included in the analysis due to the lack of predicted humpback whale density in these areas (e.g., Strait of Juan de Fuca, Puget Sound, where they are vulnerable to vessel traffic, including ferries). A comparison of average annual vessel strikes observed over recent historical time periods with these new estimates suggest that the detection rate for humpback whale ship strikes could be only 12% (Carretta et al. 2023a).

There is a large amount of uncertainty surrounding the true number of ship collisions and mortalities these species. Based on estimates of 22 annual humpback whale deaths due to vessel strikes, the number attributed to the Central America / Southern Mexico - CA-OR-WA and Mainland Mexico-CA/OR/WA humpback whale stocks during 2016-2020 by Carretta et al. (2023a) are 6.45 and 10.15 humpback whales struck by vessels/year, respectively.

However, NMFS has determined that recent stock assessments of humpback whale stocks off the U.S. West Coast do not support an assertion that the current level of vessel strikes (whether reflected by the Rockwood et al. estimates or not) are impeding the recovery of these stocks (NMFS 2022e). While Rockwood et al. (2017) used a probability of avoidance of 55%, more recent studies have shown a greater avoidance behavior by large whales (Lesage et al. 2017; Garrison et al. 2022), including humpbacks (Schuler et al. 2019), so the actual rate of collisions (and resulting M/SI) may be lower than estimated in Rockwood et al. (2017). Humpback whales also continue to show signs of recovery, with increasing abundance on the U.S. West Coast despite the persistent nature of this threat. There have also been actions in recent years that may be helping to reduce the number of vessel collisions that occur within the action area. There has been a long-term trend of decreasing vessel speeds across all U.S. West Coast waters (Moore et al. 2018), likely due to several factors that include response to increasing fuel costs and air pollution regulation. In addition, for over 10 years, NOAA has established seasonal voluntary Vessel Speed Reduction (VSR) zones off of California that have requested that all vessels 300 gross tons (GT) or larger decrease speeds to 10 knots or less to reduce the risk of vessel strikes on ESA-listed whales. Cooperation rates with VSR have been increasing over this time, although they are still modest overall (Morten et al. 2022), and the potential changes (reductions) in risk associated with VSR have been explored through analysis, all of which describe at least some anticipated reductions in risk (Rockwood et al. 2020, 2021).

The International Maritime Organization (IMO) recently adopted a U.S. proposal to increase protections for blue, fin and humpback whales off southern California, which took effect in the summer of 2023. The modifications include a 13 nautical mile extension of the existing traffic separations scheme (TSS) in the Santa Barbara Channel, resulting in vessels lining up in deeper waters where there are lower concentrations of whales, which should help reduce the risk from ship strikes. In addition, an area to be avoided by vessels (traffic exclusion zone) was expanded by more than 2,000 nm^2 and covers approximately 4,476 nm^2 of important foraging habitat off Point Conception and Point Arguello in Santa Barbara County, CA. Within the TSS, which is near the Channel Islands National Marine Sanctuary, NOAA asks merchant ships to voluntarily slow down to 10 knots or less on all primary approaches to the port of Los Angeles/Long Beach from May to December.

The Port and Waterways Safety Act (PWSA) authorizes the Commandant of the Coast Guard to designate necessary fairways and TSSs to provide safe access routes for vessels proceeding to and from United States ports. The U.S. Coast Guard (USCG) completed Port Access Route Studies for the Santa Barbara Channel and the approaches to San Francisco and made recommendations to the IMO that the TSSs be modified, in part, to reduce the co-occurrence of large ships and whales. In February 2017, NMFS completed section 7 consultation on the USCG's codification of the shipping lanes that vessels use to approach the ports of Los Angeles/Long Beach and San Francisco. Following formal consultation under ESA section 7, NMFS concluded that the proposed TSS lanes were not likely to adversely affect or jeopardize ESA-listed humpback, blue, and fin whales. On December 7, 2022 the United States District Court issued an order in *Center for Biological Diversity, et al. v. NOAA Fisheries, et al.*, Case No. 4:21-cv-00345-KAW (N.D. Cal.), vacating the biological opinion.

Whale Watching Operations and Scientific Research

Whale watching boats and research activities directed toward whales may have direct or indirect impacts on humpbacks as harassment may occur, preferred habitats may be abandoned, and fitness and survivability may be compromised if disturbance levels are too high. Specifically, whale watching companies throughout the U.S west coast, especially areas of Southern

California and Monterey Bay, are the beneficiaries of the large amount of whale activity occurring in nearshore coastal waters. To date, there have been no indications or scientific studies suggesting that whale watching activities are significantly affecting humpbacks along the U.S. West Coast. A review of the NMFS Authorizations and Permits for Protected Species (APPS) database indicates there are currently 17 scientific research projects that include directed research on fin, humpback, and/or sperm whales off the U.S. west coast. Most of these projects include some level of harassment for close approach, photography, acoustic monitoring, and/or sampling for biological data or deployment of tags. These activities are intended to be non-injurious with only minimal short-term effects. Although risks of more significant injuries or impacts do exist, a biological opinion evaluating the issuance of permits for directed research on cetaceans concluded that no mortalities of Central America or Mexico DPS humpback whales are expected from these activities and such research is not expected to cause a reduction in the likelihood of survival and recovery for these species (NMFS 2019c). Further, a recent biological opinion (NMFS 2020d) analyzing the incidental effects of NMFS' SWFSC research programs concluded that there were no adverse incidental effects to ESA-listed humpbacks covered under this opinion. Similarly, in 2024 a biological opinion analyzing the incidental effects of NMFS' NWFSC fisheries research program concluded there were no adverse incidental effects to ESA-listed humpback whales covered under this opinion (NMFS 2024b).

Other Threats and Strandings

Other threats or sources of harm for ESA-listed humpbacks in the action area exist, although oftentimes strandings occur where the source of injury or mortality is unknown. These events may also include natural mortalities with no human cause. From 2017-2021, a total of 35 humpback whale strandings were reported off the U.S. West Coast (NMFS unpublished stranding data), most of them found in areas that were difficult to access, or when accessed, the whales were too decomposed to examine or necropsy, or they were floating offshore, often with moderate decomposition. Similarly, these strandings weren't typically attributed to any specific causes, which could include natural mortality, but a few were suggestive of possible trauma or had old entanglement scars. Along the U.S. West Coast, there are increases in coastal and vessel traffic to keep up with global supply chains, specifically around the ports of Los Angeles, Long Beach, the San Francisco Bay Area, and Seattle, thereby exposing humpbacks in the action area to increased anthropogenic noise from vessels.

The potential effects to ESA-listed marine mammals from oil spills and other activities associated with oil and gas development off Southern California have been evaluated in consultations with the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE), including in 2017 (NMFS 2017). A new consultation with BOEM/BSEE on oil and gas development in Southern California recently completed in 2024 (NMFS 2024c) concluded that these activities are likely to adversely affect ESA-listed humpbacks, but are not likely to jeopardize the species (NMFS 2024c).

We acknowledge these threats to humpback whales within the action area are based on information collected through the present time, as available and analyzed through a rigorous review. While we continue to improve our outreach and reporting mechanisms to account for the threats to humpback whales, research fishing gear modifications that may reduce threats of fishing activity, and work with partner agencies such as the states of California, Oregon, and Washington to reduce fisheries interactions, we anticipate these threats will continue in the future.

2.4.3 Human Interaction Threats for Leatherback Sea Turtles

Fisheries Interaction

Within the action area, leatherback turtles are prone to interactions with fisheries, especially because their foraging areas along the U.S. West Coast overlaps with fishing grounds in the U.S. EEZ. From 1963 to 2024 there have been 135 reported leatherback sea turtle strandings along the West Coast including nine in Washington, two in Oregon, and 124 in California. Fourteen of the strandings indicated evidence of fishery interactions (twelve in California, one in Oregon, and one in Washington). Martin et al. (2015) documented 24 observed leatherback turtle interactions in the DGN fishery between 1990-2009, with 13 of these resulting in fatalities.

Genetic analysis indicated all entangled turtles were from the West Pacific DPS (Dutton et al., 1999). However, since the establishment of the Pacific Leatherback Conservation Area (PLCA) in 2001, there has been a notable decline in interactions (up to 80% reduction in the DGN fishery). In 2009 and 2012 there were two documented observed captures of leatherbacks in the DGN fishery with one of them being released alive. This conservation zone, spanning 213,000mi^2 off the coast of California and enforced from August 15 through November 15, aims to mitigate interactions during the turtles' foraging season (NMFS, 2012b). In the DGN fishery, NMFS exempted the incidental take, annually, of up to two leatherbacks (one anticipated to die) over the last five years of the fishery, set to expire in 2027 (NMFS 2023d).

Leatherbacks are encountering threats from fixed gear fisheries along the U.S. West Coast. In 2015, a leatherback turtle was found entangled in unidentified pot/trap gear off of central California, and one was reported entangled in CA Dungeness crab pot gear but released alive in 2016 (NMFS WCR standing database). In 2019, another leatherback was found dead offshore in Ventura, CA attached to two buoys belonging to the rock crab fishery (NMFS 2020a). On November 24th, 2023, a leatherback was found dead near the Farallon Islands, CA entangled in CA Dungeness Crab pot gear (NMFS 2024a).

HMS Experimental Permits

In 2018 and 2019, NMFS SFD consulted upon and/or issued four EFPs for HMS species recommended by the PFMC that may occur within the action area. These EFPs include: deep-set buoy gear (DSBG) issued in 2018 (NMFS, 2018c); Deep-Set Linked Buoy Gear (DSLBG) issued in 2018 (NMFS, 2018b); Longline Gear (LL), including deep-set longline gear (DSLL) and shallow-set longline gear (SSLL), issued in 2019 (NMFS, 2018a); and Deep-Set Shortline (DSSL) consulted on in 2019 (NMFS, 2018a). Through consultation NMFS ultimately determined that ESA-listed species, including all ESA-listed species considered in this biological opinion, was not likely to be adversely affected by three of these EFPs: DSBG, DSLBG, and DSSL. A letter of concurrence was issued in December, 2023, on the authorization of DSBG as a legal gear type to target swordfish under the HMS FMP. In addition, SFD consulted upon and issued two EFPs for HMS in the U.S. West Coast EEZ off California and Oregon, one in 2022 (for one vessel to fish from 2022 to 2023, NMFS, 2022b) and one in 2024 (for up to five vessels to fish between 2024 and 2025, NMFS, 2024c), to fish with night-set buoy gear (NSBG). Similar to other consultations above, NMFS determined that ESA-listed species, including all ESA-listed species considered in this Opinion, would not be adversely affected by these two EFPs for NSBG.

Through formal consultation, NMFS determined that the 2019 LL EFP was likely to result in the take of ESA-listed sea turtles, including leatherback sea turtles. Specifically, over the course of two years the LL EFP was expected to result in as many as two leatherback sea turtle entanglements with one mortality (NMFS, 2018a). The LL EFP was issued in April 2019, and was set to expire after two years. Two vessels fished DSLL and SSLL for around three months in 2019 with no interactions with sea turtles (100% observer coverage). On May 7, 2024, SFD requested initiation of formal consultation on the proposed issuance of EFPs to fish with longline-type gear in a portion of the U.S. West Coast EEZ, consistent with what is described in a January 2024 DEIS (NMFS, 2024d). A biological opinion for this action was completed November 22, 2024 (NMFS 2024x), which provides a description of the adaptive management program proposed to address leatherback sea turtle bycatch during these EFPs. Ultimately, this opinion anticipated up to 17 interactions, resulting in up to four mortalities, could occur over a ten-year period associated with this action.

Entrainment in Power Plants

In 2006, a biological opinion was completed and analyzed the effects of sea turtle entrainment in the two federally-regulated nuclear power plants located in California, the Diablo Canyon Power Plant found in San Luis Obispo County and the San Onofre Nuclear Generating Station found near San Clemente California (NMFS 2006). While historically leatherbacks were observed entrained in the power plants in very low numbers, since 2006, there have been only three reported sea turtle entrainments at these facilities, and none involving a leatherback. In addition, the San Onofre station began decommissioning in 2014, although some cooling water is still drawn in to cool the reactors (D. Lawson, NMFS personal communication 2015). The incidental take statement covering both power plants estimates up to 6 leatherbacks taken, (with two serious injuries each and two mortalities) over a one-year period (NMFS 2006).

There are other coastal power plants in California (non-nuclear and state-managed) where sea turtle entrainment has occurred (typically green sea turtles). Although these facilities have all been required to install large organism excluder devices by the State of California (California State Water Resources Control Board (CASWRB) 2010), occasional instances of green turtle entrainments (typically alive) continue to be reported. From 1975-2016, only one leatherback was entrained, and no leatherbacks have been entrained in power plants based on stranding data from 2017-2024 (NMFS-WCR unpublished stranding data).

Scientific Research

NMFS issues scientific research permits to allow research actions that involve take of sea turtles within the CCE. Currently there is only one permit that allows directed research on leatherback sea turtles off the U.S. West Coast through the SWFSC to conduct long-term monitoring of leatherback sea turtles on the U.S. West Coast (NMFS Permit #15634). Such permits typically involve either targeted capture or sampling of individuals that may have stranded or incidentally taken in some other manner. These permits allow a suite of activities that include tagging, tracking, and collection of biological data and samples. These activities are intended to be non-injurious, with only minimal short-term effects. While the risks of a sea turtle incurring an injury or mortality cannot be discounted as a result of directed research, a biological opinion on the issuance of permits for directed research concluded that no more than one leatherback sea turtle from any population globally would be killed over a 10-year period, and that issuing such permits was not likely to jeopardize any ESA-listed sea turtle DPS (NMFS 2019a).

Prior to completing a section 7 ESA consultation on the Southwest Fisheries Science Center's programmatic research program, one leatherback was incidentally captured during a scientific trawl net survey in 2011, and was released alive (NMFS 2015). The most recent biological opinion analyzed the effects of SWFSC research surveys and estimated that one ESA-listed sea turtle found within the action area may be captured in CCE trawl surveys and one ESA-listed sea turtle may be captured/entangled in longline surveys, with both released alive (NMFS 2020c).

The 2024 section 7 ESA consultation on the NWFSC fisheries research program estimated one ESA-listed sea turtle may be taken annually (no mortalities; NMFS 2024b).

Marine Debris

Marine debris presents a significant threat to leatherbacks when trash is ingested or entangled on body parts. While there is limited research on the full extent of the impact, available studies indicate that approximately half of sampled turtles have ingested plastics, likely mistaking them for their preferred prey, jellyfish (Q. A. Schuyler et al., 2015; Wilcox et al., 2018; Moon et al., 2023). The effects of plastic ingestion can range from gut blockages to fatalities due to gut perforation (Wilcox et al., 2018). Large pieces of marine debris, including ghost fishing gear, pose entanglement risks to leatherbacks, impeding their mobility and ultimately resulting in starvation or death (Gilman, 2016; Lebreton et al., 2019; NMFS & USFWS, 2020). Given the amount of floating debris in the Pacific Ocean within the action area, marine debris has the potential to be a significant threat, however the impact is unquantified (NMFS & USFWS, 2020). Younger sea turtles tend to feed higher in the water column near the surface so they are particularly susceptible to interacting with plastics (Wilcox et al., 2018). Individuals are also more likely to come into contact with plastics when they forage along coastlines, closer to trash origins.

There have been two leatherbacks stranding on the West Coast with plastic in their digestive system (NMFS Stranding Database, unpublished data). In 2017, a leatherback was beached in southern California and a small piece of plastic sheeting was found in their intestines during a necropsy, though it caused no obstruction and was not ruled as the cause of death. The second case of plastic ingestion was of a leatherback in Oregon where pieces of plastic were found in the stomach and small intestine. NMFS Stranding Responders ruled this turtle likely died from a killer whale predation event rather than the ingested plastic.

Pollution

Leatherback turtles forage in surface waters and this makes them and their prey susceptible to exposure to contaminants from terrestrial sources. Runoff can carry chemicals, contaminants, and other toxins into marine environments and interact with leatherback prey. When consumed, the turtles bioaccumulate these contaminants and females may transfer them to their offspring (Guirlet et al., 2008; Guzman et al., 2020). In the Caribbean Panama, leatherback eggs were found to have high concentrations of arsenic, selenium, strontium, and chromium (Guzman et al., 2020).

We do not have any record of environmental contaminants being the primary source of mortality for leatherbacks but it is possible exposure can affect turtle fitness. The Central Valley of California is the largest and densest agricultural aggregation in the world with many water sources that connect to the ocean (i.e. the San Francisco Bay and Elkhorn Slough). Some of these pesticides are known endocrine disruptors and, when washed into marine waters, interact with organisms in the surface waters, which can affect reproductive output in leatherbacks (Kavlock et al., 1996; Barraza et al., 2021). Leatherbacks foraging off the California coast are exposed to heavy metals due in part to terrestrial runoff, which is nine times higher than that observed for the St. Croix nesting population (Harris et al., 2011). In addition to carrying a variety of contaminants, runoff introduces nutrients to coastal waters, which can cause eutrophication of nearshore waters. This can result in harmful algal blooms (HABs), depletion of oxygen in the water column, acidification of waters, and alteration of marine ecosystems from the bottom-up because of an increase in primary productivity. Domoic acid, which is a potent marine algal toxin that occurs during HABs, was found in a stranded dead leatherback in 2008 (Harris et al., 2011).

Vessel Collisions

Vessel collisions are occasionally a source of injury and mortality for sea turtles along the U.S. West Coast. Lethal and nonlethal vessel-strike injuries observed can include cracked and crushed carapaces, animals cut in half, missing limbs, propeller cuts, and scars (Foley et al., 2019). Propellers from fast moving vessels can inflict deep gashes on flippers and carapaces and blunt force impacts from vessel hulls, bows, skegs, or rudders can also create traumatic injuries. Boat collisions can introduce trauma to lungs, which can lead to issues with buoyancy control if the turtle survives. Mortality may not always be immediate and injuries can kill a sea turtle hours, days, or weeks after the initial incident (Campbell-Malone et al., 2008; Martinez & Stockin, 2013; Dwyer et al., 2014). As with humpback whales, the true rate of collisions is unknown; larger vessels are unlikely to be able to detect a collision with a sea turtle, and therefore such strikes are not reported.

For the U.S. West Coast, NMFS maintains a database tracking sea turtle strandings. A review of this database indicates leatherbacks are one of two species–the other being green sea turtles–reported most often as stranded due to impacts from vessel strikes. Between 1975 and 2024, 13 leatherbacks were reportedly struck by vessels; many of these collisions occurred in central California near the ports of San Francisco and Oakland (NMFS, 2023c). From 2017 to September 2024, no vessel strikes of leatherbacks were reported off California or Oregon, although they have been reported for other species in that timeframe (i.e., 29 green sea turtles), suggesting there is still potential for low rates of collisions with leatherback sea turtles to occur. As with humpback whales, the voluntary speed reduction zones off the coast of California are likely to decrease the risk of vessel collisions for leatherback sea turtles in those areas.

Energy Exploration, Development, and Operation

We do not know if there have been instances of leatherback interactions with energy exploration, development, and/or operations on the West Coast but it is a possibility based on reports from other areas where leatherbacks occur. Some potential sources of mortality for leatherbacks associated with energy operations include vessel traffic, increased noise pollution, and exposure to pollutants.

Although the state of California is no longer issuing leases for oil and gas operations in state waters, there continues to be active offshore operations in the southern portion of the state in federal waters. On February 27, 2024, NMFS concluded consultation for the development and production of oil and gas reserves and the beginning stages of decommissioning platforms in the Southern California Planning Area (NMFS, 2024c). The consultation considered the impacts of noise from drilling, oil production, well conductor removal, vessels, and aircraft. They also looked into the impacts of liquid waste discharge, oil spills and spill response, vessel strikes, and decommissioning oil platforms. Due to their highly migratory nature and lack of overlap in critical habitat with the action area, NMFS determined leatherback turtles may be exposed to the above dangers, but are not likely to be affected by that proposed action.

Off the U.S. West Coast, there are site characterization activities ongoing to support future development of offshore energy operations that could potentially affect leatherback sea turtles. In 2022 (WCRO-2022-01796), and 2024 (WCRO-2024-01447), NMFS completed informal

consultation on these site characterization activities off the coast of Central and Northern California, and Oregon, respectively, concluding those activities were not likely to adversely affect leatherback sea turtles.

2.5 Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.02). As described in "Not Likely to Adversely Affect" Determinations (Section 2.12), the PBF for both species' designated critical habitat relate to prey, and the currently available information regarding potential effects to prey from the PCGF lead us to conclude that humpback whale and leatherback turtle critical habitat is not likely to be adversely affected by the proposed action. Further information about our determination can be found under "Not Likely to Adversely Affect" Determinations (Section 2.12).

In this effects analysis, the terms bycatch, interaction, entanglement, hooking, and capture are used interchangeably, as the primary modes of bycatch risk in the PCGF are entanglement in the lines that are associated with setting and retrieving pot gear, but also entanglement in vertical hook-and-lines which can also result in hooking of individuals, and capture in midwater trawl nets.

As described in the *Proposed Action* (Section 1.3), the PCGF includes vessels that use a variety of gear types portioned into different sectors to directly or incidentally harvest groundfish. Humpback whales and leatherback sea turtles encounter PCGF gear due to their geographic overlap with fishing effort in the U.S. West Coast EEZ. Entanglements with fixed fishing gear, such as sablefish pots and vertical hook-and-lines, including getting hooked, occur when marine species encounter parts of the gear that may be suspended in the water, laying on the seafloor, and/or floating on the surface. Many times, these encounters do not lead to entanglements but sometimes a portion of the line/gear, or a loop in the line, may catch on a body part of an animal. The gear may begin to wrap around the body (including the head/mouth area, pectoral and dorsal fins, and the tail/fluke region) as the animal moves through the water. Reacting to the contact of the gear or the drag created by the gear, the animal may perform quick and powerful changes in directions or body movements attempting to shake the gear free. Midwater trawl nets that are also commonly utilized in the PCGF are not considered fixed-gear as the trawl net is actively fished throughout the water column and is not left to soak. Based on recent incidents of interactions reported, it is thought that animals may end up in these nets due to underlying causes such as disease, prior death, or prior entanglement, but could also become captured/entangled by simply swimming into the trawl net as it is being towed or set/retrieved. The specific dynamics of gear encounters that may be more likely to lead to an entanglement are not well documented, as very few entanglements have been witnessed in the initial stages. However, forensics review of entanglement cases suggests that knots/splices/leads and other potential sources of snags, along with loose or slack lines, are likely contributors to numerous entanglements. Other possible contributors include animal behavior (whether they encounter the gear while foraging or migrating) and ocean conditions (e.g. current, tide, wind) as well as the condition and/or life stage of the animal.

Other potential impacts that could occur as a result of the PCGF include direct or incidental impacts to prey species important for humpback whales and leatherback sea turtles, vessel collisions, and/or impacts related to pollution or marine debris generated by this action that our analysis will also consider.

Approach to the Effects Analysis

A similar methodology was applied to both the humpback whale and leatherback sea turtle entanglement effects analysis described below, with further explanation and consideration of the supporting “Co-occurrence Analyses” in the attached Appendix A.

First, we reviewed the available and relevant information about the risk and incidents of bycatch of these species in the PCGF, including observer records and opportunistic reports of interactions between these species and PCGF sectors/gear, and recent bycatch estimates that have been produced for various PCGF sectors. Since 2002, NMFS has deployed observers in the PCGF under the WCGOP, implementing an objective sampling scheme to derive scientifically-based bycatch estimates. Initially, NMFS used ratio estimators for annual marine mammal bycatch estimates (e.g., Jannot et al. 2011). More recently, Somers et al. (2024) employed statistical models to address ‘rare-event’ cases like the observed entanglements of ESA-listed humpback whales in LE and OA pot fisheries. We also evaluated all the opportunistic reports of entangled whales from the U.S. West Coast, some involving PCGF gear, including some cases that were documented by the WCGOP and also reported to the NMFS WCR Marine Mammal Stranding Program. This included entanglement from other fixed gear fisheries, other types of fishing gear, non-fishery sources, and unknown sources. We also reviewed all the opportunistic reports of entangled and stranded turtles from the U.S. West Coast (NMFS WCR Sea Turtle Stranding Program). As appropriate, we also consider information from other interactions with gear that is similar or potentially related to gear used in the PCGF.

In an attempt to understand the relationship between fishing effort and the distribution of ESA-listed humpback and leatherback sea turtles, we evaluated the spatial and temporal trends in fishing effort across three gear types with known/likely risks of interaction with these species:

pot/trap, hook-and-line, and midwater trawl; using fishing effort data from the WCGOP. Fishing effort was scaled up within each individual gear type and sector based on the annual observer coverage rates (Table 2) for that unique sector, to estimate the totality of fishing effort occurring annually, and represented spatially. We also reviewed humpback density distribution model predictions, and leatherback sea turtle habitat suitability model predictions, from 2014-2023. By analyzing these fishing effort and species distribution datasets separately, we are able to gain some insight into what factors might be influencing the observed spatial and temporal trends in entanglement risk that our analysis revealed, and how (i.e., how fishing effort or species distributions is changing).

Next, for each individual gear type, we overlaid fishing effort with each species model: humpback density and leatherback habitat suitability to produce a “co-occurrence analysis” (also described and used interchangeably herein as “overlap" or “overlap analysis”). The output from this analysis was the product of the two input layers, fishing effort in sets or hours and humpback density (whales/km^2) or leatherback habitat suitability score (0-1) where there was overlap between the two input layers. The resulting output value is considered herein as ‘overlap’ or ‘co-occurrence’ and is considered to be unitless, as the value calculated from the product of these two layers is not meaningful in terms of units. The value of these overlap outputs is discussed further in Appendix A. This allowed us to see how these two data inputs interact in space and time, and how various aspects of the fishery contribute to entanglement risk with protected species. We chose to analyze the most recent decade of fishing effort and species distribution, 2014-2023 as this was data that we had access to, and it encapsulates a variety of environmental and anthropogenic changes including the marine heat wave (2014-2018), the COVID-19 pandemic, and both El Niño and La Niña conditions. It also provides insight to the most recent occurrences of both fishing effort, entanglements, and species distribution which allows us with more certainty to indicate possible future trends, given the most recent history. At the time of writing this opinion, 2023 WCGOP EM data was not available for some of the CS pot fishery, as well as the Hake, Rockfish, CP, and MS trawl fisheries; and thus, this information could not be included in the co-occurrence analysis.

However, it is important to note that a caveat to this analysis and the subsequent representation in both Appendix A and throughout this opinion is that the spatial representation of fishing effort, and visual representations of the subsequent overlap analyses, had to be filtered to protect MSA confidentiality concerns. Therefore, any description of spatial fishing effort or overlap in this opinion or Appendix A was evaluated on a 2-km resolution basis, and is unable to be visually shown in that format. This visual representation in Appendix A and the opinion of fishing effort and overlap is represented on a 10-km resolution, with values filtered out if they represented 3 fishing vessels or less. Despite this, all of our quantitative analysis was carried out on the 2-km resolution scale, with the tables and text reflecting this finer scale resolution whenever possible. Spatial and temporal trends in overlap were then further analyzed to help inform the assessment of future entanglement risk for each unique gear type and species interaction.

There have been some additional recent changes to the PCGF that may be relevant to consideration of potential effects to humpback whales and leatherback sea turtles, including improved/enhanced gear marking, and risk reduction measures including removing the requirement for both ends of a set of pot or longline gear to be buoyed at the surface at all times, and maximum amounts of surface line that can be used. These new measures are discussed further in section 1.3.8 *Fixed Gear Marking and Entanglement Risk Reduction*. While there are some details that have not been fully defined yet, and they haven't taken effect as requirements in regulation, we do consider them reasonably certain to occur given the actions taken by the PFMC, and the expressed intent of NMFS WCR SFD. Therefore, we consider their potential effects on the risks of bycatch of humpback whales and leatherback sea turtles in this opinion.

After this evaluation of entanglement/bycatch data and bycatch estimates, fishing effort, species distribution, and their respective "co-occurrence" overlap, along with the new developments in the PCGF, we combined all the information and generated expectations for future interactions with each gear type and species. We generally considered what might happen in any given year, as well as over any 5-year period, based on the current PCGF, and what could be gleaned with reasonable certainty about the trajectory of risk in the foreseeable future.

To anticipate the response of individual whales to entanglement in PCGF gear, we then reviewed information about M/SI[8] determinations from previous interaction with the PCGF, and other relevant sources, for each gear type and species as described in the most recent humpback whale SAR and utilizing M/SI determinations through 2022 (Carretta et al. 2023a, Caretta et al. 2024 *in prep*). To determine the response of an individual sea turtle to entanglement in PCGF gear, NMFS relied on assessments of injury/mortality from reported PCGF leatherback sea turtle entanglements. To gain additional perspective on the risk of injuries associated with some gear types, we also reviewed relevant information from interactions with similar gears in other

This information was used to provide a basis for estimating future risk of each gear type to a species, and determine the applicable M/SI rate(s) to expect in association with future incidents of bycatch that are anticipated. While M/SI is not the only effect of interactions with PCGF gear, we use the anticipated level of M/SI to help evaluate the effect of removals of individuals from affected populations resulting from the injuries sustained from interactions that are likely to lead to death.

Finally, for humpback whales, we drew upon the available information on the distribution of ESA-listed humpback whale DPSs along the U.S. West Coast, along with the anticipated distribution of fishing effort for different sectors of the PCGF, and resulting expected location/rate of bycatch in different areas for these different sectors, to generate expectations for

[8] Through the MMPA SARs process, NMFS evaluates the mortality and serious injury of humpback whales resulting from human activities (see e.g. Carretta et al. 2023a). Serious injury is defined as an injury that will likely result in mortality (50 CFR 229.2)

the number of anticipated future interactions and associated M/SI to apply to each of the relevant ESA-listed DPSs affected within the action area.

Other Factors from Recent Developments We Considered

As part of our effects analysis, we considered the potential implication of recent developments in the PCGF that might have some impact on fishing effort and/or bycatch risk.

Evolution of PCGF Effort

Over time, including during the last 10-15 years, there have been changes to the Groundfish FMP and federal regulations, including provisions that determine where different gear types may be deployed as described in Section 1.3.9 *Closed Areas That Apply To All Groundfish Fisheries*. Also, changes in ACLs and harvest specifications, as described in Section 1.3.1 *Overview of the Components and Operation of the Pacific Coast Groundfish Fishery*, influence the location and intensity of fishing that occurs over time.

Through our co-occurrence analysis, we examine some of the recent patterns of humpback whale and leatherback sea turtles, as part of consideration of the dynamic nature of the PCGF over time (Appendix A). We have captured what we can glean about the dynamics of the PCGF relative to the dynamics of these species, including apparent trends, and factored those into our effects analysis. Year to year, there is variability resulting from a myriad of factors that can be difficult to predict. In general, our review of the last ~10-12 years of overlap and bycatch estimates cover a wide range of these variable conditions. As a result, we conclude our analysis has considered the available information about the evolution of PCGF effort resulting from management of the PCGF through the Groundfish FMP, up to the current proposed action.

Impact of Gear Marking and Risk Reduction Measures on Bycatch Risk

As described in section 1.3.8 *Fixed Gear Marking and Entanglement Risk Reduction*, the proposed action includes new measures for the PCGF: improved/enhanced gear marking and entanglement risk reduction measures to limit the amount of surface line that may be used, along with removal of the requirement for having each end of a groundline attached to buoy lines. These measures are applicable to all PCGF pot and longline gear. It is anticipated that implementing regulations, which have yet to be finalized, will be effective in 2026.

With respect to gear marking, we do not anticipate any direct impact on the risk of PCGF fixed gear (sablefish pot or bottom longline) entanglements resulting from this action. What it will do primarily is improve our ability to potentially identify PCGF fixed gear that may be involved in entanglements that are not observed, and are ultimately sighted and reported through opportunistic sources that would have previously otherwise been labeled as “unidentified gear”. Along those same lines, it could help identify if there are any factors associated with the bycatch estimation approaches using observer entanglement rates that need additional consideration, should improve gear marking lead to significant changes in the rate of opportunistic reporting that are associated with PCGF fixed gear. It should also reinforce confidence that any gear involved in reported entanglements that we are unable to identify is likely not PCGF gear, even when such determinations are not necessarily 100% conclusive. These are all positive benefits that point toward focusing time and efforts toward addressing entanglement issues in most useful directions to understand and address sources of entanglements.

The potential impacts of the risk reductions measures have a more direct path toward impacting bycatch risk in the sablefish pot fishery. Given that the primary risk of entanglement in sablefish pot and bottom longline gear comes from the vertical buoy lines, risks could be cut by a relatively large amount if a relatively large percentage of these sets take advantage of the option to only use one vertical line. We note that we wouldn't necessarily expect risk reduction to fully equal 50% for each buoy line removed, as there have been a small number of whale entanglements reported in the groundline of U.S. West Coast fisheries with multiple trap strings of gear with similar configurations. Based on forensic review, 17 whale entanglements have involved multi-pot strings of gear that we've identified since 2014, we know at least two have involved the groundline, although there are several where that detail is unknown (NMFS unpublished data). For leatherbacks, available information from the 2008 sablefish pot entanglement does not clearly describe where part of the gear was involved (NMFS unpublished data). We acknowledge that it is possible that the extent of injuries that could result from entanglements with gear that has less vertical lines and buoys/surface gear could be reduced.

Previously, entanglements with sablefish pot gear, and other multiple-trap strings of gear fromU.S. West Coast fisheries have almost always led to serious injury or mortality absent human intervention to help remove the gear (see *Response to Pot Gear Entanglement* below), presumably in part due to the significant weight of gear involved that animals have to deal with if entangled. However, it is not clear if removal of one end line and associated surface gear would dramatically change the nature of entanglements with this type of gear configuration, especially considering the amount of the weight involved associated with the traps that are connected via the groundline.

Ultimately, while there is great potential for removal of the requirement to have both ends of a set of sablefish pot and bottom longline gear buoyed to the surface at all times, there is a great deal of uncertainty in how those potential benefits will be realized, in the near term or over the long run. As a result, until we have a clearer understanding of how extensive the fleet will take advantage of this measure, and to what other effect this measure can/will be implemented in concert with other measures such as use of lighter weight gear, we are not able to factor this potential into future expectations for entanglements in sablefish pot or bottom longline gear.

It is also possible that standardization of a maximum amount of surface gear used could reduce the risk of an entanglement occurring in that portion of the gear. Based on our forensic review of the five previous sablefish pot humpback whale entanglements documented, we conclude that surface gear likely hasn't been directly involved in those entanglements, but extensive surface gear with multiple buoys and high flyers can add to the severity of an entanglement. On review of the 345 confirmed whale entanglements (all whale species) reported since 2013, we identified surface gear as being at least somewhat involved in 13% percent of them (NMFS unpublished data). For leatherback entanglements, review of the available information suggests that surface gear could have been involved two of the three recent entanglements (information from the 2008 sablefish pot entanglements does not describe what part of the gear was involved), although we can't confirm it from that from the documentation we received (NMFS unpublished data).

Ultimately, while we recognize minimizing the extent of surface gear that may be used is a proactive step to minimize the risk of entanglement, it is not immediately clear how big a change this is from the status quo operations of the sablefish pot and bottom longline fleet, as data on the amount of surface line used is not readily available to us. While entanglement in the surface gear/line is a concern, and has occurred in numerous West Coast entanglements, having a surface line that extends up to 10 fm is unlikely to completely eliminate the risk of an entanglement in this portion of the gear altogether. As a result, until we have a clearer understanding of how this measure can/will reduce entanglement risk, we are not able to factor this into our analysis of entanglement risk for humpback whales and leatherback sea turtles in sablefish pot or bottom longline gear.

Impact of Slinky Pot Use

As described in section 1.3.3 *Overview of Limited Entry Fixed Gear Fisheries (Non-Catch Shares*), there has been a shift emerging in the sablefish pot fishery to use slinky pots, which are lighter and can be fished using a lighter groundline. Previously there wasn't explicit tracking of slinky pot use, although the new non-trawl logbook will provide information on slinky pot gear use in the future.

It is possible that use of slinky pots could change the relative risk associated with using sablefish pot gear in the PCGF. The use of lighter weight gear could result in fewer or less severe entanglements, if animals are able to more easily break or shed gear during an interaction such that entanglements or serious injuries don't materialize as a result of an interaction with this gear. Previously, entanglements with sablefish pot gear, and other multiple-trap strings of gear from U.S. West Coast fisheries have almost always led to serious injury or mortality absent human intervention to help remove the gear (see *Response to Pot Gear Entanglement* below).

At this time, we conclude the evidence to support any meaningful reduction in entanglements risk associated with the continued development and expansion of slinky pot gear use is not yet conclusive or substantiated, notably given the observed humpback whale entanglement in 2023 which involved slinky pot gear. While the circumstances of that entanglement are complicated by the involvement of additional gear, there is too much uncertainty about exactly what happened to completely discount this event as not being at least somewhat reflective of the risks that slinky pot gear use poses. Without any information collected about slinky pot use until now, we are limited in the ability to interpret how this change is impacting conduct of the PCGF sablefish pot fishery in a meaningful way, and cannot assess how future implementation would impact expectations for future entanglements. It is possible that use of slinky pots could complement the risk reduction measure of reducing the number of buoy lines used for sablefish pot gear, if lighter gear is more conducive to use of this approach. However, it remains uncertain if that should be expected, and will be something that NMFS will need to monitor moving forward.

2.5.1 Humpback Whale Effects

For the *Effects of the Action* analysis, we have identified the impact of incidental entanglement, hooking, or capture in PCGF gear as the primary adverse effect of the PCGF on both the Mexico DPS and Central DPS of ESA-listed humpback whales[9]. Gear interaction risk can be divided into risk associated with the different categories of gear type used in the PCGF: fixed pot or trap, hook-and-line, and midwater trawl net.

2.5.1.1 Exposure and Response – Bycatch in the PCGF

To determine the exposure and response of ESA-listed humpback whales to the PCGF, NMFS relies on several sets of data: (1) data on bycatch and fishing effort from the WCGOP; (2) opportunistic reports of entangled whales to the NMFS WCR Marine Mammal Stranding Program, and (3) a humpback whale species distribution model.

As described in more detail in *Approach to the Effects Analysis* above, the exposure analysis considers entanglement risk from various perspectives: (1) annual bycatch estimates, (2) 5-year average bycatch estimates, (3) recent entanglement records (4) fishing effort trends in space and time by gear type (2014-2023), (5) modeled humpback whale density predictions (2014-2023), and (6) the degree of co-occurrence of modeled humpback whale distribution with various sectors of the groundfish fishery, and which is further described in Appendix A.

2.5.1.2 Exposure and Response to Interactions with the Sablefish Pot Fishery

<u>Bycatch Estimates</u>

The NCS sector of the fixed-gear sablefish pot fishery includes the LE primary and the OA fisheries. Since the deployment of observers in 2002, three documented entanglements of

[9] Throughout the effects analysis, references to humpback whales generally are applicable to both the Mexico and Central America DPSs, unless otherwise specified.

humpback whales in the PCGF have occurred; one in the LE sablefish pot fishery (2014), one in the OA sablefish pot fishery (2016), and one in the LE sablefish pot fishery (2023) which involved both sablefish slinky pot and halibut longline gear (Somers et al. 2024). Using these data, the NWFSC estimated mean annual fleet-wide bycatch and a running 5-year fleet-wide average in the LE and OA pot sectors separately (Somers et al. 2024) (Table 8). Both the LE and OA estimates were produced using fishing effort represented by observed landings in metric tons, which was previously identified as the best fit model for these sectors (Jannot et al. 2021).

For the purposes of our analysis, we focused on the estimates from 2011-2023. Generally, 2011 is a significant point in the history of PCGF management, given rationalization of the trawl fishery. One of the consequences of this was the beginning of CS fixed gear fisheries, including the CS pot fishery. Although the LE and OA pot fisheries existed previously (with known bycatch of humpback whales first reported in 2006), we choose to focus on the bycatch estimate record starting with 2011 knowing that we were likely to draw some inferences about future risk of bycatch in the CS pot fishery based on information from the LE and OA pot fishery sectors. This time period also covers most of the documented humpback whale interactions with PCGF pot fishing, and a wide range of environmental and other conditions relevant to the current state and foreseeable future of the PCGF pot fishery. This also is consistent with the time period we used for other sectors of the PCGF, including midwater trawl fisheries since the 2011 trawl rationalization.

Table 8. Summary of humpback whale bayesian entanglement estimates 2002-2023, including lower (LCI) and upper (UCI) 95% confidence intervals, in: (a) LE pot fishery sector and (b) OA pot fishery sector.

Year	Annual Bycatch	Conf. Limit (Lower)	Conf. Limit (Upper)	Running 5- year Mean	5-year Mean CL (Lower)	5-year Mean CL (Upper)
a) LE Pot						
2002	0.17	0	1	0.00	0	0
2003	0.29	0	2	0.00	0	0
2004	0.34	0	2	0.00	0	0
2005	0.20	0	1	0.00	0	0
2006	0.25	0	2	0.25	0	2
2007	0.20	0	1	0.26	0	2
2008	0.11	0	1	0.22	0	2
2009	0.25	0	2	0.20	0	2
2010	0.22	0	1	0.21	0	2
2011	0.13	0	1	0.18	0	1.9
2012	0.11	0	1	0.16	0	1.9
2013	0.14	0	1	0.17	0	1.9
2014	1.14	1	2	0.35	0	1.9
2015	0.09	0	1	0.32	0	1.9
2016	0.06	0	1	0.31	0	1.9
2017	0.15	0	1	0.32	0	1.9
2018	0.07	0	1	0.30	0	1.9
2019	0.13	0	1	0.10	0	1
2020	0.17	0	1	0.12	0	1
2021	0.21	0	1	0.15	0	1
2022	0.13	0	1	0.14	0	1
2023	1.20	1	2	0.37	0	1.9

b) OA pot	Annual Bycatch	Conf. Limit (Lower)	Conf. Limit (Upper)	Running 5-year mean	5-year Mean CL (Lower)	5-year Mean CL (Upper)
2003	1.24	0	5	0.00	0	0
2004	1.09	0	5	0.00	0	0
2005	2.37	0	9	0.00	0	0
2006	2.77	0	10	0.00	0	0
2007	1.57	0	6	1.81	0	9.9
2008	1.52	0	6	1.86	0	9.9
2009	2.37	0	9	2.12	0	9.9
2010	2.02	0	8	2.05	0	9.9
2011	1.53	0	6	1.80	0	8.9
2012	0.76	0	4	1.64	0	8.9
2013	0.43	0	2	1.42	0	8.9
2014	0.89	0	4	1.13	0	7.8
2015	1.36	0	6	0.99	0	6
2016	2.22	1	6	1.13	0	6
2017	1.19	0	5	1.22	0	6
2018	1.00	0	4	1.33	0	6
2019	0.90	0	4	1.33	0	6
2020	0.39	0	2	1.14	0	5.9
2021	0.53	0	3	0.80	0	4.9
2022	1.57	0	6	0.88	0	5.8
2023	1.37	0	6	0.95	0	6

Bycatch Estimates Key Findings (Table 8):

- We compared humpback whale bycatch estimates since 2011:

- LE averaged 0.29 annual entanglements from 2011-2023 and ranged from 0.06-1.20.
    - The 5-year average estimate from 2015 (starts with 2011 year)-2023 was
      0.24 and ranged from 0.10-0.37
- OA averaged 1.09 annual entanglements from 2011-2023 and ranged from 0.39-2.22
    - The 5-year average estimate from 2015-2023 was 1.09 and ranged from 0.80-1.33

Observation Rate Notes (Table 3 in *Section 1.3.7.3*):

- Observer coverage rates are based and calculated based on landings (in metric tons) in each respective gear type, sector, and year.
- CS is 100% monitored either through EM or human observers (Somers et al. 2024)
- LE had an annual average observer coverage rate of 46.3% from 2011-2023, which was below the 2023 coverage of 53% (Somers et al. 2024).
- OA had an annual average coverage rate of 7.1% from 2011-2023, which was above the 2023 coverage of 5% (Somers et al. 2024).

Opportunistic Entanglement Reports

From 2011-2024, there have been two humpback whale entanglements with sablefish pot gear reported to NMFS through opportunistic observations that were not reported by or through the WCGOP, totaling five entanglements with sablefish pot gear since 2011 (we acknowledge that there was one prior opportunistic report received in 2006). These opportunistic reports come from ocean users in 2016 and 2017. These reports were identified using the identification numbers that were documented on the buoys that were recovered as part of disentanglement efforts. At this time, we do not have enough information to determine which sector(s) of the pot fishery are responsible for these humpback entanglements. Due to the difficulty in applying any type of expansion factor to these types of reports, the best use of this data is to use it to ground truth bycatch estimates by looking at the opportunistic entanglement report records as a minimum source of accounting regarding the potential total number of entanglements that may have occurred in the past.

In general, the quantity and quality of information received from opportunistic reports has increased over time, in addition to NMFS's ability to evaluate them (Saez et al. 2020). Herein, we focused on looking at how the opportunistic entanglement data and the PCGF pot fishery has changed since 2011. The volume of entanglement reports and our ability to identify the origins of gear that are involved in entanglements has improved significantly in recent years due to forensic analysis and gear marking efforts.

From 2011 to 2023 (2024 entanglements are still under review by NMFS WCR), NMFS received and evaluated 258 confirmed humpback whale entanglement reports (these all represent separate cases – does not include resighting of an entangled whale multiple times and are all only from the West Coast) (NMFS 2024a). Since 2011, five of these reports have been identified as associated with the sablefish pot fishery, which represents about ~1.9% of all confirmed entanglement reports. Of these 258 cases, 124 (48.1%), records are positively identified to some particular source or origin, and 134 (51.9%) records where the gear could not be identified. As a result, 4.0% of the humpback entanglement records that have been attributed to a known origin were attributed to the sablefish pot fishery (5 out of 124). With respect to the 134 unattributed cases, if we assume 4.0% of those may have also been attributed to sablefish gear, that would equate to ~5.4 additional sablefish entanglements that may have been reported since 2011 (4.0% of 134), that were not identified. There have also been 11 confirmed additional entanglement reports of unidentified whales with unidentified gear, some of which would be expected to involve humpback whales, from 2011-2023 (Saez et al. 2023). Based on the low likelihood (4.0%) that any entanglement report involves sablefish gear, it is unlikely that any of those 11 reports of unidentified whales would be humpback whales entangled in sablefish gear.

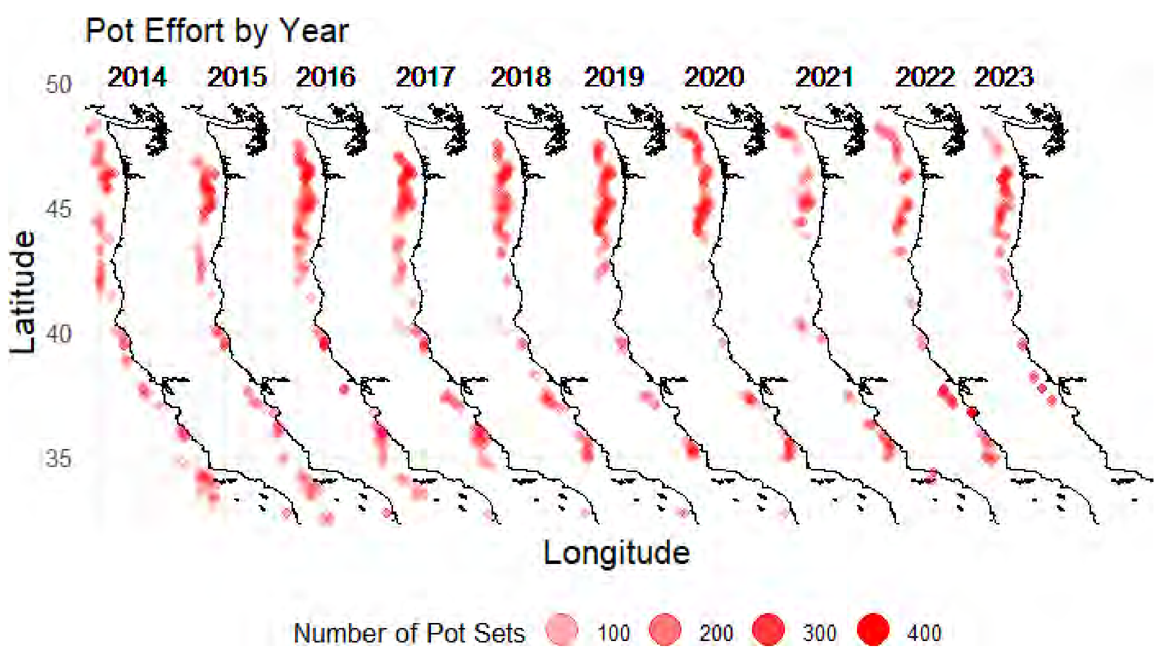
It is important to acknowledge that we do not have a clear understanding of how many humpback whale entanglements may have occurred without being reported. Overall, we conclude that the record of opportunistic entanglement reports related to the sablefish pot fishery and humpback whales, WCGOP's entanglement observations, and WCGOP's bycatch estimates do not appear to be inconsistent with each other. Although we lack specific expectations for how many actual entanglements might be detected and reported through opportunistic means, it is plausible that only a fraction of total entanglements is captured in these reports. The sablefish pot fishery operates across a broad range of the U.S. West Coast, including remote offshore areas not heavily frequented by ocean users. However, detecting these entanglements might be easier compared to those involving other types of gear because whales entangled in heavier strings of pot gear, like sablefish gear, are often more restricted in their movements and less likely to be free-swimming, making the entanglement more noticeable to observers. Ultimately, while we cannot directly calibrate opportunistic reporting with estimates of sablefish pot fishery entanglements derived from observer coverage, we find that the record of opportunistic reports does not conflict with the estimates and expectations generated from observer data and other analytical methods used to date.

PCGF Sablefish Pot Fishing Effort

For analysis of sablefish pot fishing effort in this opinion, we represent effort by the number of unique pot sets unless specifically stated otherwise. This is because pot sets are likely a more accurate depiction of relative fishing effort as it relates to entanglement risk than other metrics. Although there is variation in how many pots may be used in a single set, or landings derived from that set, the vertical lines at the end of a string of pots is the main factor associated with whale entanglements, and is generally understood to have involved two vertical lines for most every set made previously (see Impact of Gear Marking and Risk Reduction Measures on Bycatch Risk section below).

Pot sets show varying patterns of distribution and fishing effort over the years (displayed by Figure 9, and further broken down by sector in Figure 10). The WCGOP calculates an observer coverage rate for each year, gear, and sector of the groundfish fishery. Since the observer coverage rates vary over time, and across sectors, it is difficult to directly compare effort metrics gathered from WCGOP data without adjusting for the relative proportion of effort that was covered by observers. Therefore, for every year in each sector, we divided the observed number of sets by proportion of the landings observed in that year to represent the estimated 100% totality of fishing effort (number of sets) within each sector.

There has been a northward shift in PCGF pot fishing effort over time; in recent years there has been minimal effort within the Southern California Bight (Figure 9). This is largely due to the northward shift of effort in the CS sector, but effort in both the LE and OA sectors follow this northward trend as well (WCGOP, unpublished data*[10]). The magnitude of pot effort from 2014-2023 has been relatively steady (Figure 10). LE effort was broadly distributed throughout the range of pot effort across the coast, and OA effort (observed) in recent years has been concentrated along northern and central California. PCGF pot fishing for all sectors was heaviest from April-November, with LE, OA, and CS effort peaking in October, August, and October, respectively (Figure A-3, Table A-2).



[10] * While we did examine this data using the same visual and data analysis formats, we are unable to effectively illustrate these patterns visually without compromising MSA confidentiality. The * will represent this situation throughout the Opinion and Appendix A, where appropriate.

Figure 9: Pot sets scaled up by sector to represent 100% of fishing effort based on observed WCGOP data, plotted by year (2014-2023), and labeled by magnitude of pot sets.

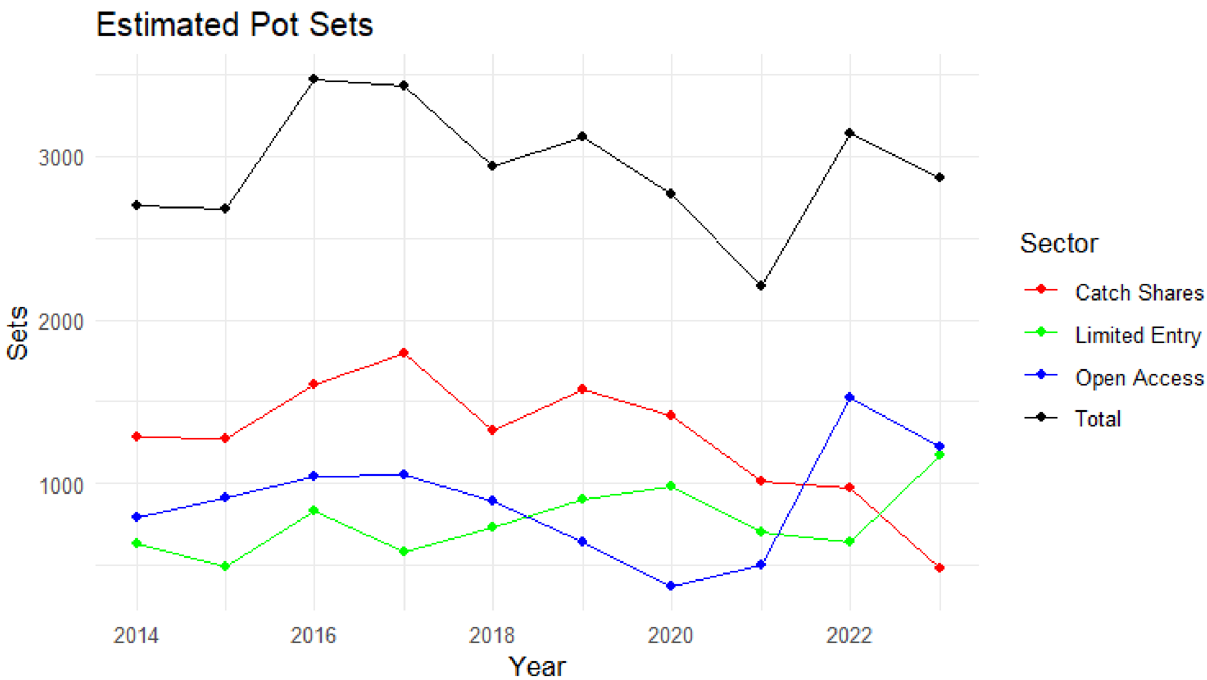


Figure 10: Estimated pot sets by sector for the years 2014-2023. Lines are colored by sector and the black line represents the total sets summed for all sectors.

The CS sector fishery is generally considered 100% covered, either by EM or human observers. The LE and OA sectors have substantially less observer coverage and do not utilize EM, only human observers. The LE sector on average from 2014-2023 has 52% of landings observed, and the OA sector on average has 8% of landings observed (Somers et al. 2024). With respect to our co-occurrence analysis, this presents the following difficulties with presentation and interpretation. With limited coverage in the OA sector, observations could be biased to specific areas or time periods associated with observer deployment, which can be magnified by scaling the OA sector data up based on those limited observer coverage rates on an annual basis (over a longer time, coverage of the OA sector is expected to be a representative sample of the entire fishery). Thus, areas that overlap with species models then appear as if there is a large overlap of effort occurring in that area, but in actuality it is inflated, or potentially vice versa, because of the limited OA sector data available for a given year. Essentially this heavily weights consideration of observed OA sector data points.

Co-Occurrence Analysis

Historically, all reported humpback whale entanglements involving sablefish pot fishing were known to have occurred or been reported off the coasts of Oregon and California, except for the recent 2023 entanglement near the Washington/Oregon border, 25 miles offshore from the Columbia River in Washington. While we do not have confirmed locations of where the gear was set in all of these previous cases (e.g., opportunistic sighting reports), we assumed it was likely most previous entanglements occurred off the coast of Oregon or California based on the relative distribution of effort (landings) across the sablefish pot fishery (NMFS 2020a).

In order to anticipate what will happen in the future, including with respect to where along the U.S. West Coast that bycatch risks, and ultimately interactions with PCGF gear might occur, along with the trends in general magnitude of risks for different sectors, we examined the recent co-occurrence of the different PCGF sectors with humpback whales (see Appendix A for full description of the effort)

Pot fishing and the resulting overlap with humpback whales peaks in the late summer/early fall months of September and October (Table A-2, A-9). Peak overlap does differ by fishery sector with the LE sector containing the most overlap in October, the CS sector in November, and the OA sector in June (Table A-9). Overall, 86.9% of overlap between pot fishing and humpback whales occurs during the primary ‘whale season’ when humpback whale abundance is highest on the U.S. West Coast from April-November. Predicted peak whale density in the months from August to November coincides with elevated fishing effort in the areas surrounding Cape Mendocino in California and Cape Blanco in Oregon, suggesting these areas have been and could be areas of higher potential entanglement risk (Figure A-3, A-18). Generally speaking, the elevated entanglement risk to humpbacks resulting from predicted co-occurrence predominantly in summer and fall coincides with the previous entanglement record, where humpbacks tend to be reported entangled in larger frequencies in the summer and fall compared to the winter and spring (Saez et al. 2020).

We also looked at the interannual variability of overlap over the last decade, to help understand how risk may be changing over time. Over time, we see overlap risk has shifted northwards, with less overlap occurring in California waters in recent years, compared to the waters off of Oregon and Washington. The magnitude of overlap between humpbacks and pot effort remained relatively stable from 2014-2023, with slight oscillations (Figure 11). The year with the highest overlap across all sectors for the time series was 2017; however, the LE sector peaked in overlap in 2020, the OA sector peaked in overlap in 2015, and the CS sector peaked in overlap in 2017 (Figure 11).

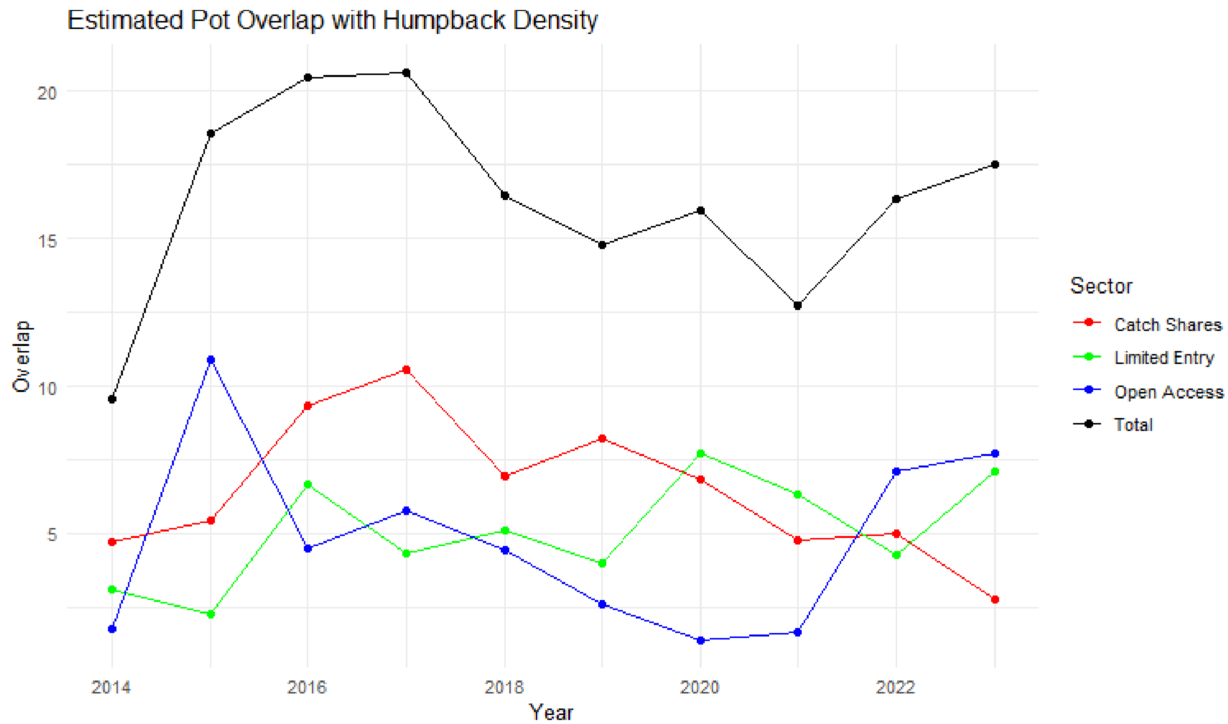


Figure 11: Estimates of the pot set overlap with the humpback whale density distribution model. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each year for all years 2014-2023.

Across the entire time series, areas of highest overlap values occur along the Oregon/Washington border, specifically near the Columbia River mouth, around the San Francisco and Monterey Bay areas in California, directly south of Cape Mendocino in California, and Big Sur, CA (Figure 12). There is consistent overlap across the broad distribution of both humpbacks and pot fishing effort, but it appears that the densest aggregations of overlap are along the Oregon coast, with continued overlap along the coast of Washington, and more disconnected patches of overlap along the California coast. OA sector overlap is most concentrated in northern California south of Cape Mendocino, in the Monterey Bay area, and offshore of the Columbia River mouth area (WCGOP, unpublished data*). The LE sector overlap is concentrated around Cape Mendocino and extends north to Cape Elizabeth in Washington, sharing a similar spatial overlap as the CS sector, and similar areas of increased overlap with OA (WCGOP, unpublished data*).

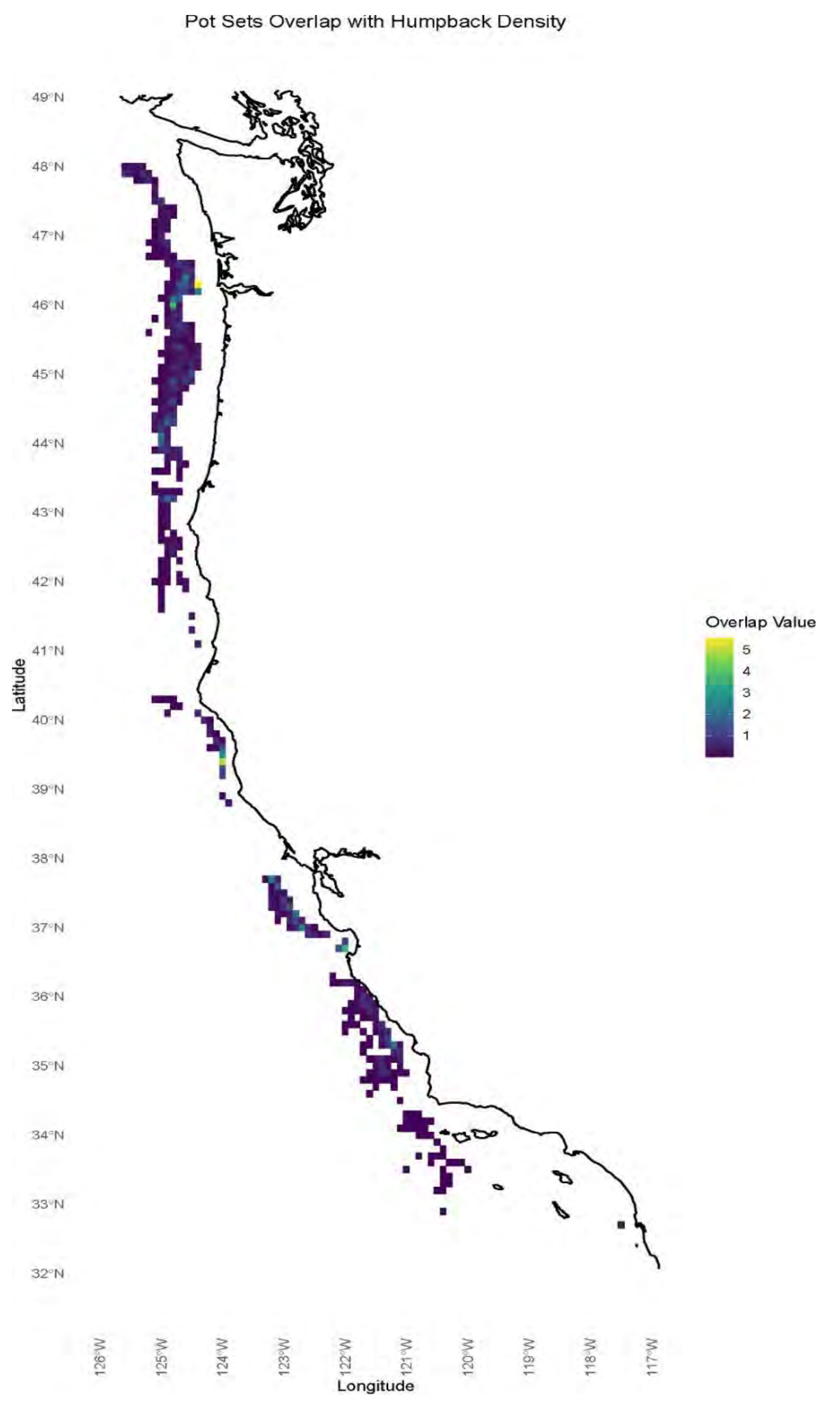


Figure 12: The product of the estimated number of pot sets overlapped with humpback whale density. Overlap is colored by magnitude of overlap and is a unitless metric.

We also considered what proportion of pot sets had at least some overlap with predicted humpback whale occurrence (i.e., whale density prediction was greater than zero). Given what we know about humpback whale DPSs and their relative distributions along the U.S. West Coast, we also wanted to view how these fisheries overlap in California and Oregon (CA/OR), versus

Washington (WA) (Table 9), as part of risk assessment with respect to the different humpback whale DPSs. Our findings indicate a little less than half of total estimated pot sets in the LE sector overlapped with an area where humpback whales were predicted to occur, with 27% of these sets occurring in WA, and 73% of these sets occurring in CA/OR, similar to CS (Table 9). For the OA sector, a similar number of estimated sets overlapped, with relatively fewer of the estimated overlap sets occurring in WA, and most occurring in CA/OR (Table 9). In total, 40% of total estimated sablefish pot fishing sets were predicted to have overlapped with humpback whale distribution, with 75% of those overlapping sets occurring in CA/OR and 25% in WA (Table 9), which is also very similar to the relative proportions of landings (Table A-12). The comparable overlap proportions between California/Oregon and Washington between the CS and LE sectors indicates these sectors are similar. Given the lower observer coverage in the OA sector, it is difficult to directly compare it to CS and LE sectors.

Table 9: Total overlap relative to the percentage of pots sets with overlap with predicted humpback whale distribution (above zero) for each sablefish pot sector, broken down by area of fishing (California/Oregon versus Washington). Fishing effort sets are estimated/scaled up to account for 100% of fishing effort.

Sector	Overlapping Sets/Total Sets	Proportion Overlap in CA/OR	Proportion Overlap in WA
LE	42%	73%	27%
OA	38%	89%	11%
CS	42%	75%	25%
Total	40%	75%	25%

<u>Anticipated Future Entanglements in PCGF Sablefish Pot Gear</u>

Having reviewed and evaluated the available information, including recent developments that aren't necessarily reflected in the historical information regarding humpback whale bycatch risk in the PCGF sablefish pot fishery, we combine it all together to anticipate future levels of entanglement, based on the current state of the PCGF.

First, we look to the historical bycatch estimates for the sablefish pot fishery, generated for the LE and OA sectors, since those represent the most complete assessment of what has occurred up to the point. As described in *Bycatch Estimates* above in this section (Table 8), annual estimates of humpback whale entanglements have been as high (from 2011-2023) as 1.20 and 2.22 for the LE (2023) and OA (2016) sectors respectively, and the highest 5-year averages have been 0.37 and 1.33, for the LE and OA sectors respectively. Although the trends in effort and predicted level of co-occurrence has been relatively flat over the last ten years for these sectors, the recent increase in the total effort during 2023 (along with predicted co-occurrence), along with the increasing population of humpback whales in the action area, suggest that bycatch is more likely to occur at the high end of range of what has occurred. Therefore, we look to the maximum values from recent years (since 2011) to inform our expectations for future bycatch for these sectors, in terms of what may happen in any one year, and over a 5-year average. As a result, we consider that as many as 3.42 humpbacks may have been entangled in total during any one year, and 1.70 may be the highest average of entanglements over a 5-year period since 2011.

There are no bycatch estimates representing the CS sablefish pot sector, because no bycatch events have been observed in this sector. This does not mean the estimates of what has occurred in this sector are necessarily “zero”, but rather estimates cannot be produced. Given the rarity of humpback whale entanglements, significant observer coverage of the CS sector, and CS containing the lowest co-occurrence of all the sectors, it is possible no entanglements have occurred in the CS sector. However, given the general nature of fishing sablefish pot gear by CS vessels shares similar characteristics as the LE and OA sectors, we assume that some risk of future entanglements exists.

To help evaluate this for the CS sector, we elected to use information from the historical bycatch estimates for the LE and OA sectors, and the overlap analysis we completed for each of these sectors (Appendix A). The overlap analysis generally reflects both the similarities and differences in relative entanglement risk in terms of the distribution of risk in space, time, total effort, and summed annual overlap of the fishing effort along with the predicted humpback whale densities to scale the relative risk of the CS sector, despite the absence of previously documented entanglements. We compared annual overlap values between PCGF pot fishing and humpback whale density for each sector and calculated the summed overlap for each sector throughout the time series (Table 10; Appendix A). The average overlap for over the last 10 years for the CS sector was 6.45, and for LE sector the average was 5.10, which would indicate that generally speaking the CS sector has had a similar level of overlap and potential for entanglement as the LE sector. However, we note the CS sector is 100% monitored compared to the LE sector, and an entanglement has not previously been observed in this sector. One thing we note is that the relative level of overlap in the CS sector has been less than the LE sector during the most recent years. We note that the average overlap of the OA sector has also been similar to the LE sector, but slightly lower than the CS sector, on average during this time. However, we view the overlap results of the OA sector as having the greatest level of uncertainty based on the limited observer coverage and data available, which has to be scaled up by a large proportion, and are cautious in using this information to draw too many inferences for this type of application given the possible biases. After further consideration, we elect to use the LE sector overlap to make inferences about relative risk in the CS sector, as the LE sector has much higher observer coverage rates, and therefore less potential for spatial and overlap bias. Ultimately, we conclude that the relative overlap of the CS sector has been similar to the overlap level of the LE sector over time, although the trends over the last ten years are heading in opposite directions.

Table 10: Overlap separated by year and sector for all sablefish pot overlap with the humpback whale density model. These include overlap within all months of the year.

	LE	OA	CS	Total
2014	3.11	1.17	4.69	9.55
2015	2.24	10.91	5.43	18.58
2016	6.66	4.47	9.33	20.46
2017	4.34	5.77	10.53	20.64
2018	5.08	4.44	6.93	16.46
2019	4.25	2.60	8.21	14.81
2020	7.70	1.40	6.85	15.95
2021	6.31	1.63	4.79	12.73
2022	4.25	7.11	4.99	16.35
2023	7.09	7.72	2.74	17.54
Average	**5.10**	**4.72**	**6.45**	**9.55**

Using this information, we generally can conclude that the risk of entanglements in the CS sector is generally equivalent to the risk in the LE sector. Looking at our expectation for future entanglements in the LE sector, we assume there could be as many as 1.20 entanglements in any year estimated to occur, which would equate to an estimation of a similar number of (1.20) entanglements in the CS sector in any year. Following along the same line, we assumed that an average of as many as 0.37 entanglements could occur over a 5-year period in the LE sector, which would equate to an estimated average of the same number (0.37) entanglements occurring over a 5-year period in the CS sector. Although our overlap analysis suggests that risks of entanglements in the CS have been generally declining in recent years, primarily as a result of the northward shift in fishing effort, entanglement risks could increase again or at least be sporadically high in certain years in the future. While there may be some other differences between the CS and the other PCGF pot fishery sectors that could explain why the CS sector has not been associated with entanglements previously, we do not have any clear understanding of how or why that is the case.

As a result, we anticipate annual overall estimates for the entire PCGF sablefish pot fishery as follows:

> **Annual maximum** = LE entanglements (1.20) + OA entanglements (2.22) + CS entanglements (1.20) = no more than 4.62 entanglements
>
> **Maximum 5-year running average** = LE entanglements (0.37) + OA entanglements (1.33) + CS entanglements (0.37) = no more than 2.07 entanglements

DPS Apportionment

In order to apportion the total number of humpback whale entanglements that we expect to occur as a result of the proposed action, we applied information from our overlap analysis to weight the relative amount of humpback whale entanglement risk across the entire fishery, based on the assumed distribution of the humpback whale DPSs, described in Section 2.2.2.1. Through the overlap analysis (Appendix A), we estimated that ~75% of the risk of humpback whale entanglement in the PCGF sablefish pot fishery occurs off California and Oregon, and ~25% occurs off Washington, based on the distribution of overlap summed across all sectors (Table A-11). Given the assumed distribution of humpback whale DPSs off the U.S. West Coast, we expect 42.3% of humpback whales that may become entangled in PCGF sablefish pot gear off California/Oregon will be Central America DPS individuals, and 57.7% will be Mexico DPS individuals. Similarly, we expect 5.9% of humpback whales entangled in sablefish pot gear off WA will be from the Central America DPS, 25.4% will be from the Mexico DPS, and 68.8% will be from the unlisted Hawaii DPS (Table 3). Therefore, using these two sets of information in combination, along with our expectations for the total number of entanglements across the entire sablefish pot fishery, to generate an annual and 5-year average maximum estimate for each ESA-listed humpback whale DPSs, as represented in Table 11.

Table 11. Anticipated bycatch of ESA-listed humpback whale DPSs in the PCGF sablefish pot fishery.

	CA/OR Bycatch	**WA Bycatch**	**Total Bycatch**
Mexico DPS			
Annual Maximum	2.00	0.29	2.29

Maximum 5-year Running Average	0.90	0.13	1.03
Central America DPS			
Annual Maximum	1.48	0.07	1.55
Maximum 5-year Running Average	0.66	0.03	0.69

Response to Pot Gear Entanglement

The survival probability of a marine mammal entangled in fishing gear depends largely on the species, age, or size of the individual involved. Documented cases indicate an entangled marine mammal may travel for extended periods of time and over long distances before freeing themselves, being disentangled by stranding network personnel, or dying as a direct result of the entanglement (Angliss & DeMaster 1998). It is often unknown whether an entanglement immediately causes a serious or debilitating an injury that will eventually to death[11]. If the gear is heavy or significantly restricts an animal's ability to swim, it could become exhausted from repeatedly trying to reach the surface to breathe and might eventually drown. Less severe entanglements can cause exhaustion, depletion of energy stores, and starvation due to the increased drag (Wallace 1985). Tightly wrapped gear around an animal's appendage can cause debilitating injuries, especially if it constricts, causes lacerations, or impairs swimming or feeding (Scordino 1985). Such injuries can make the animal more susceptible to disease or predation (Angliss & DeMaster 1998), and the lacerations may become infected. Sustained stress from repeated or prolonged entanglement may impair a marine mammal's ability to fight infection or disease (Angliss & DeMaster 1998). Younger animals are particularly at risk because as they grow, tightly wrapped gear becomes more constricting and many large cetaceans that become entangled in fishing gear are juveniles (Angliss & DeMaster 1998). Data from the NMFS WCR Stranding Database do not provide conclusive information on the size or age of most entangled whales, although juvenile whale entanglements are certainly part of that record.

The specific outcome of an entanglement event after the last sighting of an entangled or disentangled whale is rarely known. NMFS assesses the likelihood of M/SI for each entanglement based on the probability that the bycatch event results in M/SI, using the criteria outlined in Process for Distinguishing Serious from Non-Serious Injury of Marine Mammals (NMFS 2023a), and referred to in the SARs (Caretta et al. 2023). In the absence of

[11] The current criteria used for assessing the severity of injury to marine mammals are published as Protected Resources Policy Directive Process for Distinguishing Serious from Non-Serious Injury 02-238, effective February 7, 2023.

specific survival and mortality data for any ESA-listed humpback whale entanglements or bycatch events in the PCGF, we rely on M/SI rates from previous entanglements to guide our expectations for future incidents.

From the five confirmed humpback whale entanglements reported (observers and opportunistic reports combined) with sablefish pot gear since 2011, four cases have a readily available M/SI score. The total assessed M/SI with sablefish pot gear is 2.5; equating to an average M/SI rate of 0.63 (M/SI = 2.5/4 cases). This includes: one case where gear was removed during a disentanglement response leading to non-serious injury determination that otherwise would have been a serious injury (M/SI = 0); two cases where partial disentanglement resulted in a prorated serious injury score (M/SI = 0.75); and one case where the whale was observed to be deceased (M/SI = 1.0). Without intervention, the M/SI rate from the initial entanglement description would have been greater without a disentanglement response. Assuming no intervention occurred, the initial average M/SI rate would be 94% (3.75/4 cases). This is consistent with our general understanding that strings of multiple traps have the capability of inflicting serious injuries given their heavy weight and tendency to dramatically restrict movement of entangled whales. However, restricted movement may make it easier to respond and potentially disentangle whales. The 2023 entanglement that involved sablefish pot gear has not yet been evaluated for M/SI.

Given the relatively low number of humpback whale entanglements in sablefish pot gear, we examined cases with similar multi-trap string configurations (i.e. spot prawn or hagfish fisheries) as they provide additional examples of likely outcomes for entangled whales. The addition of other M/SI cases with similar gear configuration increases our sample size and therefore our confidence in our M/SI rate. The overall M/SI rate for multi-trap gear humpback whale entanglements (i.e. sablefish and spot prawn entanglements) from 2011-2022 is 0.5 (50%; M/SI = 7.5/15 cases); when interventions had occurred, and 0.92 (92%; M/SI = 13.75/15 cases) if intervention had not occurred. This is a highly similar rate to the 0.94 calculated strictly utilizing sablefish pot entanglements, thereby increasing our sample size and confidence in our M/SI rate. Although future intervention is not guaranteed, our intervention rate has been high for these types of entanglements, when reported. Assuming previous intervention and success rates will remain reflective of the future is uncertain. Therefore, we assume no intervention will occur in future entanglements. Thus, the extent of injuries documented prior to human intervention will represent the potential fate of all humpback whales that may get entangled with sablefish pot strings, in the future. Consequently, we estimate a M/SI rate of 0.92, for future entanglements in the PCGF sablefish pot fishery (Table 12).

Table 12. Anticipated M/SI of ESA-listed humpback whale DPSs in PCGF sablefish pot gear.

	Total Bycatch in PCGF Pots	Anticipated M/SI
Mexico DPS		
Annual Maximum	2.29	2.11
Maximum 5-year Running Average	1.03	0.95
Central America DPS		
Annual Maximum	1.55	1.43
Maximum 5-year Running Average	0.69	0.63

2.5.1.3 Exposure and Response to Interactions with Hook-and-Line Fisheries

Hook-and-line fishing gear can entail a wide variety of gear types and configurations that consequently pose varying levels of entanglement risk. Bottom longline is the most common hook-and-line gear type utilized in the commercial PCGF (SFD personal comm. November 1st, 2024), which poses a similar type of threat for entanglement as sablefish pot gear with vertical lines on each end of a string of gear (in this case hooks), attached to a horizontal groundline on the bottom, although there are differences in the specific lines (e.g., size/strength) and fishing practices (e.g., soak time) that are distinguishable from traditional sablefish pot gear. There has also been a growing sector of the PCGF that utilizes vertical line gear including rod-and-reel, stick, jig and other vertical longline-type gear which poses an entanglement and hooking risk due to the vertical lines/hooks in the water column. Additionally, although the gear associated with the PCGF recreational fishing sector is not well described, we generally understand that it primarily, if not exclusively, involved monofilament hook-and-line gear. Although typically much lighter than gear used in commercial fishing, recreational gear poses some risk of hooking and/or entanglements of whales and sea turtles.

Most of the data available for analyzing hook-and-line activity in the PCGF fishing is aggregated across gear types within WCGOP data, which precludes our analysis of specific hook-and-line gear in this Opinion. However, given that a majority of PCGF hook-and-line effort is bottom longline, we will assume that the majority of risk will be equated to bottom longline gear. However, we do consider the applicability of information across specific hook-and-line gears types, as appropriate. We also note that effort data on PCGF recreational fishing in federal waters, distinguished from recreational fishing in state waters for groundfish species, is not available, and we generally assume that the PCGF recreational fishery in federal waters is only a small fraction of recreational fishing for groundfish fisheries off the U.S. West Coast.

Bycatch Estimates

Previously, the WCGOP has generated bycatch estimates for the OA hook-and-line sector as a whole on two occasions (Hanson et al 2023, Somers et al. 2024), as a product of an interaction reported by a fishery observer in 2021 with OA vertical jig gear. This occurred offshore of California, and involved stationary vertical jig hook-and-line gear in which the gear was attached to the vessel. The vessel was targeting slope rockfish. The observer report for the 2021 incident states that during the retrieval of the unbaited line, a large humpback either purposely mouthed the gear or inadvertently tangled in the gear, although the observer did not witness the gear on the animal. The line was severed by the skipper as the whale swam beneath the vessel. Despite the positive identification of the whale, there was no visual confirmation of the entanglement, the configuration and amount of gear that might have been involved was unknown, as was whether there was any trailing gear remaining on the whale. These uncertainties have led to this observation being deemed an unconfirmed entanglement report by NMFS (89 FR 77789).

In addition to the uncertainty surrounding the event itself, the bycatch estimates produced from it have been generated across all OA hook-and-line gear/effort together, including bottom longline fishing effort, which has been the predominant gear type used for OA hook-and-line fishing. While all hook-and-line gears share some commonality with use of lines and hooks, the type of vertical jig gear associated with this unconfirmed entanglement is a different gear configuration than bottom longline gear. Across a long timeline of observer coverage of the NCS LEFG, OA, and TL sectors of bottom longline fishing, and the CS sector bottom longline fishing, there have been no previous observations of entanglements or hooking of humpback whales with that gear (WCGOP data).

The production of the bycatch estimates from WCGOP across the entire OA hook-and-line fishery were a result of their observation program deployment structure that aggregates coverage of all OA hook-and-line effort into one combined unit, despite the differences in gear configuration. As a result, they are unable to further segregate their analysis between PCGF bottom longline gear and vertical jig or other types of OA hook-and-line gear (WCGOP pers com. November 1st 2023). Given the uncertainty of what happened in 2021, with a gear type that represents only a small portion of the OA hook-and-line fishery, is a different gear configuration than PCGF bottom longline, has a previously documented track record of no observed entanglements, we do not think these bycatch estimates are representative of the entanglement risk posed OA hook-and-line fisheries as a whole, and will not be relied upon for use in our effects analysis.

Opportunistic Entanglement Reports

In addition to the one unconfirmed interaction with PCGF vertical jig gear reported by an observer described above, we consider the available information from other opportunistic reports of whale entanglements to help assess the potential risk of future PCGF hook-and-line interactions with humpback whales, including recreational fisheries. In total, there have been five recent confirmed reports of humpback whale entanglements off the U.S. West Coast with hook-and-line fishing gear, including monofilament hook-and-line, and commercial longline fisheries.

In May of 2015, there was a report of an entanglement of a humpback wrapped with a heavy gauge monofilament line, identified by NMFS as possible longline or commercial gear of unknown origin. In October of 2016, a humpback whale entanglement with monofilament line over the flukes of the animal was documented with a photograph, and another entanglement was documented in August of 2019 with a similar loop of monofilament line around the humpback's tail stock; both of unknown origins. In September of 2021, a recreational fisherman reported and submitted a video of an entangled humpback with monofilament line that NMFS later deemed was associated with California recreational hook-and-line fishing. However, it was not determined whether or not this recreational fisherman was targeting groundfish in the EEZ, and therefore associated with the PCGF. In conjunction with the sablefish pot entanglement of a humpback in 2023, this humpback was also entangled with Pacific halibut longline gear. In summary, these entanglement cases provide some evidence about the risk of hooking or entanglement that PCGF hook-and-line may pose, even if these entanglement cannot be attributed to the PCGF, given some of the general similarities of PCGF with the gears involved in these cases. Use of similar gear, particularly monofilament line, is also prevalent in many other commercial and recreational fisheries along the U.S. West Coast that are not associated with the PCGF, especially in recreational fisheries in state waters.

These five opportunistic reports described above, and one unconfirmed interaction with PCGF vertical jig, represent a small fraction of 258 confirmed humpback whale entanglement reports that have been received from 2011 to 2023. These have mostly been associated with monofilament lines, which is relatively easy to distinguish generally (although not to any specific origin) from the documentation provided with most entanglement reports. We presume this low rate of documented entanglements generally captures the low, but none-zero risk of interactions associated with monofilament hook-and-line gear, which is used throughout numerous commercial and recreational fisheries through the U.S. West Coast, including vertical jigs and/or recreational fishing gear.

We acknowledge that it is possible that certain types of PCGF hook-and-line gear such as bottom longline gear could be associated with one or more of the ~52% of U.S. West Coast entanglement records where the gear could not be identified, given similarities in the use of vertical lines supported by buoys similar to pot gear, and the one recent entanglement with bottom longline gear used in a different commercial fishery. However, given the lack of observations of entanglements historically in PCGF bottom longline gear, we conclude that there is some underlying difference in risk between bottom longline and pot gear, especially within the PCGF, that we have yet to fully understand. Likely, operational practices including soak time, and specific gear configuration and the strengths of components, could be factors. Therefore, we conclude there is a lower risk of interactions associated with bottom longline gear than with sablefish pot gear.

PCGF Commercial Hook-and-Line Fishing Effort

Similar to sablefish pot effort, for analysis of hook-and-line fishing effort in this opinion, we will choose to represent effort by the number of unique hook-and-line sets unless specifically stated otherwise. This is because sets are likely a more accurate depiction of relative fishing effort as it relates to entanglement risk, given the deployment of most of these gear sets involve one or two vertical lines deployed in the water column, and those vertical lines (including any hooks attached) represent the largest component of risk, based on our knowledge to date. We are limited to analysis of PCGF commercial hook-and-line effort, as the availability of spatially-explicit data on recreational PCGF fishing in the EEZ was not available.

As discussed previously, WCGOP aggregates all commercial PCGF hook-and-line effort together across different hook-and-line gears into one unit. Therefore, we are limited to analysis of PCGF hook-and-line fishing effort in this one aggregated unit. Based on our general understanding, given that the majority of the PCGF hook-and-line fishing effort is associated with bottom longline fishing, we assume that our analysis is most representative of the bottom longline fishing effort, and generally reflective of all PCGF hook-and-line effort.

Hook-and-line sets, combined across all sectors, and broken down by sector, show varying patterns of distribution and magnitude over the years (displayed by Figure 13, and further broken down by sector in Figure 14). Similar to what was described for coverage of sablefish pot effort, hook-and-line has varying levels of observer coverage across sectors. Effort in the following analysis has been scaled up accordingly using the same methodology as discussed in the previous section *2.5.1.2 PCGF Pot Fishing Effort* (and in Appendix A) to estimate the totality of fishing effort every year for each hook-and-line sector.

Hook-and-line effort has decreased in the amount of sets over time from 2014-2023, particularly for the CS sector, where there has been no effort from 2020 onwards (Figure 14). Despite the decrease in number of sets, hook-and-line effort still covers a wide distribution from southern California to northern Washington (Figure 13). OA sector effort occurred along the entire coast, LE TL sector effort has been concentrated around southern California, and LE sector effort occurred north of Monterey Bay, CA. When the CS sector was still operating, it was concentrated also in southern and central California (WCGOP, unpublished data*). Hook-and-line effort has been concentrated from April-October with the total fishing effort across all sectors peaking in August. The LE, LE TL, OA, and CS sectors peaked in effort in September, August, August, and October, respectively (Table A-4).

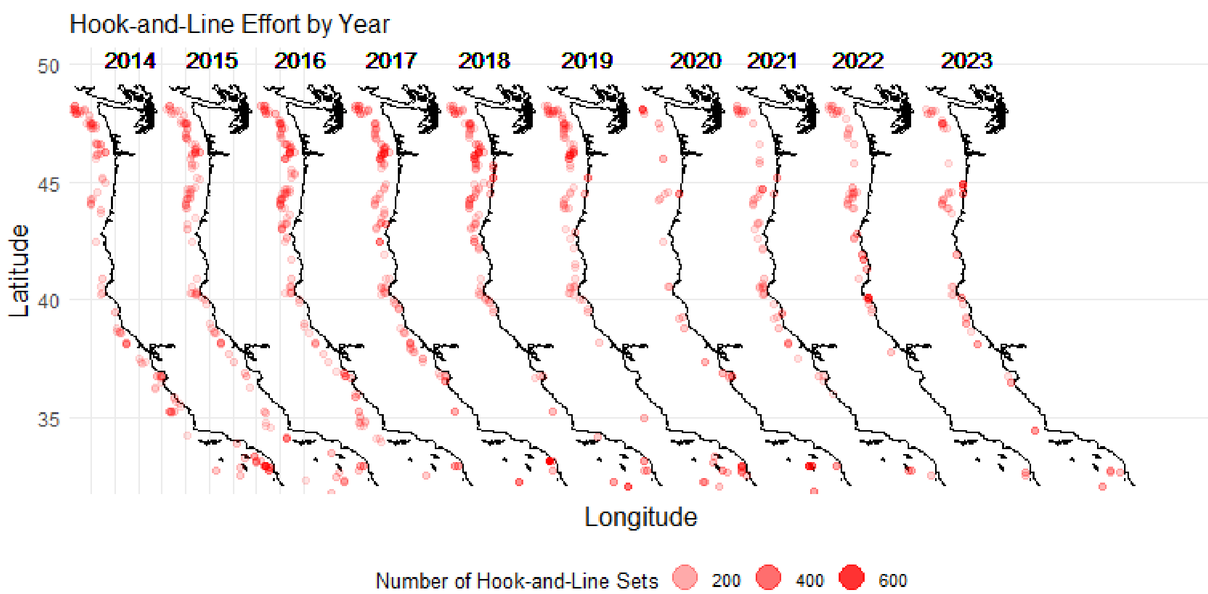


Figure 13: Hook-and-line sets scaled up by sector to represent 100% of fishing effort based on observed WCGOP data, plotted by year (2014-2023) and labeled by magnitude of hook-and-line sets.

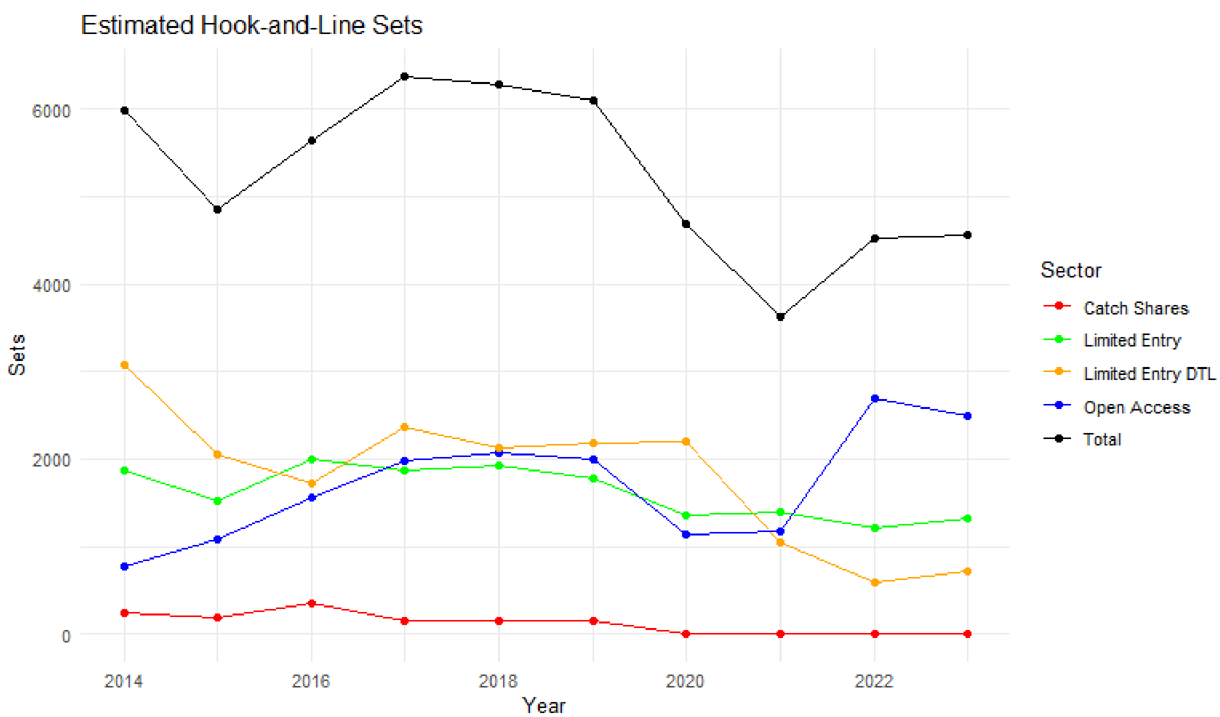


Figure 14: Estimated hook-and-line sets by sector for the years 2014-2023. Lines are colored by sector and the black line represents the total sets summed for all sectors.

The LE sector of the hook-and-line fishery has an average observer coverage rate from 2014-

2023 of 39% (Somers et al. 2024). Both the OA and LE TL sectors have an average observer coverage rate over the same time series of 4% (Somers et al. 2024). These have had substantially lower observer coverage than the ~100% covered CS fishery, either by EM or human observers, but NCS now constitutes 100% of the hook-and-line effort since 2020. For reasons described earlier, we are cautious in our interpretation of results for the OA and LE TL sector in particular given the low coverage rate, especially with respect to any individual year.

Co-Occurrence Analysis

While there is a lack of confirmed entanglements with PCGF hook-and-line gear historically, NMFS is exploring the recent patterns of risk to evaluate as part of consideration of what we will anticipate with hook-and-line PCGF gear in the future. This analysis will evaluate where along the U.S. West Coast bycatch risks for PCGF gear may be present, along with trends in general magnitude of risks for different sectors. See Appendix A for the full description of the underlying co-occurrence analysis we conducted.

Overlap across all commercial PCGF hook-and-line fisheries peaks in October, while fishing effort peaks in August, indicating that humpback whale distribution later in the season is driving this peak (Table A-14 and A-4). However, the second highest month of overlap was August which also corresponds with peak fishing effort. The timing of highest overlap varies slightly across sectors, with LE sector overlap peaking in September, LE TL and CS sector overlaps both peaking in October, and the OA sector overlap peaking in June (Table A-14). Fishing effort appears to be concentrated further north in the earlier spring and summer months, possibly leading to lower overlap despite higher fishing effort, as predicted humpback whales densities haven't reached their maximum levels that far north early in the year (WCGOP, unpublished data*). The largest overlap in the hook-and-line sector within California and Oregon occurs in the latter half of the year, from July to December (WCGOP, unpublished data*). In Washington, overlap mostly occurs from September-November, with the lower amount of overlap occurring earlier in the year concentrated in the northern part of the state and further offshore compared to peak overlap in September-November (WCGOP, unpublished data*).

We also looked at the interannual variability of overlap over the last decade, to help understand how risk may change in the future. Overlap for the different sectors has varied throughout the years, not following a definitive trend, although across all hook-and-line sectors altogether there has been less overlap in recent years compared to the previous years (Figure 15). The NCS sectors showed the highest year-over-year overlap compared to the CS sector, which appears almost negligible in comparison (Figure 15). The LE sector overlap peaked in 2016, the LE TL sector overlap peaked in 2016, the OA sector overlap peaked in 2022, and the CS sector peaked in 2016. Accordingly, across all hook-and-line sectors, overlap with humpbacks peaked in 2016 and has oscillated in magnitude throughout the years (Figure 15, Table A-15). Overlap throughout the years has not displayed any spatial trend in terms of aggregation in a single place or moving northward or southward, likely due to the broad distribution of hook-and-line fishing. Some minor spatial trends include: during the marine heat wave period (2014-2018), overlap was more concentrated in central and southern California and around the Columbia River.

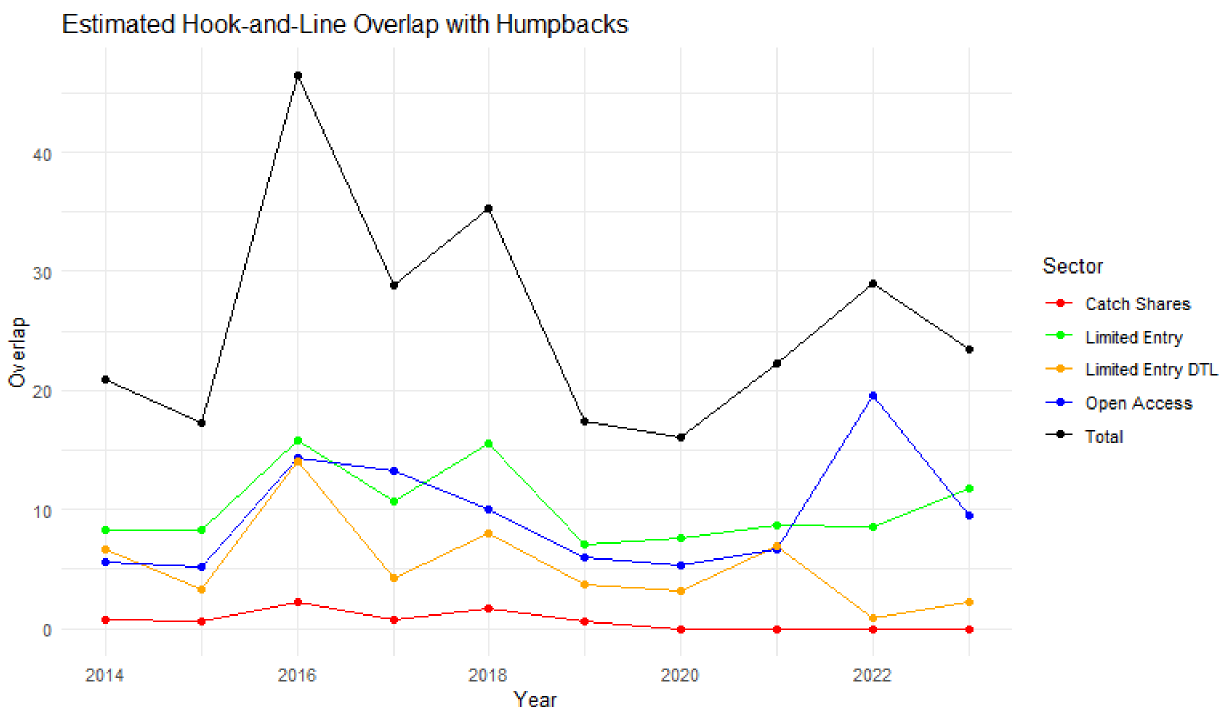


Figure 15: Estimated hook-and-line set overlap with the humpback whale density. Lines and points are colored by the sector in which the overlap belongs or the total overlap.

Predicted whale density in the months from August to November coincide with elevated fishing effort in the areas offshore Cape Elizabeth, Washington, the Columbia River, Point Reyes, California, Monterey Bay, California, and offshore Orange County and San Diego, California, suggesting these areas could be the highest risk spots for potential interactions (Figure 16 and WCGOP, unpublished data*). However, there is generally wide-spread overlap across the entire coast, with a slightly denser aggregation further north along the Oregon and Washington coasts (Figure 16). Overlap in California and Oregon is dominated by the LE sector in Oregon and northern California through Monterey Bay (with a majority of the OA sector overlap occurring in this same geographic area), with a predominance of LE TL and CS sector overlap in Central and Southern California (WCGOP, unpublished data*). Overlap off of Washington is dominated by the LE sector throughout the state, except for areas of OA sector overlap near the Columbia River, and CS sector overlap south of Cape Elizabeth (WCGOP, unpublished data*).

Hook-and-Line Sets Overlap with Humpback Density

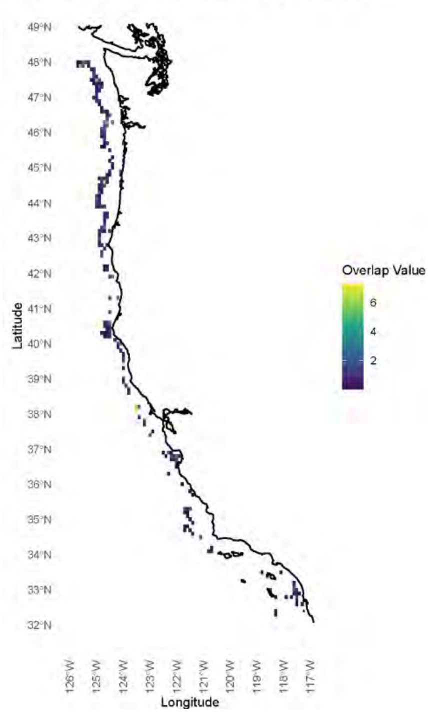


Figure 16: Estimated overlap between hook-and-line sets and predicted humpback whale density. Overlap is colored by magnitude of overlap which is a unitless metric.

We considered what proportion of hook-and-line sets had at least some overlap with predicted humpback whale distribution (i.e., whale density prediction greater than zero). Given what we know about humpback whale DPSs and their relative distributions along the U.S. West Coast, we also wanted to view how these fisheries interact in CA/OR versus WA (Table 13). Our findings indicate 42% of total estimated hook-and-line sets in the LE sector overlapped with an area where humpback whales were predicted to occur, with 35% of these sets occurring in WA and 62% in CA/OR (Table 13). For the LE TL sector, 37% of estimated sets overlapped, with 3% occurring in WA, and 97% in CA/OR (Table 13). For the OA sector, 41% of estimated sets overlapped, with 19% of the estimated overlap sets occurring in WA, and 81% in CA/OR (Table 13). In the CS sector, 41% of estimated sets overlapped, with 54% of the estimated overlap sets occurring in WA, and 46% in CA/OR (Table 13). In total, 38% of total estimated hook-and-line fishing sets were predicted to have overlapped with humpback whale distribution, with 65% of those overlapping sets occurring in CA/OR and 35% in WA, which is also very similar to the relative proportions of landings (Table 13 and Table A-17).

Table 13: Percentage of hook-and-line sets with at least some overlap for each sector, and what proportion of overlap occurs in California and Oregon versus Washington. Fishing effort sets are estimated to account for 100% of fishing effort.

Sector	Percentage of Overlapping Sets	Proportion with Overlap in CA/OR	Proportion with Overlap in WA
LE	42%	62%	38%
LE TL	37%	97%	3%
OA	41%	81%	19%
CS	41%	46%	54%
Total	38%	65%	35%

Anticipated Future Entanglements in the PCGF Hook-and-Line Gear

Having reviewed and evaluated the available information, including recent developments that aren't necessarily reflected in the historical information regarding humpback whale bycatch risk in the PCGF hook-and-line gear, we combine it all together to anticipate future levels of entanglement, based on the current state of the PCGF.

We have concluded that there are no viable bycatch estimates produced for PCGF hook-and-line fisheries given the difficulty in aggregating risk across all of the hook-and-line gear types, and the uncertainty associated with the one unconfirmed interaction reported. This does not mean the estimates of what has occurred across the PCGF hook-and-line fisheries is "zero", but rather a reliable estimate cannot be produced.

To help evaluate future entanglement risk, we elected to use information from the overlap analysis we completed for commercial PCGF hook-and-line fisheries, aggregated across all hook-and-line gears (Appendix A). PCGF hook-and-line overlap has been variable over time, with less overlap estimated in recent years (Figure A-26). However, all sectors besides OA peaked in overlap in 2016, indicating that peak overlap has not occurred in recent years (Table 14). This is also likely reflective of the fact that hook-and-line fishing effort peaked in magnitude (i.e. number of sets) from 2017-2019, and decreased to a stable number of annual sets since 2020 (Table A-3). This stable amount of hook-and-line fishing, in addition to the stable yet oscillating overlap does not lead NMFS to believe that entanglement risk of humpbacks in PCGF
hook-and-line gear is increasing or will necessarily be increasing in the foreseeable future, although it remains a steady potential risk.

Table 14: Summed overlap for all PCGF hook-and-line sectors by year. These are the monthly summed overlap for all months within the year that possess any overlap between the

two data layers (i.e., excludes “zeros”).

Year	LE	LE DTL	OA	CS	Total
2014	8.32	6.62	5.65	0.75	20.91
2015	8.23	3.35	5.16	0.57	17.32
2016	15.84	14.07	14.37	2.21	46.49
2017	10.65	4.21	13.21	0.73	28.81
2018	15.57	8.05	10.08	1.66	35.36
2019	7.12	3.71	6.01	0.55	17.39
2020	7.56	3.21	5.37	0	16.14
2021	8.66	6.94	6.63	0	22.23
2022	8.54	0.87	19.56	0	28.97
2023	11.80	2.23	9.46	0	23.50

Ultimately, the one observed (but unconfirmed) interaction, along with the recent occurrences of entanglements with gear that is similar to commercial PCGF hook-and-line gear, suggest that humpback whale entanglements/hookings with commercial PCGF hook-and-line fisheries are reasonably certain to occur over the foreseeable future. However, there are many factors that we have considered that suggest that any such event(s) would be rare and limited in number. Given the historical record and lack of confirmed observation of entanglements with PCGF bottom longline fishing at least, there are likely some aspects of the gear and operation that lend to limited interaction risk. As we looked at recent co-occurrence across all hook-and-line gear (which is predominantly bottom longline), the risks are not increasing, given most likely to some reduced effort in recent years. In addition, risk reduction measures going into place soon may produce additional risks. While the details surrounding the risk of other specific components of PCGF hook-and-line fisheries associated with vertical jig (and other similar vertical gear configurations) are not as well defined, there is enough information to suggest humpback whales will be at risk of entanglement/hooking resulting from occasional interaction with these activities.

We recognize that recreational hook-and-line gear poses a risk as well, as evidenced by recent occurrences of humpback whale entanglements with gear similar to what is used in PCGF recreational fisheries. If any humpback whale interactions with recreational fishing for groundfish species occur off the U.S. West Coast, it is far more likely those will not be associated with the PCGF. Given that only a fraction of recreational fishing for groundfish species is associated with the PCGF fishery, and our inability to more specifically assess the risk of this portion of PCGF hook-and-line fisheries, we cannot conclude that humpback whale entanglements/hookings with recreational PCGF hook-and-line fisheries are reasonably certain to occur.

As a result, without a clear quantitative assessment to rely upon, we qualitatively assume that up to one entanglement or hooking with commercial PCFG hook-and-line fishing would occur over any five-year period, and that this could come from any commercial PCGF hook-and-line sector or gear type. This is consistent with the lack of any confirmed record of PCGF entanglements or hooking, but other information that suggests an interaction(s) may have recently happened, and that there are occasional entanglements or hookings of humpback whales with hook-and-line fishing gear off the U.S. West Coast similar to what is used in the PCGF. While we don't expect that there will necessarily be one every five years, or even one out of every 10 years, NMFS commonly views the impact of fisheries on marine mammals over 5-year periods for MMPA stock assessment reports, and there is no evidence to support that PCGF hook-and-line interactions will occur more frequently than that.

Annual maximum = no more than one entanglement
Maximum 5-year running average **=** 0.2

DPS Apportionment

In order to apportion the impact of humpback whale entanglements with commercial PCGF hook-and-line fisheries that we anticipate will occur in the future with each DPS, we applied information from our overlap analysis to weight the relative amount of humpback whale entanglement risk across the entire fishery (commercial), based on the assumed distribution of the humpback whale DPSs, described in Section 2.2.2.1. Through the overlap analysis (Appendix A), we estimated that ~65% of the risk of humpback whale entanglement in commercial PCGF hook-and-line fisheries occurs off CA/OR and ~35% occurs off WA, based on the distribution of overlap summed across all sectors (Table A-17). We understand that it does not reflect or characterize the use of specific hook-and-line gear (such as vertical jig gear), as that information is not determinable from the available data. Given the assumed distribution of humpback whale DPSs off the U.S. West Coast, we expect 42.3% of humpback whales that may become entangled in commercial PCGF hook-and-line gear off CA/ OR will be Central America DPS individuals, and 57.7% will be Mexico DPS individuals. Similarly, we expect 5.9% of humpback whales entangled in PCGF hook-and-line gear off WA will be from the Central America DPS, 25.4% will be from the Mexico DPS, and 68.8% will be from the unlisted Hawaii DPS (Table 3). Therefore, using these two sets of information in combination, along with our expectations for the total number of entanglements across commercial PCGF hook-and-line fisheries, to generate an annual and 5-year average maximum estimate for each ESA-listed humpback whale DPSs, as represented in Table 15.

Table 15. Anticipated bycatch of ESA-listed humpback whale DPSs in the PCGF hook-and-line fishery.

	OR/CA Bycatch	**WA Bycatch**	**Total Bycatch**

Mexico DPS			
Annual Maximum	0.38	0.09	0.47
Maximum 5-year Running Average	0.08	0.02	0.10
Central America DPS			
Annual Maximum	0.27	0.02	0.29
Maximum 5-year Running Average	0.05	~0.01[a]	0.06

[A] indicates value artificially rounded up from a small non-zero value (.004).

Response to Hook-and-Line Gear Entanglement

Because there is a wide range of hook-and-line gears associated with commercial PCGF gear, and no previously confirmed entanglement or hooking events with PCGF gear to draw information about M/SI from, it is difficult to pinpoint expectations for how humpback whales might respond to future interactions. As a result, we first review information about the severity of injuries from the recent opportunistic reports of humpback whale interactions from the U.S. West Coast that involve gear similar to what is used in PCGF hook-and-line fisheries since 2011. Four of those reported entanglements have a readily available M/SI score, all of which involved monofilament lines. The total assessed M/SI with monofilament line gear is 2.50; equating to a M/SI rate of 0.63 (M/SI = 2.5/4 cases). This includes one case where an animal was photographed with line over its flukes, but was resighted later in the day with gear no longer visible entangling the animal, resulting from an apparent self-release, leading to a determination of a non-serious injury (M/SI determination = 0). There were two cases where there were superficial scars on the animal and the amount and configuration of gear was unknown, leading to a prorated serious injury assessment when a clear determination cannot be made (M/SI determination = 0.75). Finally, there was one case in 2015 where the amount and configuration of gear trailing was still unknown, but since gear was deeply embedded and constricting the animal with fresh wounds, the final determination was a serious injury (M/SI determination = 1.0). We note that while the specific fishery this entanglement is associated with is unknown, our evaluation indicated that it was a heavier gauge of monofilament, possibly involved with longline (pelagic or vertical - not bottom longline) or some other commercial fishing operation. None of these cases involved human intervention.

We acknowledge that the unconfirmed entanglement report with PCGF vertical jig in 2021 had previously received a prorated M/SI assessment of 0.75 by Carretta et al (2023), based on the unknown amount and configuration of gear involved in the interaction. Upon further review of the entanglement report, NMFS determined the 2021 humpback whale entanglement was not a confirmed entanglement, and according to NMFS' Process for Distinguishing Serious from Non-Serious Injury of Marine Mammals, an injury determination should not be conducted for this event (NMFS 2023f). So, we do not consider the previous M/SI assessment for that event further. The 2023 event that involved sablefish pot gear and Pacific halibut longline gear has not yet been evaluated for M/SI. However, even when that occurs, that event is complex with multiple gear types involved and other unusual circumstances that make it difficult to apply the extent of injury that the whale may have received from that case necessarily to any future expectations.

Given the limited amount of information about the severity of humpback whale interactions in hook-and-line gear from the U.S. West Coast, we also examined information on whale entanglements with similar gear configurations in adjacent locations such as Alaska, as they provide additional examples of likely outcomes for entangled whales. In Alaska, there was a report of a humpback whale being entangled in recreational hook-and-line gear in 2016 that was ultimately determined to be a non-serious injury as the whale appeared to free itself of the entangling gear (Freed et al. 2022). In 2018, a humpback whale in Alaska was observed to be entangled in 100 ft of unknown longline gear with 1 buoy attached. This animal was successfully disentangled, the gear was removed, the whale swam away, and the final injury was determined to be non-serious (Freed et al. 2023). In 2020, a humpback whale in Alaska was observed to be entangled in unknown commercial longline gear, observed towing three longline buoys, swimming in circles, and showing signs of distress. This entanglement was assessed a prorated M/SI value of 0.75 (Freed et al. 2023). In 2021, a humpback whale in Alaska was observed entangled in Pacific halibut longline research gear. A partial disentanglement was conducted, and the entanglement was ultimately assessed a prorated M/SI value of 0.75 (Freed et al. 2023). Finally, also in 2021, a humpback whale in Alaska was observed with a small amount of trailing line draped over the fluke edge with a circle hook from an unknown fishery attached to the line. This was ultimately determined to be a non-serious injury (Freed et al. 2023).

From all of this information, we draw the following observations and conclusions. There is considerable uncertainty surrounding the injuries that hook-and-line gear interactions cause for humpback whales, as most cases we reviewed have resulted in prorated M/SI assessment given limited information on the extent of those injuries. Given that the one confirmed serious injury from hook-and-line gear documented from the U.S. West Coast was associated with heavier gauge monofilament line, we conclude there is potential for commercial hook-and-line PCGF interactions to lead to a serious injury or mortality, especially in the event that heavier commercial gear such as bottom longlines were to be involved. Over a long period of time, we expect that there could be some PCGF hook-and-line interactions that result in non-serious injuries, and some that result in serious injuries or mortality, and some (most likely) that will not conclude with a definitive assessment either way. Given that our expectation is for no more than one entanglement over a five-year period, we will anticipate that it could result in a serious injury or mortality.

Table 16. Anticipated M/SI of ESA-listed humpback whale DPSs in commercial PCGF hook-and-line gear.

	Total Bycatch in PCGF hook-and-line gear	**Anticipated M/SI**
Mexico DPS		
Annual Maximum	0.47	0.47
Maximum 5-year Running Average	0.10	0.10
Central America DPS		
Annual Maximum	0.29	0.29
Maximum 5-year Running Average	0.06	0.06

2.5.1.4 Exposure and Response to Interactions with the Midwater Trawl Fishery

As described in section 1.3.2 *Overview of Trawl Fisheries*, the trawl fishery comprises several different sectors. For the purposes of this effects analysis, we focus our analysis on the potential for interactions (captures or entanglements) with mid-water trawl fisheries, given the recent interactions with PCGF midwater trawls that have been documented. For humpback whales, we conclude the risk of bottom trawling interactions is extremely unlikely, given the nature of bottom trawling activity/gear and the lack of historical observation of interactions, and therefore discountable. We will further evaluate the risk of potential interactions with various midwater hake and rockfish sectors in this effects analysis.

<u>Bycatch Estimates</u>

Bycatch estimates have not been produced for any PCGF trawl fisheries/sectors. Given the ~100% coverage of trawl effort with human observers and/or EM, the recent reports of interactions that have been received are considered to represent all that have occurred.

<u>Previous Entanglement Reports</u>

Before 2020, no bycatch interactions between whales and PCGF trawl gear were documented, and it was not previously considered likely that humpbacks would be caught in PCGF trawl gear. However, recent humpback whale interactions with PCGF midwater trawl gear have warranted updated consideration of the risks to ESA-listed humpback whales posed by this gear, including two events in 2020 (previously documented and reviewed in NMFS 2020c), one in 2023, and another one in 2024.

In July, 2020, EM in the Pacific whiting trawl fishery documented two separate incidents where humpback whales were incidentally captured/entangled in the forward section of midwater trawl nets (NMFS EM data; NMFS 2020a). In both situations, the humpback whales were clearly dead at the time the net was hauled in. No information is available that would allow the whales to be identified as belonging to a particular DPS.

In one 2020 event, the captain indicated the whale was clearly in poor condition, suggesting a death prior to being swept up in the trawl. The view of the whale in the EM video is obstructed, which hinders an evaluation of the whale's condition. Multiple NMFS SWFSC and WCR Marine Mammal Stranding Program staff reviewed the EM video, and could not determine whether the whale was likely dead or alive at the time of capture. The EM documentation of this event was not of sufficient quality/quantity to make a definitive assessment of whether or not the animal was alive when it encountered the trawl.

In the second 2020 event which occurred between Astoria and Newport, Oregon, the captain also indicated the whale was dead when it encountered the trawl net. In this case, the view of the whale in the EM video was directly overhead off of the stern and unobstructed. There were four small buoys tangled in the net ahead of the whale suggesting the whale may have been entangled in fixed gear when swept up in the trawl net, although this previous entanglement could not be confirmed upon review of the EM documentation. Once again, multiple NMFS SWFSC and WCR Marine Mammal Stranding Program staff reviewed the EM video, and could not determine whether the whale was likely dead or alive at the time of capture. However, given what was visible of the condition of the animal, there was some evidence to support the proposition that the whale was dead when captured in the trawl. The apparent presence of additional gear on the whale also supports this possibility. An entangled whale would be more susceptible to bycatch in trawl gear than an unencumbered whale. Although there is some evidence to suggest the whale was dead prior to encountering the trawl, there was not sufficient documentation to make a definitive assessment either way. Ultimately, NMFS could not rule out the possibility that at least one of these events, if not both, could have been the result of live humpback whales being incidentally caught in midwater Pacific whiting trawl gear.

In August 2023, a live humpback was reported captured alive within a mid-water trawl net belonging to a PCGF trawl vessel targeting hake off Coos Bay, OR and fishing in ~140 fathoms. The entanglement description states the whale swam into the net as it was being deployed and became entangled around the caudal peduncle/fluke with the "jibs" on the front end of the trawl net and entangled further around the remainder of the body. This humpback was cut free and released alive and reported directly by the fishing vessel to the NMFS West Coast Entanglement Response Program, and was additionally monitored through the EM program. This event marked the first confirmed bycatch of humpback whales in PCGF midwater trawl gear, which is significant given that trawl fisheries are 100% monitored either by EM or a physical observer, with effort covered by EM with a human observer at a mean coverage rate of 26% annually (Somers et al. 2023; NMFS 2024e).

In June 2024, there was another observation of a humpback whale captured by a midwater hake vessel in the mouth section of the trawl net within the shoreside sector of the PCGF fishing in ~180 fathoms off of Westport, Washington, documented through the EM program. The captain believes this interaction occurred during haulback as there was nothing unusual detected by gear sensors or the crew during fishing. The crew placed the whale at the stern ramp for approximately 1.5 hours while they cut the animal free. However, they did not report breathing or the animal moving upon release. Once again, multiple NMFS SWFSC and WCR Marine Mammal Stranding Program staff reviewed the EM video, and could not immediately determine whether the whale was dead or alive at the time of capture from the video. However, there was no report of foul smell while releasing the animal, indicating that if the animal was dead, it had not been for very long, which provides some evidence that this whale was captured and died as a result of the midwater trawling effort. This case will receive additional review as part of the NMFS stock assessment and M/SI evaluation process for future humpback whale SARs. However, at this time, based on the available information, we consider this event to be attributed as an interaction with PCGF midwater trawl gear.

These events are clear indications that the risks of future humpback entanglements with PCGF midwater trawl gear are high. This is a new development for the PCGF midwater trawl fisheries, which operate across a broad range of the U.S. West Coast.

PCGF Midwater Trawl Fishing Effort

Midwater trawl effort will be represented by the total number of trawl hours, adding up the time associated with each trawl tow, throughout the remainder of this opinion (see Appendix A), unless stated otherwise. This is because trawl hours are likely a more accurate depiction of relative fishing effort as it relates to incidental capture/entanglement risk than other metrics. We chose to represent midwater trawling effort in the number of trawl hours as it is the most accurate depiction of fishing effort with this gear type as it relates to entanglement risk. There is variation in the amount of landings that can be captured from a trawl tow, and the time a net is in the water represents the amount of time the trawl net poses an interaction risk to marine animals.

The midwater trawl fishery will also be divided into two components: the shoreside (SS) and at-sea (AS) sectors. These will be analyzed separately as their magnitude of effort are substantially different, making it hard to compare how risks may be changing over time within and among their subsectors (also referred to as sectors herein). It is also important to note that some of the vessels associated with the AS fishery (CPs) tend to be larger as they are able to

catch and process their landings on-board. Additionally, the AS vessels are required to have two human observers on board at a time, while the SS sector is observed through a single human observer or through EM. The SS sector contains: Hake (non-EM), Hake (EM), Rockfish (non-EM), and Rockfish (EM) within the WCGOP database, but these will be represented as Midwater Hake and Midwater Rockfish as we combine the EM and non-EM data into single sectors. The AS sector contains: CP and MS. The SS sector will only represent 2014-2022 data when analyzing year to year trends throughout this opinion and the attached Appendix A. This is because 2023 does not include a majority of observed data due to 2023 EM data not being available at the time of publication. The 2023 human-observed data is still included in all of the monthly and overlap data presented, but will be omitted from intraannual analysis given the inability to compare that with unavailable EM data. Since the AS sector is mostly observed by humans, the observed 2023 data will be included and represented throughout this opinion as this encompasses a majority of effort in 2023.

SS midwater trawl hours show varying patterns of distribution and magnitude over the years (displayed in total by Figure 17; broken down by sector in Figure 18). The SS midwater trawl fishery is monitored ~100% either through human observers or EM. Therefore, unlike the pot and hook-and-line sectors, the midwater trawling effort did not need to be scaled up based on observer coverage to represent total fishing effort.

SS midwater trawl effort only occurs north of 40°N, and has not changed in spatial effort substantially over the years (Figure 17). A majority of effort occurs from north of Cape Blanco, Oregon to Neah Bay, Washington (Figure 17). A large majority of effort within this fishery targets hake as opposed to rockfish, and within the hake sectors, a majority of the effort is observed through EM (Figure 18). Throughout this time series, although the location of effort has not varied substantially, the number of trawl hours has increased steadily throughout the years until recently (Table A-5, Figure 17, and Figure 18). Effort across sectors peaked in July, with the Hake sector peaking in August, and the Rockfish sector peaking in November (Table A-7). Both sectors, Rockfish and Hake, peaked in the number of trawl hours in 2022, displaying an increasing trend over time (Figure 18).

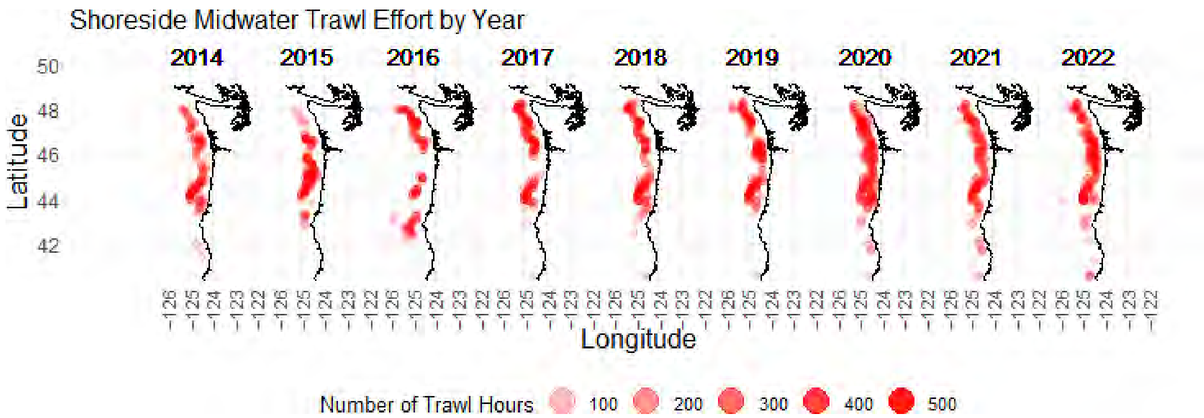


Figure 17: Shoreside trawl hours representing 100% of fishing effort based on observed WCGOP data, plotted by year (2014-2022), and labeled by magnitude of pot sets.

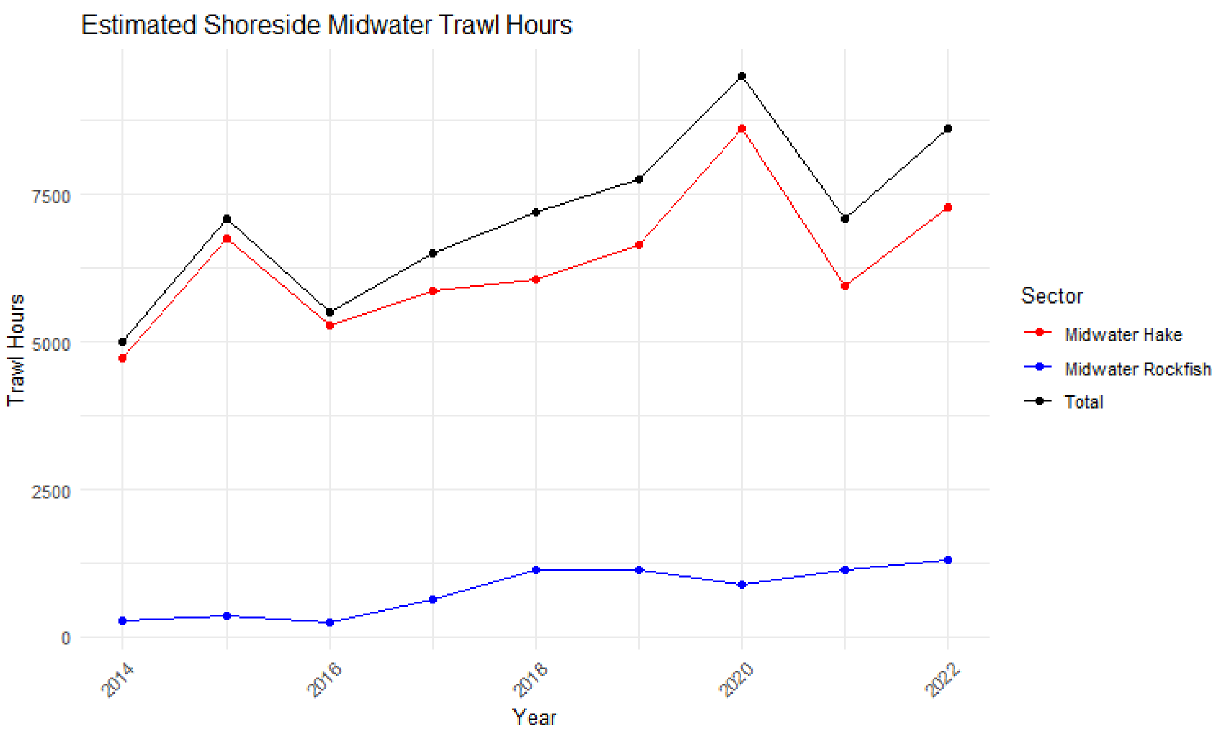


Figure 18: Estimated shoreside midwater trawl hours by sector for the years 2014-2022 (EM data not available for 2023). Lines are colored by sector and the black line represents the total hours summed for all sectors.

AS midwater trawl fishing effort distribution appears to stay relatively consistent across space, given the effort is heavily concentrated in northern waters, fairly similar to SS sector effort distribution (Figure 19). The only major difference is that AS sector effort is concentrated even further north, with no effort south of 42°N latitude (Figure 19). Further, the AS sector displays significantly more trawl effort in hours in comparison to the SS sector. Finally, AS effort occurs further inshore, as far west as 127°W, whereas SS effort extends almost to 130°W[12] (Figure 19). However, this is not well represented by Figure 19 due to confidentiality requirements. Trawling effort displays a strong seasonal distribution with AS trawl effort only occurring from May-November (Figure A-14). There appears to be two peaks in effort: one in May and June; and again, in October, with July and August being months of lower amounts of effort (Figure A-16). The CP and MS sub-sectors both follow these same monthly trends.

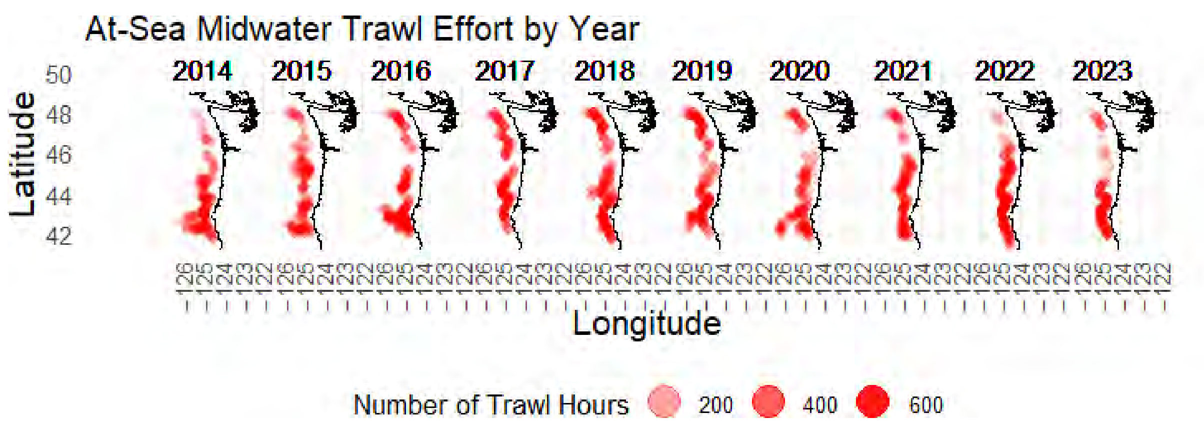


Figure 19: Trawl hours from the at-sea sector, representing ~100% of fishing effort based on observed WCGOP data, plotted by year (2014-2023) and labeled magnitude of trawl hours.

AS midwater trawling in total has fluctuated throughout the time series in terms of total trawl hours per year (Figure 20), but there has been a slight general upward trend in effort across the time series with 2022 representing the highest annual effort of the decade (Figure 20). The CP sector peaked in effort in 2018 and the MS sector peaked in effort in 2022 (Figure 20).

[12] SS effort far offshore has not occurred in recent years and occurred earlier in the time series (2014-2023). This further offshore effort also did not comprise a significant amount of effort.

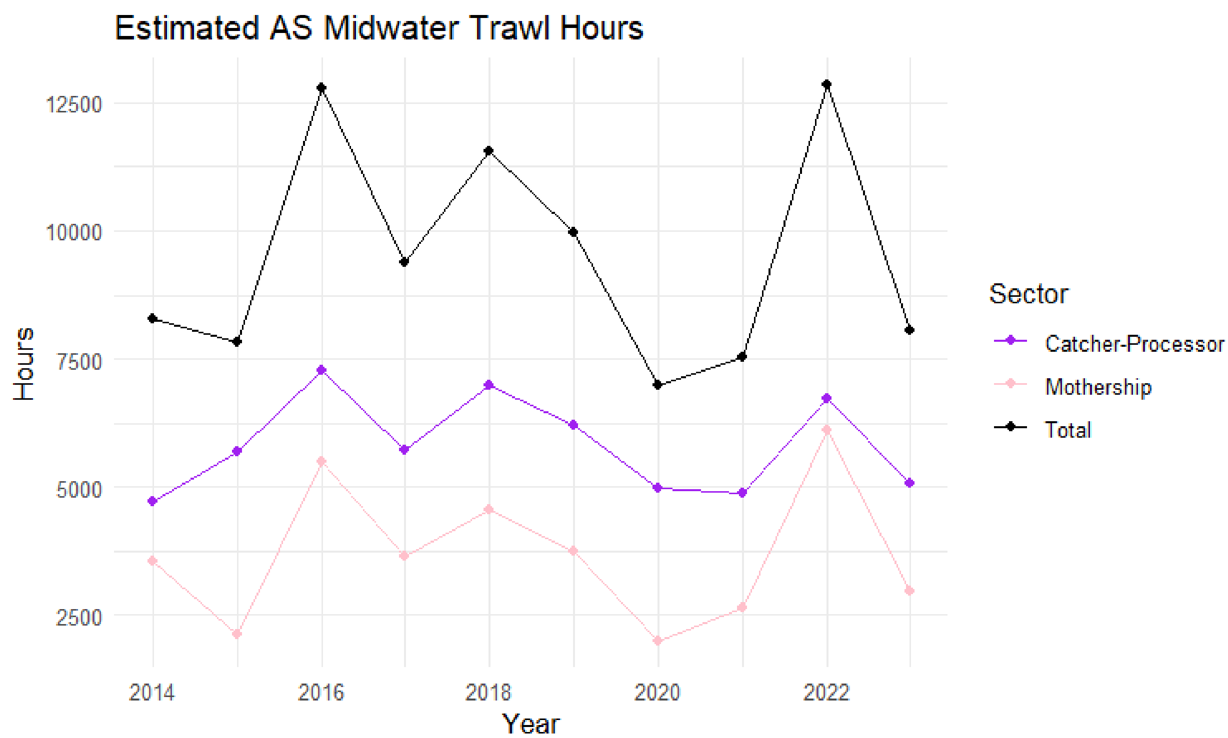


Figure 20: Estimated at-sea midwater trawl hours by sector for the years 2014-2023. Lines are colored by sector and the black line represents the total sets summed for all sectors within the at-sea sector.

Co-Occurrence Analysis

There have been two humpback whale captures attributed as interactions with PCGF midwater trawl gear; one released alive in 2023 and one released dead in 2024. Along with the previous reports from 2020, the available information in aggregate indicates that we should anticipate interactions happening in the future. Therefore, we explore the recent patterns of risk through our co-occurrence analysis to help understand if these recent developments are associated with any changes in risk over time, and what we may anticipate happening with midwater trawl gear in the future.

SS midwater trawl fishing and subsequent SS sector overlap peaked in July and June, which is right before peak humpback whale density in the area where this fishing activity occurs (Table A-7 and Table A-19). The month of peak overlap is variable across sectors, with the Hake sector peaking in July, and the Rockfish sector peaking in October, which both correspond with the highest levels of fishing effort in those sectors at those times (Table A-19). June and July are the busiest periods for fishing effort across sectors, while entanglement risks in August-October are due in part to increased whale density on the trawl grounds during that period. Conversely, the months of January, February, and March show the lowest overlap values, correlating with the period when humpback whales are largely absent from the West Coast (Table A-19).

SS sector overlap was concentrated earlier in the year, June-July, along the nearshore Oregon coast. From August-November, SS sector overlap begins to occur in more offshore areas, and further north (almost explicitly in Oregon and Washington waters), likely coinciding with predicted humpback whale distributions as SS sector fishing effort location does not change drastically throughout the months.

We also looked at interannual variability of the SS sectors overlap over the last decade, to help understand how SS sector risk has been changing, and where it may be headed in the future. SS sector overlap varied throughout the years, but over the time series overlap has generally increased, specifically for the Hake sector, which constitutes a large majority of both the total fishing effort and overlap (Figure 21). Total SS overlap across both sectors was highest in 2020, and then second highest in 2022 (Figure 21). When examined by each sector, overlap was highest in 2020 for the Hake sector, and in 2018 for the Rockfish sector (Figure 21).

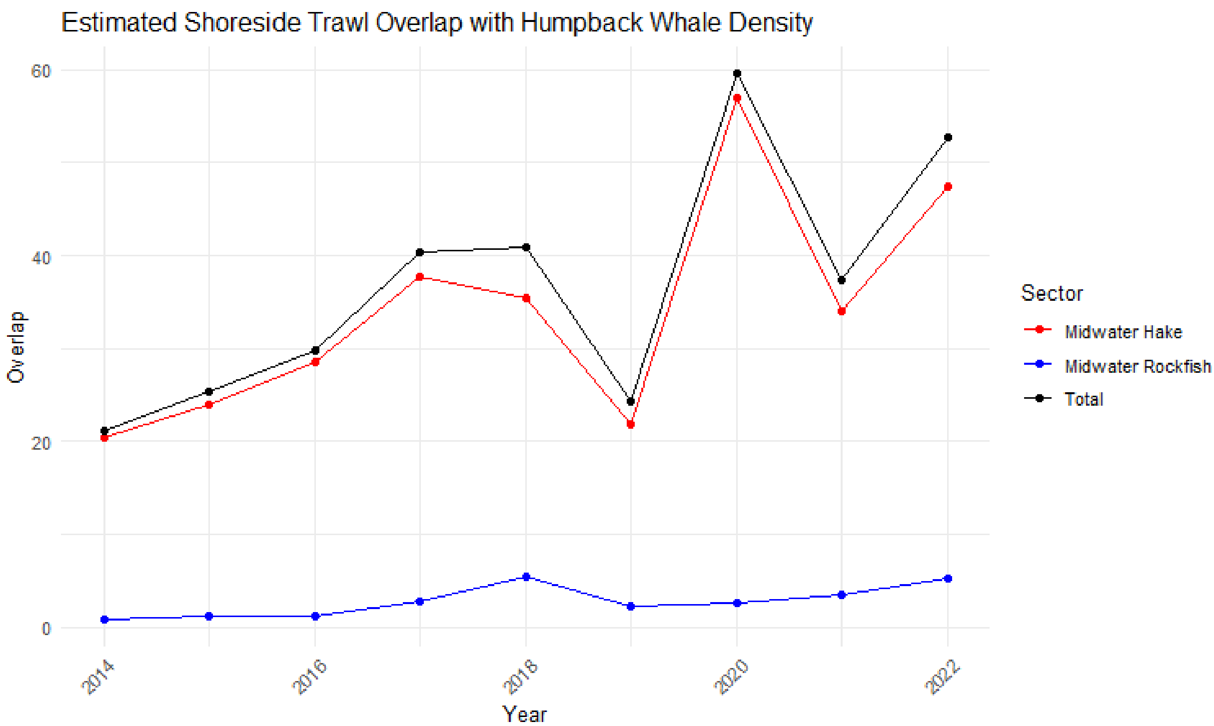


Figure 21: Estimated shoreside midwater trawl overlap with humpback whale density. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each year for all years 2014-2022.

AS sector overlap displays a bimodal peak in overlap throughout the year (Figure A-33). The first peak in overlap occurred in June and the following occurred in October (Table A-20). The AS sector fishing effort also displayed these same two bimodal peaks (Figure A-16). Is it likely that higher predicted humpback whale densities where fishing occurs are exacerbating the AS overlap in the later month of October. Both AS sectors follow this same temporal distribution of overlap, peaking in June and October (Figure A-16).

We also analyzed interannual variability of AS sector overlap over the last decade, to help understand how AS sector risk may have changed, and what to expect in the future. AS sector overlap has varied drastically throughout the years, with all sectors peaking in overlap first in 2018, and then again in 2022 (Figure 22). These two peaks in 2018 and 2022 correlate with increased AS sector effort which also experienced peaks in those years (Figure 20). Additionally, predicted humpback distributions during these two years do not differ substantially (Figure A-17), likely indicating that the magnitude of fishing effort is driving the variable overlap.

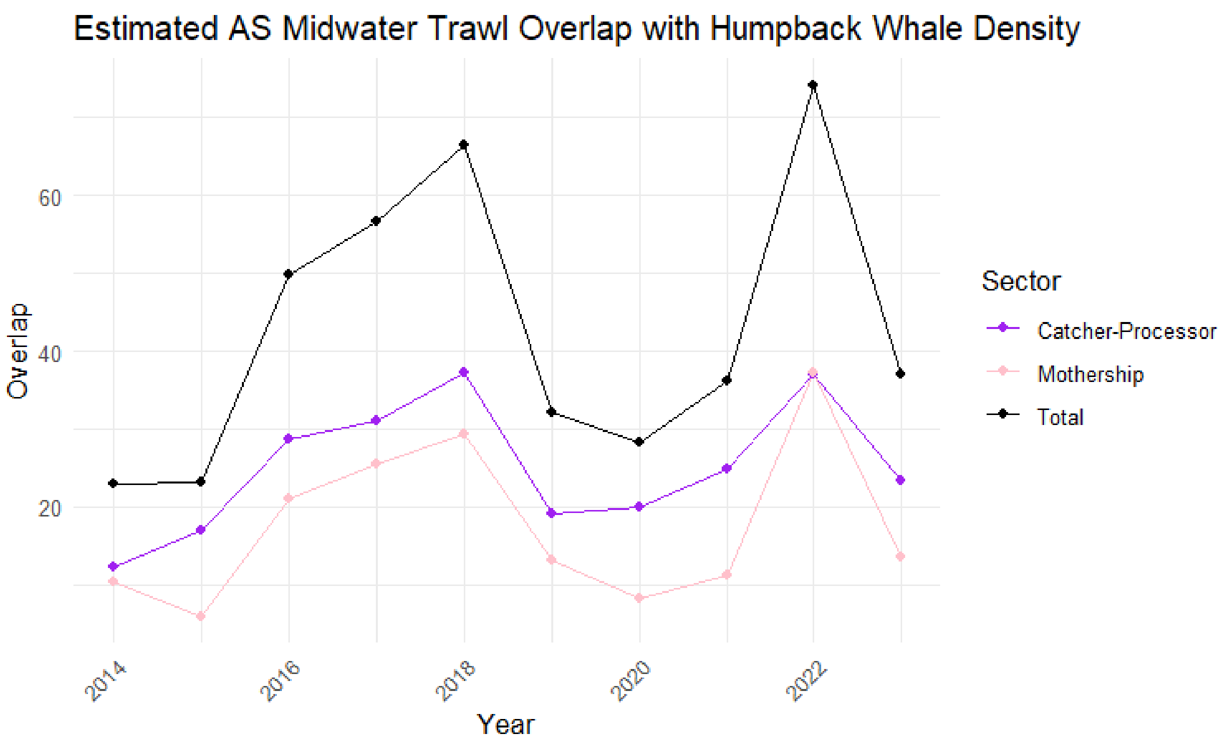


Figure 22: Estimated at-sea midwater trawl overlap with humpback whale density. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each year for all years 2014-2023.

Overlap between SS midwater trawl fishing and humpback whales is densest between 45°-46°N and 125°-126°W, north of the Columbia River mouth, and off of La Push, Washington, suggesting these areas have the highest risk for humpback whale interactions with SS sector trawling (Figure 23). There is minimal overlap pretty widely distributed and continuous throughout the Oregon and Washington coasts, with sparse overlap occurring along a small section of the northern California coast (Figure 23). The midwater Hake sector spans a wide range, from California to Washington, with significant overlap in both nearshore and offshore areas (WCGOP, unpublished data*). Overlap appears to occur across the entire fishing distribution and remain consistent over time in terms of spatial distribution of overlap.

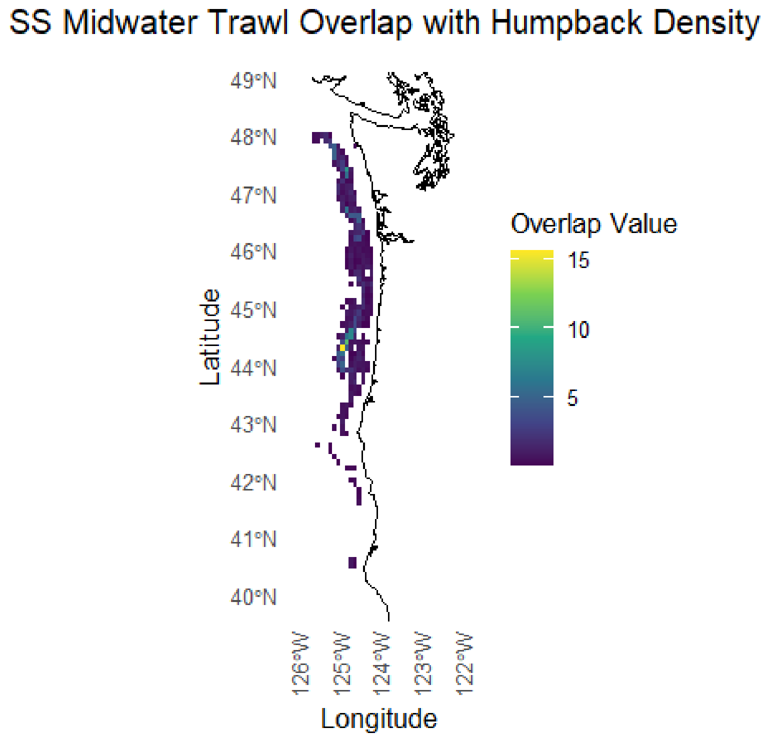


Figure 23: The overlap of shoreside trawl hours and predicted humpback whale density. Overlap is colored by the magnitude of overlap which is unitless

Overlap between AS midwater trawl fishing and humpback whales is densest around Cape Blanco, OR and off of La Push, WA (Figure 24). Overlap also occurs exclusively north of 41°N, pretty much exclusively within Oregon and Washington, which is indicative of AS fishing effort distribution. Oregon waters appear to house the most risk to entanglement risk with humpbacks within the AS fishery. AS overlap does appear to peak in magnitude in more nearshore areas, with the offshore overlap values remaining relatively small in comparison to the nearshore overlap values (Figure 24).

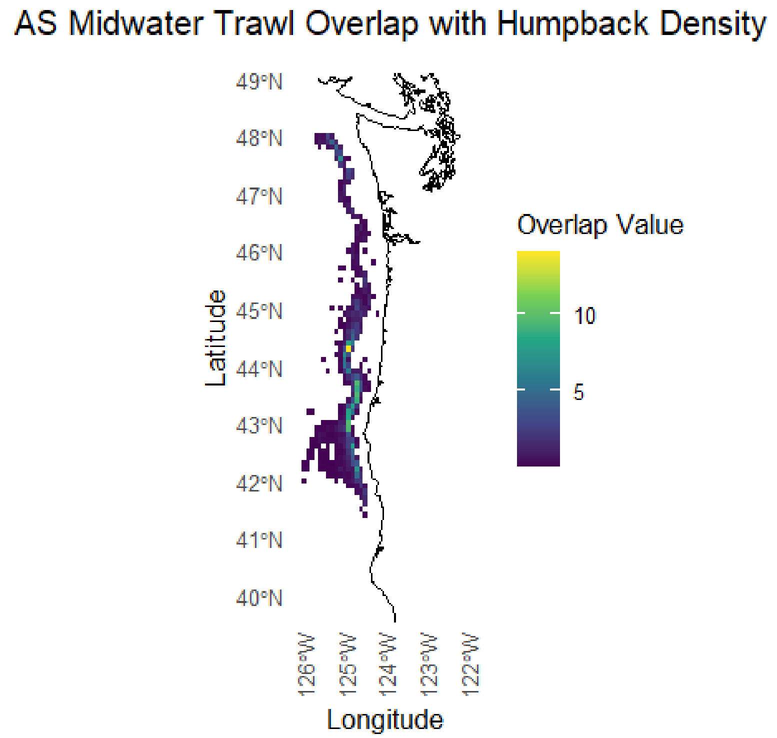


Figure 24: The overlap of at-sea trawl hours and predicted humpback whale density. Overlap is colored by the magnitude of overlap which is unitless.

We considered what proportion of SS sector trawl hours had at least some overlap with predicted humpback whale distribution (i.e., whale density prediction greater than zero). Given what we know about humpback whale DPSs and their relative distributions along the U.S. West Coast, we wanted to view how these fisheries interact in California and Oregon, versus Washington (Table 17). Our findings indicate that 28% of the total estimated trawl hours in the Hake sector overlapped with an area where humpback whales were predicted to occur, with more of those occurring in CA/OR than WA (Table 17). For the Rockfish sector, 26% of trawl hours overlapped with humpback whale density, with 47% occurring in CA/OR and 53% in WA (Table 17). In total, 27% of total estimated SS trawl hours were predicted to have overlapped with predicted humpback whale distribution, with 62% of the overlap occurring in CA/OR, and 38% in WA which is also similar to their landing proportions (Table 17, Table A-24).

Table 17: Proportion of shoreside trawl hours with at least some overlap for each trawl sector, and what proportion of overlap occurs off California and Oregon versus Washington.

Sector	Overlapping Trawl Hours	Proportion Overlap in CA/OR	Proportion Overlap in WA
Midwater Hake	28%	64%	36%
Midwater Rockfish	24%	47%	53%
Total	27%	62%	38%

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Table 18: Proportion of at-sea trawl overlap for each sector, and what proportion of overlap occurs off California and Oregon versus Washington.

Sector	Overlapping Trawl Hours	Proportion Overlap in CA/OR	Proportion Overlap in WA
Catcher-Processor	28%	85%	15%
Mothership	27%	83%	17%
Total	27%	84%	16%

Anticipated Future Interactions in PCGF Midwater Trawl Gear

Having reviewed and evaluated the available information, we combine it all together to anticipate future levels of humpback whale interactions with PCGF midwater trawl gear, based on the current state of the PCGF.

There are no bycatch estimates available for any/all PCGF midwater trawl fisheries, as the interaction record that we have reported above is considered a full census of what has occurred since 2011 since the PCGF trawl fishery is 100% observed either through human observers or EM. Up until recently, no PCGF midwater trawl interactions had been confirmed, as the circumstances behind the previous interactions remained uncertain, and NMFS had not anticipated future occurrences. However, the 2023 and 2024 incidental captures confirm that the PCGF midwater trawl fishery is at risk of capturing humpback whales along the U.S. West Coast, indicating these events should be expected in the future, even as we endeavor to learn more about why they may be occurring after a long record of being absent. We note that all four of our recent cases have involved targeting midwater hake, and have been associated with the SS Hake sector of the fishery.

To help evaluate future entanglement risk, we elected to use information from the overlap analysis we completed for the PCGF midwater trawl fishery (Appendix A). We compared annual overlap values between the SS and AS sectors throughout the time series (Table 19, Table 20; Appendix A). SS sector overlap has oscillated throughout the years, but has generally been highest in recent years (Figure A-34, Table 19). Midwater Hake fishing makes up a majority of both the total fishing effort and overlap within the SS sector of the PCGF midwater trawl fishery (Figure A-34 & A-11). Given this, although we do not have access to 2023 EM data, we conclude it is likely that the recent increase in trawl hours has increased overlap and interaction risks with humpbacks in the midwater hake fishery. Provided this information, NMFS believes that this entanglement risk is likely to remain similar or potentially increase in the future, given the current trajectory. The Midwater Rockfish fishery generally reflects a relatively low level of humpback whale risk, in comparison to the Midwater Hake fishery.

Table 19: Overlap by year and sector for all shoreside midwater trawl and humpback whale density. These are the summed overlap for all months within the year. There is no EM data for 2014 and the 2023 EM was unavailable upon time of publication.

	Hake	Rockfish	Total
2014	20.4	0.8	21.2
2015	24.0	1.3	25.3
2016	28.5	1.2	29.7
2017	37.7	2.8	40.4
2018	35.5	5.4	41.0
2019	21.9	2.3	24.2
2020	57.0	2.6	59.5
2021	34.0	3.5	37.4
2022	47.5	5.2	52.7
Average	**34.1**	**2.8**	**36.8**

AS overlap has oscillated throughout the years and is closely correlated with the magnitude of AS fishing effort (Figure A-35 and Table 20). Both the CP and MS sectors follow this same trend with overlap initially peaking in 2018 before decreasing and then peaking in overlap again in 2022. We note that the magnitude of the overlap of the AS sector is similar to the SS Hake sector, although the year to year variation is not identical.

Table 20: Overlap by year and sector for all at-sea midwater trawl and humpback whale density. These are the summed overlap for all months within the year. There is no EM data for 2014 and the 2023 EM was unavailable upon time of publication.

	Catcher-Processor	Mothership	Total
2014	12.4	10.5	22.9
2015	17.1	6.0	23.1
2016	28.8	21.1	49.9
2017	31.0	25.6	56.6
2018	37.2	29.4	66.5
2019	19.1	13.1	32.2
2020	20.1	8.2	28.3
2021	24.9	11.3	36.1
2022	37.0	37.2	74.2
2023	23.4	13.6	37.0
Average	**25.1**	**17.6**	**42.7**

There has been a single live capture/release of a humpback in the PCGF midwater trawl fishery in 2023, and a recent interaction with a dead humpback in the PCGF midwater trawl fishery in 2024 that is still under review by NMFS. Additionally, overlap between predicted humpback whale density and midwater trawl fishing, especially hake fishery, has increased throughout the most recent decade. The AS sector has had a similar magnitude of risk to the SS sector based on our analysis; however, there may be differences in AS operations that we don’t fully understand that lower risk compared to the SS sector.

As a result, we conclude it is reasonably certain to anticipate an occasional capture/entanglement of a humpback whale in the PCGF midwater trawl fishery. Based on recent history, that is expected to occur in the hake fishery, most likely in the SS sector. However, we recognize that interaction in the AS sector is also foreseeable in the future as well. Currently, we do not anticipate more than one interaction with PCGF humpback whales would occur a year; however, given the recent interactions documented and recent increases in trawl effort and risk, we assume that two interactions could occur within a 5-year time period in PCGF midwater trawl fisheries.

Annual maximum = no more than one capture/entanglement
Maximum 5-year running average = no more than two captures/entanglements in five years, or 0.4

DPS Apportionment

In order to apportion our expectations for the total number of humpback whale interactions that may occur with PCGF midwater trawl fisheries in the future, we applied information from our overlap analysis to weight the relative amount of humpback whale entanglement risk across PCGF midwater trawl fisheries, based on the assumed distribution of the humpback whale DPSs, described in Section 2.2.2.1. Through the overlap analysis (Appendix A), we estimated that
~60% of the risk of humpback whale interactions in the SS midwater hake trawl fishery occurs off California and Oregon, and ~40% occurs off Washington, based on the distribution of overlap (Table A-23). Our analysis suggests that the SS Hake sector is most likely where future humpback whale interactions would occur. However, we have acknowledged that an interaction with the AS midwater trawl sector is foreseeable. Through our overlap analysis (Appendix A), we estimated that ~84% of the risk of humpback interactions occurs off California and Oregon in the AS sector, and ~16% occurs off Washington. To be conservative, we will use the proportion of risk based on the distribution of the AS sector, which assumes a higher likelihood of encountering ESA-listed DPSs than the SS Hake sector, given the higher percentage of effort occurring off California and Oregon. Given the assumed distribution of humpback whale DPSs off the U.S. West Coast, we expect 42.3% of humpback whales that may become entangled in SS midwater hake trawl gear off California/Oregon will be Central America DPS individuals, and 57.7% will be Mexico DPS individuals. Similarly, we expect 5.9% of humpback whales entangled in SS midwater hake trawl gear off WA will be from the Central America DPS, 25.4% will be from the Mexico DPS, and 68.8% will be from the unlisted Hawaii DPS (Table 3). Therefore, using these two sets of information in combination, along with our expectations for the total number of entanglements across the entire SS midwater hake trawl fishery, we can generate an annual and 5-year average maximum estimate for each ESA-listed humpback whale DPS, as represented in Table 21.

Table 21. Anticipated bycatch of ESA-listed humpback whale DPSs in the groundfish midwater trawl fishery.

	CA/OR Bycatch	WA Bycatch	Total Bycatch
Mexico DPS			

Annual Maximum	0.48	0.04	0.52
Maximum 5-year Running Average	0.19	0.02	0.21
Central America DPS			
Annual Maximum	0.36	0.01	0.37
Maximum 5-year Running Average	0.14	~0.01[a]	0.15

[a] indicates value artificially rounded up from a small non-zero value (.004).

Response to Midwater Trawl Gear Entanglement

There is limited information to work with given the reports of interaction with PCGF midwater trawl gear that we have thus far. Although both whales associated with the 2020 events were dead, NMFS is unable to determine whether the animal was dead or alive prior to capture in the trawl net. The 2023 event captured an alive humpback whale, and the animal was released alive, but a final M/SI determination has not been assessed by NMFS. In the most recent 2024 event, the humpback was hauled in dead.

Given the relatively low number of humpback whale interactions in PCGF midwater trawl gear, we examined cases of humpback whale interactions with similar gear configurations in other places, as they provide additional examples of likely outcomes for entangled whales. Incidents of whale bycatch in trawl fisheries in the U.S. appear to be extremely rare according to marine mammal SARs. Reviewing the most recent human-caused M/SI report on the Alaska groundfish fishery from 2017-2021, there have been four humpback whale bycatch interactions with commercial trawl gear documented during this time period (Freed et al. 2023). All four of these were humpback whale mortalities observed in the Bering Sea/Aleutian Islands pollock trawl fishery: one in 2018 and 2020, and two in 2021, all of which were entangled and observed dead with M/SI attributed to the Bering Sea/Aleutian Islands pollock trawl fishery (Freed et al. 2023). Looking at U.S. East Coast fisheries, we found no instances in which a whale was recorded as having been incidentally killed or injured in an East Coast midwater trawl fishery.

Considering the live release event of 2023, and the mortality associated with the other interactions, including the putative mortality case of 2024 (which has yet to be officially confirmed and assigned M/SI) , we assume that any humpback interaction that occurs within a given year could be dead, but that not all interactions are expected to lead to mortality. As a result, we assume a 50% mortality rate across the two interactions that we foresee occurring over a 5-year period.

Table 22. Anticipated M/SI of ESA-listed humpback whale DPSs in the PCGF midwater trawl fishery.

	Total Bycatch in Midwater Trawl	Anticipated M/SI
Mexico DPS		
Annual Maximum	0.52	0.52
Maximum 5-year Running Average	0.21	0.11
Central America DPS		
Annual Maximum	0.37	0.37
Maximum 5-year Running Average	0.15	0.08

2.5.1.5 Risk of Prey Removal

Important prey species for both DPSs of humpback whales that are incidentally captured in the PCGF, primarily in the trawl fisheries, include Pacific sardines, Pacific herring, and northern anchovies. As summarized in the "Not Likely to Adversely Affect" Determinations (Section 2.12), humpbacks are generalists, targeting a variety of prey while foraging and switching between prey depending on abundance or quality.

The Groundfish Expanded Mortality Multi-Year (GEMM) database is a multi-year companion to the annual Groundfish Mortality Report that includes mortality estimates by fishery sector of all observed species, except protected fish, marine mammals, sea birds, and sea turtles. Based on the GEMM dataset, 695 marine species were caught in the PCGF from 2002-2022. Of those species, 232 species were in excess of one mt. Two of those species are primary humpback whale prey (Pacific sardine and Pacific herring).

Pacific sardines were caught in the PCGF from 2012-2014 (589-1129 mt), while Pacific herring catches increased in more recent years, 2018-2022 (37-232 mt) (Figure 25). Anchovies were caught in even lower amounts than either sardines or herring. The PCGF typically removes less than 200 metric tons (mt) of potential humpback prey biomass per year, primarily as bycatch in trawl gear (Figure 25). Assuming each whale is consuming between 1 and 1.5 tons of fish per day (Clapham and Baxter 2013), this amounts to less than 6 months' worth of food for a single whale, or one day's worth of food for less than 200 whales, removed in total over the course of a year and across a wide geographic area. Given that there are now ~5,000 humpback whales off the U.S. West Coast (Calambokidis and Barlow 2020), that may equate to a foraging need of ~1 million mt for a given feeding season lasting 8 months. Ultimately, the potential removal of prey by the PCGF represents a negligible portion of the prey needs of the humpback whale DPSs. We know that humpback whales are plastic feeders, capable of switching prey among schooling fish or euphausiids, as available. As a result, we conclude PCGF prey removals will have undetectable effects on both the Central America and Mexico humpback whale DPSs.

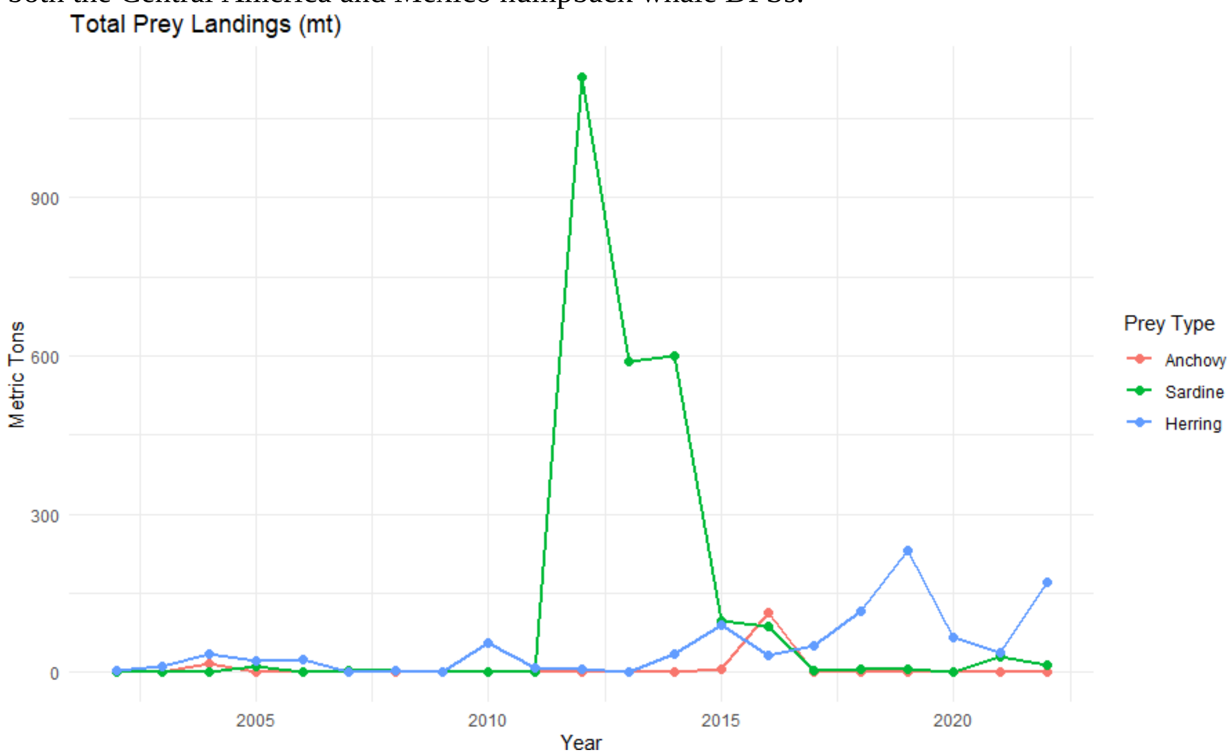

Figure 25. Total catch (mt) of primary humpback prey items: northern anchovy, Pacific sardine, and Pacific herring. Data was gathered from NWFSC GEMM database using both landings of prey and discarded landings with a mortality rate applied and summed together.

In Section 2.12.1 *"Not Likely to Adversely Affect" Determinations*, the extent of incidental capture of these important prey species in the PCGF, and the relative impact of these removals on designated critical habitat are described in detail.

2.5.1.6 Risk of Pollution and Contaminants

Currently, available information does not indicate that pollution resulting from the operation of the PCGF is significantly impacting ESA-listed humpback whales, or the PBFs of their critical habitat. Organic pollutants, including petroleum products (or oil spills) that may be utilized by fishing vessels in the PCGF during their operations, may have the potential to directly impact humpback whales or the prey they rely on by killing or reducing the fitness of these organisms through sub-lethal effects. There is very little published literature providing evidence of extensive marine pollution from commercial fishing vessels. One of the only relevant studies concerns summarizing pollution incidents involving longline and purse seine vessels operating within the Western and Central Pacific Ocean from 2003-2015 (Richardson et al. 2016). Fisheries observer data from this study indicated a majority of these pollution incidents were related to the dumping of plastic waste and derelict or lost fishing gear with a large majority of these occurring from purse seine vessels, not longline vessels. Oil spillages and leakages only accounted for 16% of reported incidents in purse seine vessels and 3% in longline vessels (Richardson et al. 2016). Even if a petroleum spill occurs, we would generally expect those releases to be relatively small given the limited fuel capacities of these vessels, and actions that are generally required by MARPOL regulations implemented by the U.S. Coast Guard (see 33 USC § 1901 and 33 CFR § 151). Given the continual and dispersed movement of vessels within the action area, we generally do not anticipate that the release of a small amount of petroleum into the marine environment will cause acute or chronic exposure to humpbacks and their prey, since all of these are mobile.

Without evidence to support analyses of how these factors may affect ESA-listed species as a result of the proposed action, NMFS concludes that the potential release of pollution via PCGF fishing vessels is a minor risk for ESA-listed humpback whale DPSs.

2.5.1.7 Risk of Vessel Collision

The probability of a vessel collision depends on the number, size, and speed of vessels, as well as the distribution, abundance, and behavior of the species (Conn and Silber 2013; Hazel et al. 2007; Jensen and Silber 2004; Laist et al. 2001; Vanderlaan and Taggart 2007). The size and speed of a vessel are related both to the ability of a vessel to avoid a collision (i.e., they determine maneuverability and stopping distance), and whether a serious injury or mortality would result if a collision occurred. Jensen and Silber (2004) summarized large whale vessel collisions world-wide from 1975 to 2003 and found that most collisions occurred in the open ocean involving large vessels. Commercial fishing vessels were responsible for four of 134 records (3%), and one collision (0.75%) was reported for a research boat, pilot boat, whale catcher boat, and dredge boat. Schoeman et al. (2020) also reviewed global records of vessel collisions with marine mammals, and found a broad range of vessel types are involved with collisions, although the relationship between vessel speed and severity of injury depends both on the vessel type and the species involved. With respect to large whales, lethal or severe injuries are often caused by vessels 80 meters (262.5 feet) in length or greater, traveling 25.9 kilometers per hour (14 knots) or faster (Laist et al. 2001). Most publications on the topic discuss collisions between large whales and large vessels; however, smaller marine mammals may also be at risk of collision (Schoeman et al. 2020).

Currently, available information does not indicate that vessel collisions from the operation of the PCGF are occurring with ESA-listed humpback whales. Collisions are possible within the action area given humpbacks must spend time at the surface to breathe, and may be near or at the surface during feeding. As described in the *Environmental Baseline* along the U.S. West Coast from 2016-2020, 14 confirmed humpback whale vessel strike cases were reported; eight in

California, one in Oregon, and five in Washington (Carretta et al., 2023a). However, it remains unclear whether these strikes are more commonly associated with larger vessels or smaller ones similar to the majority of those used in the PCGF. Collisions with PCGF vessels would be observable by fishers and observer programs, and there are no reported collisions of humpback whales with boats of the PCGF.

With the exception of some very large capture-processing trawl vessels, most PCGF vessels are considerably smaller than large commercial shipping vessels. Regarding the vessel sizes and types used, the SAFE report also outlines that most vessels in the LE Fixed Gear sector are under 100 feet in length, which also reduces the likelihood of severe injuries in the event of a collision with marine mammals compared to larger vessels. Trawl vessels tend to have larger boat sizes, ranging from 35 to 95 feet with an average length of 65 ft (source). Most documented ship strikes are associated with larger vessels like tankers, container ships, and cruise ships, which travel at higher speeds and have a greater potential for lethal impacts (Winker et al. 2020), while ship strikes specifically related to fishing types of vessels are less common (NMFS, 2022c).

The proposed PCGF activities would also require vessels to spend the majority of their time at sea moving much more slowly than the speeds typically associated with vessel collision M/SI. The average operational speed of commercial fishing vessels is only around 4 knots during fishing operations, which includes speed during gear deployment and retrieval, with cruising speeds between 6-14 knots between fishing grounds and ports of call. This results in the majority of vessel traffic associated with the proposed action moving at much slower speeds compared to the 14 knots often associated with an increased risk of marine mammal injuries from vessel strikes (Laist et al. 2001). In addition, smaller vessels such as fishing vessels are generally more maneuverable, and therefore execute changes in course and speed more readily than larger vessels, further reducing the likelihood of collision.

Based on the broadly distributed patterns of PCGF vessel movements across the U.S. West Coast, relatively small sizes and slow speeds of the PCGF vessels, and the fact that no collisions with large whales have been reported from any PCGF vessels previously, the probability of PCGF vessels colliding with humpback whales as a result of the proposed action is extremely small. We conclude that adverse effects to ESA-listed Mexico or Central America DPSs of humpback whales as a result of collisions with PCGF vessels is improbable.

2.5.2 Leatherback Sea Turtle Effects

For the *Effects of the Action* analysis, we have identified the impact of incidental entanglement, hooking, or capture in PCGF gear as the primary adverse effect of the PCGF on ESA-listed leatherback sea turtles. Gear interaction risk can be divided into risk associated with the different categories of gear type used in the PCGF: fixed pot or trap, hook-and-line, and midwater trawling.

2.5.2.1 Exposure and Response – Bycatch in the PCGF

To determine the exposure and response of ESA-listed leatherback sea turtles to the PCGF, NMFS relies on several sets of data sources: (1) data on bycatch and fishing effort from the WCGOP; (2) opportunistic reports of entangled sea turtles reported to the NMFS WCR Marine Turtle Stranding Program, and (3) a leatherback habitat suitability model.

As described in more detail in the Approach to the Effects Analysis above, the exposure analysis considers entanglement risk from various perspectives: (1) annual bycatch estimates, (2) 5-year average bycatch estimates, (3) recent entanglement and stranding records, (4) fishing effort trends in space and time by gear type (2014-2023), (5) modeled leatherback habitat suitability predictions (2014-2023), and (6) the degree of co-occurrence of modeled leatherback habitat suitability with various sectors of the groundfish fishery, as described further in Appendix A.

2.5.2.2 Exposure and Response to Interactions with the PCGF Pot/Trap Fishery

Bycatch Estimates

The NCS sector of the fixed-gear sablefish pot fishery consists of the LE primary and the OA fisheries. Since the deployment of observers in 2002, only one documented take of a leatherback sea turtle in the PCGF has occurred in the OA sablefish pot fishery in 2008. Using this data, the NWFSC utilized Bayesian methods to estimate mean annual and 5-year annual average fleet-wide bycatch in the OA fixed gear sector (Table 23, Somers et al. 2024). These estimates were produced by using fishing effort represented by the observed number of sets.

Table 23: Summary of leatherback sea turtle bayesian bycatch estimates 2003-2023 in the OA pot fishery sector.

Year	Annual Bycatch	Conf. Limit (Lower)	Conf. Limit (Upper)	Running 5-year Mean	5-year Mean CL (Lower)	5-year Mean CL (Upper)
2003	3.22	0	11	0	0	0
2004	1.86	0	7	0	0	0
2005	1.71	0	7	0	0	0
2006	2.15	0	8	0	0	0
2007	2.12	0	8	2.21	0	11
2008	2.74	1	8	2.12	0	8

2009	1.82	0	7	2.11	0	8
2010	2.04	0	8	2.18	0	8
2011	1.05	0	5	1.95	0	8
2012	0.88	0	4	1.71	0	8
2013	0.51	0	3	1.26	0	8
2014	0.73	0	3	1.04	0	8
2015	0.91	0	4	0.81	0	5
2016	0.90	0	4	0.78	0	4
2017	0.94	0	4	0.80	0	4
2018	0.82	0	4	0.86	0	4
2019	0.57	0	3	0.83	0	4
2020	0.31	0	2	0.71	0	4
2021	0.51	0	3	0.63	0	4
2022	1.67	0	7	0.78	0	7
2023	1.08	0	5	0.83	0	7

OA Fixed Gear Bycatch Estimates Summary (Table 23):

- We compared leatherback sea turtle bycatch estimates since 2011:
    - OA averaged 0.84 annual entanglements from 2011-2023 and ranged from 0.31-1.67
    - OA 5-year annual average estimates from 2015 (starts with 2011 year)-2023 was

      0.81 and ranged from 0.63-0.86

Observation Rate Summary (Table 2 in Section 1.3.7.3) and are further described in Section 2.5.1.2, above.

<u>Opportunistic Entanglement Reports</u>

The single leatherback turtle entanglement observed in the PCGF in 2008 in the OA sablefish pot fishery was also reported to the NMFS West Coast Region Sea Turtle Stranding program. Most entanglements reported through the stranding networks cannot be attributed to specific fisheries, and are often characterized as line or buoys from unidentified fisheries. There are other entanglement records from the U.S. West Coast, associated with other types of fishing gear and unknown sources. Since the 2008 entanglement, there have been four opportunistically reported entanglements of leatherbacks along the U.S. West Coast, three of which were identified in gear that was attributed to specific fishery origins:

- 2016 – live leatherback reported off the coast of Central California entangled in California commercial Dungeness crab gear
- 2019 – dead leatherback reported off the coast of Southern California entangled in California rock crab gear
- 2023 – dead leatherback reported off the coast of Central California entangled in California commercial Dungeness crab gear

There was one additional entanglement reported in 2015 of a dead leatherback reported off the coast of Central California entangled in unidentified gear. The 2015 entanglement involved gear that is consistent with gear commonly used in West Coast commercial and recreational fixed gear fisheries. There were two bullet buoys visible on the photo documentation from the report that was provided, although no visible markings or other indications that could be used to identify the type or owner of the gear were discerned. Therefore, this entanglement is considered to be associated with unidentified fishing gear. Although we cannot confidently identify the origin or completely discount the PCGF as a possible origin, the gear configuration using bullet buoys documented is different than the common configurations known to be used in the PCGF sablefish pot gear fishery, which typically include larger polyballs used as surface gear attached to large/heavy strings of traps.

There is uncertainty regarding the total number of leatherback sea turtle entanglements that occur across all sources along the U.S. West Coast. While it is expected that a portion of entanglements that occur go unreported, we are unsure how large that portion is. The sablefish pot fishery is conducted across a wide range of the U.S. West Coast, including offshore areas that are not necessarily frequented by a high volume of ocean users. Despite this, detections of entanglements with this gear may be easier than entanglements with other gear because turtles entangled with heavier strings of pot gear like sablefish gear are often more restricted in their movements, and potentially less likely to be free-swimming with an entanglement that might be more cryptic, such as a single monofilament line, to a casual observer passing by.

Given that only one leatherback sea turtle has been observed within the PCGF over a 21-year period (2003-2024), and there have only been 4 other reported entanglements of leatherback sea turtles in fishing gear since 2008, we are not able to specifically calibrate or link opportunistic reporting with estimates of sablefish pot fishery or other PCGF entanglements. The minimal number of strandings in recent years is likely indicative of their decreasing abundance off the

U.S. West Coast as the Western Pacific population has declined.

PCGF Pot Sablefish Pot Fishing Effort

Pot fishing effort was analyzed as described in Section 2.5.1.2 (*PCGF Sablefish Pot/ Fishing Effort)*, and the results carried forward into the analyses below. PCGF pot fishing effort shifted northward over time, with minimal effort occurring in southern California in recent years, mostly due to the shift in distribution of CS sector effort over the time series, 2014-2023 (Figure 9). The number of pot sets throughout the time series was relatively stable (Figure 10). PCGF pot effort generally extended from April-November, and peaked in effort from August-October for all sectors of the fishery (Table A-2).

Co-Occurrence Analysis

In order to consider what might happen in the future, including with respect to where along the U.S. West Coast that risks for interactions with PCGF gear might occur, along with the recent trends in general magnitude of risks for different sectors, we decided to examine the recent co-occurrence of the different PCGF sectors with leatherback sea turtles (see Appendix A for full description of the effort).

It is important to note that the leatherback model utilized in this co-occurrence analysis differs from the one utilized in the humpback whale co-occurrence analysis. The leatherback model is an estimate of suitable habitat that produces values on a scale of zero to one. This is based mostly from environmental data used to predict which areas of the oceans could theoretically support leatherback habitat, but does not predict or estimate the density or number of leatherbacks that may occur within an area. Given the recent declines in leatherback abundance and their low observation rates along the U.S. West Coast, it is difficult to collect the data necessary to generate density estimate predictions commensurate with models that have been created for other more abundant species such as humpback whales (the humpback whale model is a measure of whale density and produces outputs in a measure of whales/km^2). Thus, the leatherback model produces suitable habitat values in areas that would be theoretically attractive to leatherbacks, but does not necessarily mean that leatherbacks are found in those areas during those times. We know, given our correspondence with NMFS scientists who have been conducting surveys for leatherback sea turtles off the U.S. West Coast (Benson personal comm, August 8th, 2024), that leatherbacks have not recently been sighted during surveys in some of the specific areas where this model predicts high habitat suitability, such as off the Pacific Northwest (PNW) near the Columbia River. The caveats to the models used in our analysis are further addressed in Appendix A.

Pot fishing and the subsequent overlap with leatherback habitat suitability has peaked in the late summer and early fall from August-October (Figure A-3). Peak overlap does differ by fishery sector, with the LE sector peaked in September, the OA sector peaked in August, and the CS sector in October. Total overlap across sectors peaked in August (Figure A-3). Areas of the highest predicted habitat suitability in the months from August-October (Figure A-20) coincide with higher fishing effort (Figure A-3) in the areas surrounding the Columbia River mouth, north of Cape Blanco, Oregon, and around Big Sur, California, suggesting that these have been the areas with the highest potential entanglement risk (Figure 27).

We also looked at the interannual variability of overlap over the last decade, to help understand how risk has been changing over time, and what to anticipate in the future. Over time, we see overlap risk has shifted northwards, with minimal overlap occurring in California waters in recent years, and a majority of overlap occurring north of Cape Mendocino, CA (WCGOP, unpublished data*). Overlap in recent years is concentrated north along the Oregon and Washington coasts (WCGOP, unpublished data*). Overlap between leatherbacks and sablefish pot effort has oscillated and remained relatively stable from 2014-2023 (Figure 26). While 2023 was the highest year of overlap for the LE and CS sectors, OA overlap was highest in 2014 (Figure 26).

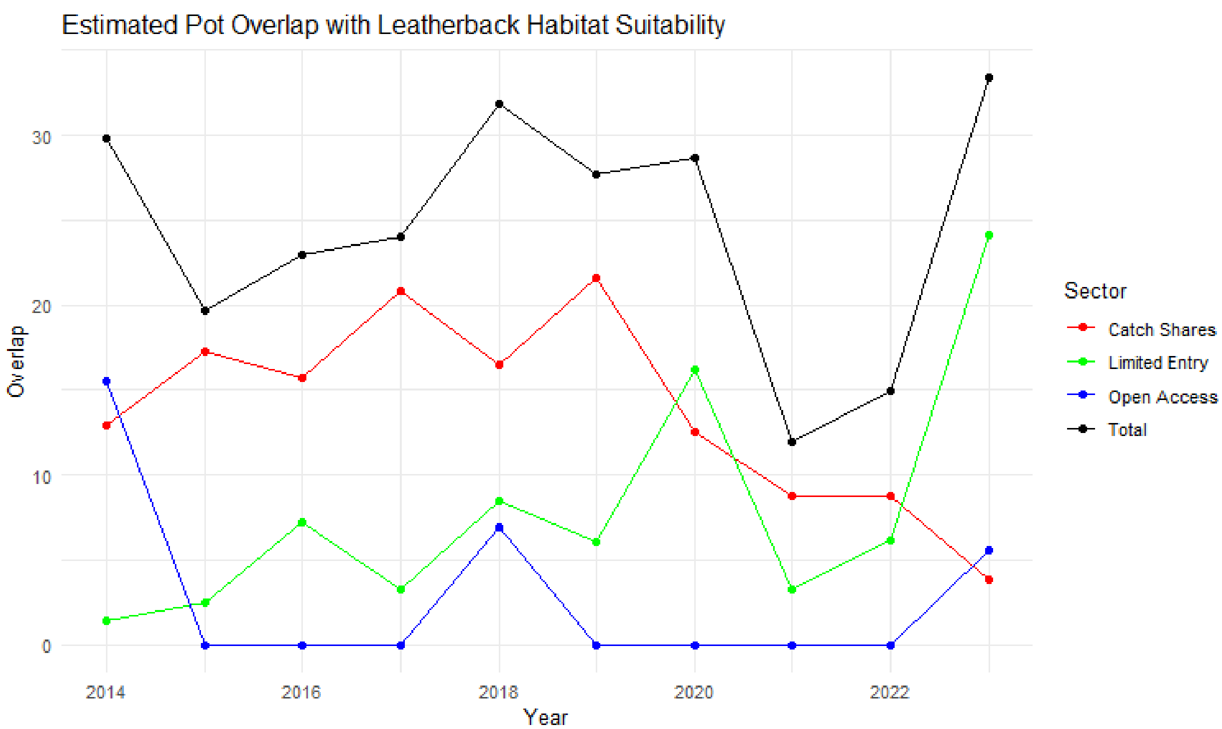

Figure 26: Estimated pot sets overlap with leatherback sea turtle habitat suitability. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each year for all years 2014-2023.

Overlap has shifted northward over time likely as a direct result of pot fishing effort shifting north, especially in the CS sector (Figure A-1). In recent years there have been limited sightings of leatherbacks in survey areas that were part of their historic distribution along the Pacific Northwest coast (Benson, SWFSC, personal comm August 8th 2024). This decline is likely due to decreases of the Western Pacific population rather than any broad distribution changes impacted by climate change. Functionally, the lack of presence of leatherbacks in otherwise suitable habitat especially in the PNW diminishes the level of entanglement risk in this area, and to the sablefish pot fishery as a whole. Despite this, there are still high efforts of pot fishing in summer and fall months off the coast of Oregon, if any leatherbacks did occur in this area. The northward shift in fishing effort is especially pertinent to suitable leatherback habitat that occurs off of Cape Elizabeth, WA as this is a key area for leatherback critical habitat due to the dense aggregations of sea nettles that occur in this area (Benson SWFSC, Personal comm, August 8th, 2024). In recent years, we have seen an increase in pot fishing in this area, potentially elevating the risk to leatherbacks that might occupy those northern areas. However, given there have been limited sightings of leatherbacks in this area in recent years, it is likely that this northern push in pot effort has not increased the entanglement risk of leatherbacks, and that leatherback interaction risk is trending lower overall given the limited abundance of this species across the areas where sablefish pot fishing is concentrated.

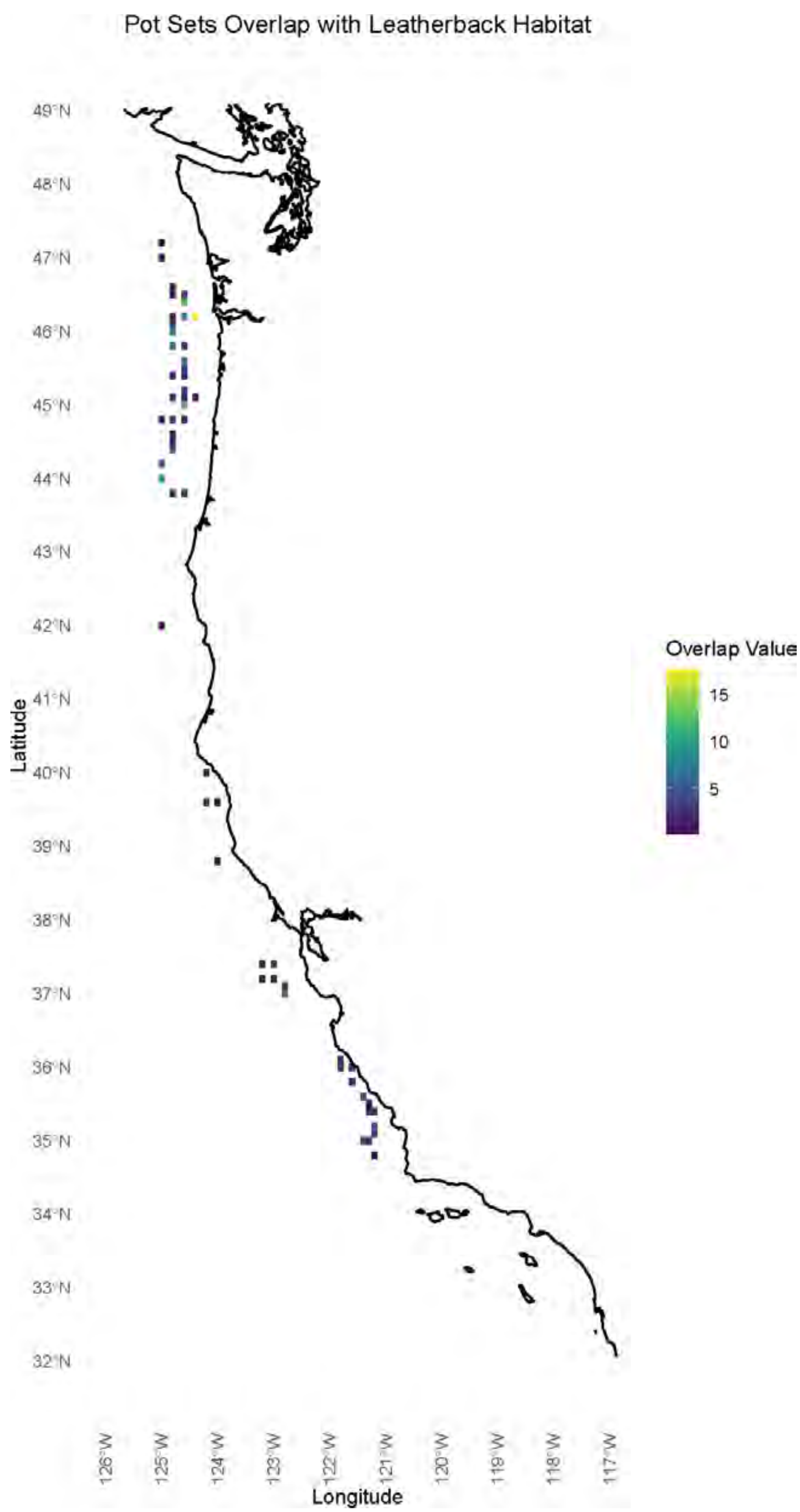

Figure 27: Overlap of scaled number of pot sets (scaled to represent 100% fishing effort based on observer coverage annual rates), with leatherback habitat suitability. Overlap is colored by the magnitude of overlap and is unitless.

OA sablefish pot fishing effort is similar in timing to LE effort, as they both have a seasonal peak in effort in the late summer and early fall months, unlike CS effort, which is relatively stable year-round. Upon analyzing the spatial distribution of OA fishing effort from 2014-2023, a majority (94%) of the observed effort occurs within northern and central California between 35.5° and 40° latitude. This is distinct from the LE and CS, which are concentrated further north; increasingly so in recent years. Leatherbacks are known to forage closer to shore in their central California habitat (within depths of less than 200 m: Benson personal comm August 8th, 2024; Benson et al. 2011), and sightings from aerial surveys are concentrated in depths less than 100 m (Benson et al. 2020). As a result, there is limited co-occurrence with sablefish pot fishing in California averaging depths around 300 m with a median depth of 250 m (140-170 fathoms) (WCGOP data). In comparison, leatherback foraging habitat in Oregon occurs further offshore, out to around 2000 m (Benson et al. 2011), where they are not likely to interact with sablefish pot gear.

Given there is only a single observed leatherback entanglement in the sablefish pot fishery within the OA sector of the fishery that occurred offshore of northern California, we wanted to more closely examine the risk this specific sector poses to leatherbacks despite its limited observer coverage. Overall, only 0.85% of observed OA sets overlapped with a location that contains a leatherback habitat suitability score (i.e. suitability > 0). This would indicate generally that the OA sector has not posed a high risk of leatherback entanglement in the past (still noting the relatively low observer coverage rate and limited available data). Additionally, there have been no observed entanglements of leatherbacks within the PCGF since 2008, which could be linked to their declining abundance in the action area over time.

Anticipated Future Entanglements in the PCGF Sablefish Pot Gear

Having reviewed and evaluated the available information, including recent developments that aren't necessarily reflected in the historical information regarding leatherback sea turtle bycatch risk in the PCGF sablefish pot fishery, we combine it all together to generate expectations for future levels of entanglement that we anticipate, based on the current state of the PCGF.

First, we look to the historical leatherback bycatch estimates for the sablefish pot fishery, generated for the OA sector. As described in Bycatch Estimates, annual estimates for leatherback sea turtle entanglements have been as high (from 2011-2023) as 1.67 (in 2022), and the highest 5-year average has been 0.86 (2015-2019). There are no bycatch estimates representing CS or LE effort because no bycatch events have been observed. This does not mean the estimates of what has occurred in this sector is "zero", but rather estimates cannot be produced.

Looking at the overlap analysis, we acknowledge that it suggests that the CS and LE sectors are at some risk of leatherback interactions. However, as discussed previously, much of that risk is generated from predicted suitable habitat off the PNW, where we are decreasingly confident that leatherback turtles have been or will be occurring in the foreseeable future, given their decreased abundance off the U.S. West Coast as the Western Pacific population has declined. Therefore, given the lack of previous observations of leatherback bycatch in the LE and CS sectors, and given the northward shift in overlap and fishing effort and lack of recent leatherback sightings in these same northern waters, we do not anticipate future interactions in those sectors.

Table 24: Overlap separated by year and sector for all sablefish pot overlap with leatherback habitat suitability. These are the monthly summed overlap for all months within the year.

	LE	OA	CS	Total
2014	1.4	15.5	12.9	29.8
2015	2.4	0	17.3	19.7
2016	7.2	0	15.8	22.9
2017	3.2	0	20.9	24.0
2018	8.4	6.9	16.5	31.9
2019	6.1	0	21.6	27.7
2020	16.2	0	12.5	28.7
2021	3.2	0	8.8	12.0
2022	6.2	0	8.7	14.9
2023	24.1	5.6	3.8	33.4
Average	**7.8**	**2.8**	**13.9**	**24.5**

Although the trends in effort and predicted level of co-occurrence are difficult to characterize over the last ten years for the OA sector, given the limited observer coverage and data collected in this sector, the recent rise in the total effort, suggest that future bycatch in the OA sector still could occur at the high end of range of what has occurred previously moving forward. Unlike the LE and CS sectors, most of the OA sector effort occurs off of California, where we are more confident about the likelihood of leatherback occurrence moving forward. Therefore, we look at the maximum values from recent years (since 2011) to inform our expectations for future bycatch for these sectors, in terms of what may happen in any one year, and over a 5-year annual average. As a result, we consider that as many as 1.67 leatherbacks may be entangled in total during any one year, and 0.86 may be the highest annual average of entanglements over a 5-year period.

Annual maximum = no more than 1.67 entanglements

Maximum 5-year running average = no more than 0.86 entanglements

Population Apportionment

The distinction between the global population of leatherbacks and their relevance to the action area and this opinion was discussed in Section 2.2.2.2 *Status of the Species*, which discussed both the West and East Pacific populations of leatherback sea turtles. All of the leatherback sea turtles that have been tagged on the West Coast have originated from the West Pacific population of leatherbacks. Given this knowledge, NMFS expects that all of the expected leatherback sea turtle entanglements in the PCGF sablefish pot fishery will be associated with the West Pacific population.

Response to the Pot Gear Entanglement

The probability a marine turtle will initially survive an entanglement in fishing gear depends largely on the species, age, and size of the turtle involved. Documented cases indicate entangled marine turtles may travel for extended periods of time and over long distances before freeing themselves or being disentangled by stranding network personnel, or they may die as a direct result of the entanglement. It is often unclear if an entanglement immediately results in a serious or debilitating injury that could eventually lead to death. If the gear is heavy or significantly restricts the turtle’s ability to swim, the animal could become exhausted from repeatedly trying to reach the surface to breathe and might eventually drown. Less severe entanglements may also lead to exhaustion, depletion of energy stores, restricted movement, choking, and starvation due to the increased drag (Barreiros & Raykov 2014; 2020 Status Review). Turtles are commonly entangled around their flippers, and if wrapped tightly, the injury can debilitate the animal, especially if the gear is constricting, causes lacerations, or impairs swimming or feeding ability (Witzell and Cramer 1995, Coelho et al 2015, Huang 2015). Such injuries may make the animal more susceptible to disease or predation (Status Review 2020). Lacerations themselves may become a source of infection (Innis et al. 2010). Sustained stress from repeated or prolonged entanglement in gear or gear left on the animal, may reduce the ability to heal and fight infection or disease (Innis et al. 2010; 2020 Status Review). Younger animals are particularly at risk if the entangling gear is tightly wrapped, as continued growth will constrict gear further. Data from the NMFS WCR Stranding Database does not provide conclusive information on the size or age of most turtles reported entangled.

Among the 5 reported U.S. West Coast leatherback entanglements from 2008–2024, four individuals have been dead, with only one released alive. The specific outcome of an entanglement event after the last sighting of an entangled or disentangled turtle is rarely known, NMFS assesses the likelihood of post-interaction mortality associated with each entanglement. These evaluations are based on the current criteria outlined in the process for post-interaction morality determinations for sea turtles incidentally caught in trawl, net, and pot/trap fisheries, initially issued in 2017 and renewed in 2022 (NMFS 2022d).

We reviewed information about leatherback mortality rates in pot and trap fishing gear in other places, such as the U.S. East and Coast, Gulf of Mexico, and Canada, where variable mortality rates have been described (Upite et al. 2018, NMFS 2017, Hamelin et al. 2017). However, we are unable to determine if the entanglements presented are associated with gear configurations of strings (similar to sablefish gear) or single vertical lines, and post-interaction mortality estimates for the historical leatherback interactions are generally not available.

Given our limited expectation for the number of leatherback interactions that will occur, and the risk of a significant injury or mortality that is posed by leatherback entanglements in heavy pot/trap gear fished in strings like sablefish pot gear, we will assume a mortality (initial and post-release) rate of 1.0, or 100%, for future entanglements in the sablefish pot fishery.

Annual maximum mortality = no more than 1.67
Maximum 5-year running average mortality = no more than 0.86

2.5.2.3 Risk of the PCGF Hook-and-Line and Trawl Fisheries

There have been no documented interactions between leatherback sea turtles and PCGF hook-and-line gear throughout the duration of the WCGOP. There are no bycatch estimates for PCGF hook-and-line and midwater trawl fishing because no bycatch events have been observed in these PCGF sectors. Upon analyzing the stranding reports of leatherback turtles on the West Coast since 1970, there is also no mention of gear similar to PCGF hook-and-line gear, such as monofilament line. There is no mention of trawl nets or other associated trawl gear associated with strandings of leatherbacks beyond one leatherback incidentally captured during a scientific trawl net survey in 2011, and released alive (NMFS 2015). Our co-occurrence analysis with PCGF hook-and-line and midwater trawl fisheries are available for review in Appendix A.

Considering all of the information above, we do not foresee or anticipate leatherback interactions with the PCGF hook-and-line and trawl fisheries in the future.

2.5.2.4 Risk of Prey Removal

Important prey species for leatherback sea turtles incidentally captured in the PCGF include various species of jellyfish or gelatinous zooplankton, particularly brown sea nettles (*Chrysaora fuscescens*). As summarized in the "Not Likely to Adversely Affect" Determinations (Section 2.12), leatherbacks target gelatinous zooplankton such as jellyfish and tunicates, requiring large quantities due to their low energy content. In Section 2.12.1 "*Not Likely to Adversely Affect" Determinations*, the extent of incidental capture of these important prey species in the PCGF, and the relative impact of these removals on the proposed critical habitat, are described in detail.

Jellyfish and tunicates are caught in the PCGF[13] in relatively small amounts, and are typically classified as unidentified species in the GEMM database (Figure 28). Jellyfish catch peaked in earlier years from 2002-2005, while tunicate catches have remained relatively stable and near zero during the entire time series. Jellyfish catch ranges from 5 mt (2017) to 820 mt (2002), and 0 mt (2006) to 5 mt (2017) for tunicates. Neither of these prey items were caught in significant amounts that would impact the foraging or migratory behavior of individual leatherback sea turtles while living within the CCE.

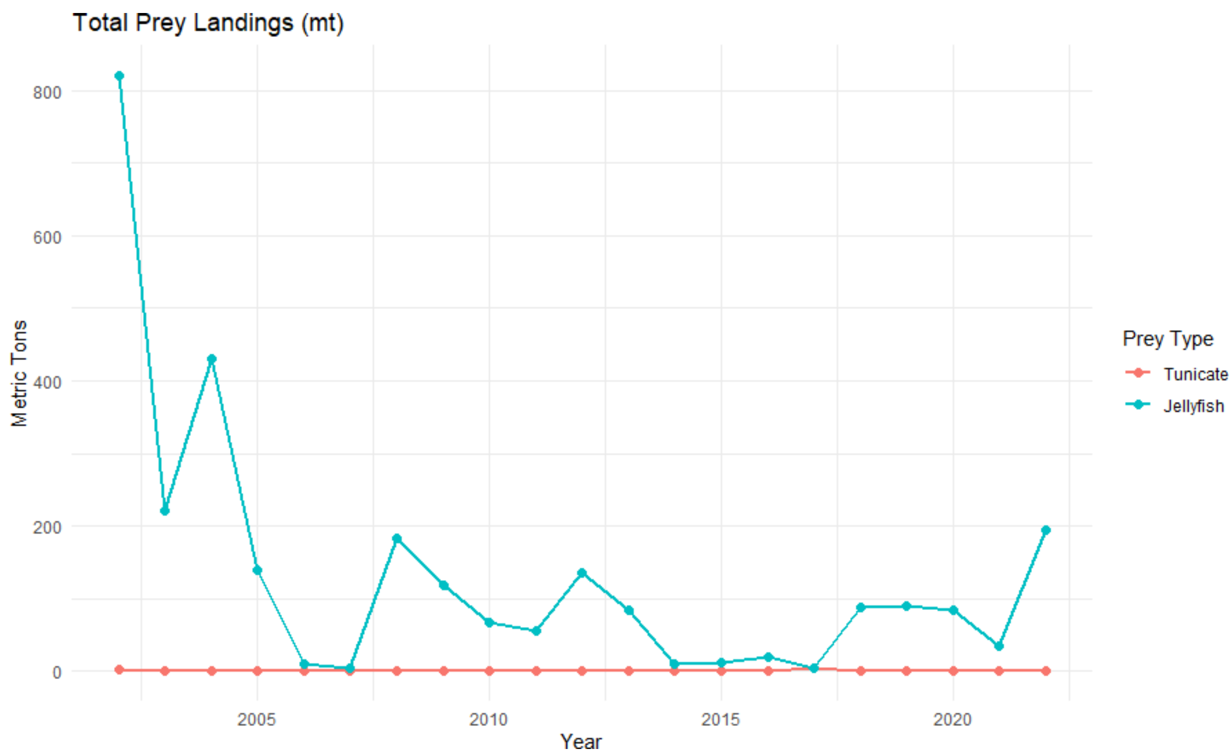

Figure 28: Total prey landings (mt) of pertinent leatherback prey items: jellyfish and tunicates. Data was gathered from NWFSC GEMM database using actual landings of prey and discarded landings with a mortality rate applied and summed together.

Ultimately our analysis in Section 2.12.1 *"Not Likely to Adversely Affect" Determinations*, concludes the PCGF is not likely to adversely affect the prey feature of the critical habitat designation, because the bycatch of leatherback prey species by the PCGF is minimal compared to the amount of prey required and available for leatherback sea turtles within the CCE. Despite the decline of the Western Pacific population of leatherback, this trend is consistent across many

[13] GEMM includes total estimated discard, discard with discard mortality rates (DMRs) applied, landings, catch (discard and landings), and mortality (discard with DMRs applied and landings) for all species and groupings recorded in A-SHOP, EM, PacFIN, RecFIN, and WCGOP data for the years 2002 to 2022.

global leatherback populations, and not likely associated with lack of prey resources, which has not been identified as a significant population threat for leatherback. As a result, we conclude the impacts of prey removal by the PCGF are negligible.

2.5.2.5 Risk of Vessel Collisions

As described above for humpback whales, available information does not indicate that vessel collisions from the operation of the PCGF are significantly impacting ESA-listed leatherback sea turtles. There have been no reported collisions of PCGF vessels with leatherback sea turtles, and the relatively small sizes and slower speeds of these fishing vessels makes them less likely to result in collisions, or for such collisions to result in serious injury or mortality, as compared to other larger, faster-moving vessel classes (i.e., tankers, container ships, and cruise ships) most frequently associated with marine life vessel collisions. While vessel collisions with sea turtles are known to occur on the U.S. West Coast, as described in the *Environmental Baseline*, there have also been no observed cases of leatherback sea turtle vessel collisions or strandings of any kind since 2017. Based on the broadly distributed patterns of vessel movements, relatively small sizes and slow speeds of the PCGF vessels, and the fact that vessel collisions with leatherbacks are infrequent generally and have never been reported from any PCGF vessels previously, the probability of PCGF vessels colliding with leatherback sea turtles is extremely small. We conclude that vessel collisions with ESA-listed leatherback sea turtles as a result of the proposed action are improbable.

2.5.2.6 Risk of Pollution and Contaminants

Similar to our analysis in section 2.5.1.7 *Risk of Pollution and Contaminants* for humpback whales, the available information does not indicate that pollution resulting from the operation of the PCGF is significantly impacting leatherbacks, or the PBFs of their critical habitat. Given the continual and dispersed movement of vessels within the action area, we generally do not anticipate that the release of a small amount of petroleum into the marine environment will cause acute or chronic exposure to leatherbacks, and their prey, since they are mobile. Without evidence to support analyses of how these factors may affect ESA-listed species as a result of the proposed action, NMFS concludes the potential release of pollution via PCGF fishing vessels is a minor risk for leatherbacks.

2.5.3 Population Risk of PCGF Interactions

2.5.3.1 Humpback Whales

In order to estimate the risk that interactions with PCGF sablefish pot, hook-and-line, and midwater trawl gear poses to ESA-listed humpback whale DPSs, we consider how many mortalities and serious injuries are expected to occur. For the purposes of this biological opinion, we assume that all age-classes are vulnerable to entanglement and of equal significance and males are as vulnerable as females.

Interactions, including entanglement, hooking, and capture, have been anticipated in a range of PCGF gears/fisheries, including sablefish pot, hook-and-line (including bottom longline, vertical jigs/longline/other, recreational), and hake midwater trawls. Our expectations for the future number of interactions, and resulting mortality (or serious injury) that could lead to removal from the population, are detailed throughout section 2.5.1.1 *Exposure and Response – Bycatch in the PCGF*. For all humpback whale interactions in PCGF gear (including from the ESA-listed DPSs and the unlisted Hawaii DPS), we estimate up to 6.62 humpback whales could be entangled in any given year, with the possibility of 6.25 killed or seriously injured in any given year as a result of the proposed action, if the maximum number of entanglements anticipated happened across all components of the PCGF in the same year (which is unlikely). We also anticipate that the annual average over any five-year period will not exceed 2.67 individual(s) entangled, leading to no more than 2.30 serious injuries. For the ESA-listed humpback whale DPS affected by PCGF interactions, we have aggregated and summed these expectations across the PCGF into Table 25.

Table 25. Anticipated PCGF interactions and resulting M/SI with ESA-listed DPSs.

	Mexico DPS		**Central America DPS**	
	Annual Max	**Max 5-year Running Ave**	**Annual Max**	**Max 5-year Running Ave**
Total Bycatch in PCGF Pots	2.29	1.03	1.55	0.69
Anticipated M/SI in pots	2.11	0.95	1.43	0.63
Total Bycatch in PCGF hook-and-line gear	0.47	0.1	0.29	0.06
Anticipated M/SI in hook-and-line	0.47	0.1	0.29	0.06
Total Bycatch in Midwater Trawl	0.52	0.21	0.37	0.15
Anticipated M/SI in Midwater	0.52	0.11	0.37	0.08

Trawl				
Total Bycatch in PCGF	**3.28**	**1.34**	**2.21**	**0.90**
Anticipated M/SI	**3.10**	**1.16**	**2.09**	**0.77**

Mexico DPS

Across the PCGF, we anticipate that as many as 3.28 Mexico DPS whales may be entangled, hooked, and/or captured in a given year, resulting in the mortality or serious injury of 3.10 Mexico DPS whales. We also expect that the annual average over any 5-year period will not exceed 1.34 interactions, with 1.16 mortalities or serious injuries. Necessarily, this means that the annual average over time throughout the duration of the proposed actions should not exceed these values.

As described in the *Status of the Species* (Section 2.2.2.1.1), there are no recent estimates of the entire Mexico DPS specifically, but the best available information indicates that there are at least 7,500 individuals in the Mexico DPS of humpback whales. Given this information, we expect that interactions with the PCGF could result in the removal of up to 0.04% (3.10/7,500) of the Mexico DPS during any year, and over time, no more than 0.02% (1.16/7,500) of the Mexico DPS each year over any 5-year period.

Central America DPS

Across the PCGF, we anticipate that as many as 2.21 Central America DPS whales may be entangled, hooked, and/or captured in any given year, resulting in the mortality or serious injury of 2.09 Central America DPS whales. Over time, we expect that the annual average over any 5-year period will not exceed 0.90 interactions, with 0.77 mortalities or serious injuries.

As described in the *Status of the Species* (section 2.2.2.1.2), the Central America DPS has an estimated population of 1,496 whales. Given this information, we expect that interactions with the PCGF could result in the removal of up to 0.14% (2.09/1,496) of the Central America DPS during any year, and over time, no more than 0.05% (0.77/1,496) of the Central America DPS each year over any 5-year period.

2.5.3.2 Leatherback Turtles

In order to estimate the risk that the PCGF sablefish poses to leatherbacks, we need to determine the number of adult females removed from the Western Pacific subpopulation, as this is our primary metric for tracking population impacts for leatherback sea turtles. However, the available data on the demographics of leatherbacks found off the U.S. West Coast that would interact with the PCGF is limited. Based on aerial surveys conducted off central California from 1990-2003, the majority of leatherbacks observed were larger subadults or adults (Benson et al. 2007b). Only five leatherbacks observed captured in the California DGN fishery were measured by observers, and they were assumed to be large subadults or adults. Therefore, we assume that any leatherback interaction that occurs with the PCGF sablefish pot fishery will be a subadult or adult.

The sex ratio of the Western Pacific population is unknown, but researchers that have captured leatherbacks in-water off central California have documented that approximately two out of three leatherbacks were females (~67%) (Benson et al. 2007b). Given this we assume the 67% of leatherback interactions with the PCGF will be adult females.

In section 2.5.2.2 *Exposure and Response to Interactions with the PCGF Pot/Trap*, we describe our expectation that no more than 1.67 leatherbacks will be entangled and killed in PCGF sablefish pot gear in any year. Assuming these are all adult leatherbacks, and using the estimated sex ratio (0.67) this amounts to 1.12 adult females. We also described our expectation that, over time, that annual average of any 5-year period would be no more than 0.86 entanglements/mortalities per year. Using the same information, this amounts to an average of 0.58 adult females per year. As described in section 2.5.2.2, we assume all of these entanglements could lead to mortality, and removal from the population.

As summarized in the *Status of the Species* (section 2.2.2.2), the best current estimated adult female abundance of the Western Pacific population is 1,054 individuals. Given this information, we expect that entanglements with PCGF sablefish pot gear could lead to removal of 0.1% (1.12/1054) of the total Western Pacific adult female population in any given year, and over time, no more than 0.06% (0.58/1054) of the total Western Pacific adult female population, on average each year, over any 5-year period.

2.6. Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02 and 402.17(a)). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

The states of California, Oregon, and Washington have been implementing regulations aimed at reducing the impacts of entanglements on ESA-listed species, including Central America and Mexico DPSs of humpback whales, and leatherback sea turtles. These regulations generally include seasonal reductions of gear/effort and depth restrictions, and other measures to reduce entanglement risk and/or better understand the dynamics of this risk (e.g. establishing an entanglement detection network, implementing a lost/abandoned gear retrieval program, implementing electronic vessel position monitoring, gear marking, testing innovative gear). A working group, comprising non-governmental organizations, industry, biologists, and state and federal representatives, aimed to address entanglements of large whales and leatherback sea turtles in the California Dungeness crab fishery was established in 2015. This group developed a Risk Assessment Mitigation Program (RAMP) which was finalized by California Department of Fish and Wildlife (CDFW) on November 1, 2020 (14 CFR Sec. § 132.8), requiring regular evaluations of entanglement risks and implementation of management actions if entanglements are confirmed or key species concentrations are observed during the fishing season (November 1-June 30). The regulations include triggers for management actions (e.g. fishery closure, advisories, depth constraints, gear requirements, alternative gear, etc.) if entanglements of key species are confirmed or concentrations of these species are observed. While the RAMP continues to operate, we anticipate that there will be adjustments to the California Dungeness crab fishery during future seasons that will reduce the risks of humpback whale and leatherback entanglements, although we do not anticipate the RAMP will completely eliminate those risks and all future occurrences, based on the performance of the RAMP to date. However, we do anticipate that less entanglements will occur than under the conditions that existed before the program, directly as a result of RAMP implementation.

Some continuing non-Federal activities are reasonably certain to contribute to the overall environmental health and habitat quality within the action area. In section 2.4 *Environmental Baseline*, we described the current and ongoing impacts associated with other activities that affect ESA-listed species along the U.S. West Coast. We are reasonably certain that these activities and impacts will continue to occur while this proposed action occurs. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline vs. cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the rangewide status of the species and critical habitat (Section 2.4).

We did not identify additional state or private activities that are reasonably certain to occur within the action area, do not involve Federal activities, and could result in cumulative effects to ESA-listed species within the action area. Activities that may occur in these areas will likely consist of state or Federal government actions related to ocean use policy and management of public resources, such as commercial and recreational fishing, aquaculture, energy development projects that include offshore wind, and/or other spatial planning/management projects. Changes in ocean use policies as a result of non-Federal government action are highly uncertain and may be subject to sudden changes as political and financial situations develop. Examples of actions that may occur include development of aquaculture projects; changes to state fisheries that alter fishing patterns or influence the bycatch of ESA-listed marine species; installation of hydrokinetic projects near areas where marine mammals are known to migrate through or congregate; designation or modification of marine protected areas that include habitat or resources that are known to affect marine mammals; and coastal development that alter patterns of shipping or boating traffic. However, none of these potential state, local, or private actions, can be anticipated with any reasonable certainty in the action area at this time, and some of those described as examples would likely involve Federal involvement of some type.

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species (Section 2.2), to formulate the agency's opinion as to whether the proposed action is likely to (1) appreciably reduce the likelihood of the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution, or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species. This biological opinion does not perform an analysis of destruction or adverse modification of critical habitat because NMFS has determined that the proposed action is not likely to adversely affect designated critical habitat. The prior sections of this opinion analyzed the potential for effects of the proposed action at the level of individual ESA-listed leatherback sea turtles and humpback whales. The rest of this biological opinion will be focused on describing how this anticipated level of effect, when added to the status, environmental baseline, and cumulative effects, affects the likelihood of both the survival and recovery of each species.

The description of the Proposed Action's effects includes any influence of current environmental conditions and their associated variability. While climate change is expected to continue over the duration of the action's effects, we cannot distinguish changes in temperature, precipitation, or other factors attributable to climate change, including changes in predator-prey relationships, from those due to annual and decadal climate variability when estimating the potential for entanglement risk in any given future year based on the past 10 years of data. Within the action area over the next several decades, several species (including leatherback sea turtles) are expected to shift their distributions poleward and offshore, primarily in waters off OR and WA, most likely due to a combination of more favorable thermal conditions and distributional shifts of their prey (Lezama-Ochoa et al. 2024). However, as described in the *Rangewide Status of the Species* (Section 2.2) and *Environmental Baseline* (Section 2.4), analyses of these climate-driven distributional shifts of species or responses to threats are almost exclusively based on ~50-100 year and almost centennial timeframes. This precludes a clear identification of forthcoming changes in marine environmental conditions and associated influence on species and the Proposed Action's effects in any given year over the near-term. The *Status of the Species* and *Environmental Baseline* have generally captured the impacts that are happening to these

ESA-listed species as the conditions in the Pacific Ocean have changed over recent decades, as part of the underlying climate change that is occurring. For these reasons, although climate change is expected to continue to affect species distribution, and present or exacerbate threats over the long term, it is not expected to amplify the effects of the Proposed Action in ways not already described in the Effects section, or any other components of the Integration and Synthesis.

2.7.1 Humpback Whales

In the *Status of the Species* section, we identified two DPSs of humpback whales that may be affected by the PCGF occurring off the U.S. West Coast. Both DPSs are associated with the former CA/OR/WA stock of humpback whales, now designated using DIPs that share both wintering and feeding areas.

Based on the best available information from Calambokidis and Barlow (2020), Curtis et al. (2022), and Cheesman et al. (2024), we conclude that ~8% annual likely represents the growth of the Mexico DPS, although the growth of the Central America DPS has been estimated to be lower. Based on the most recent information, we assume 57.7% of the humpback whales off the coast of California and Oregon are part of the Mexico DPS and 42.3% are part of the Central America DPS. In Washington waters, we assume the Mexico DPS represents 25.4% of humpback whales in the area, and the Central America DPS represents 5.9%, with any remaining whales being from the unlisted Hawaii DPS.

As described in the *Status of the Species* and *Environmental Baseline* section, humpback whales face a number of threats throughout their range, including within the action area. While efforts are underway to mitigate some ongoing threats to ESA-listed humpback whales (such as gear marking, voluntary VSR zones), most are likely to continue into the future.

Entanglement in fishing gear remains a critical threat limiting the recovery of ESA-listed humpback whales (NMFS 2022e). Trends in entanglement reports from 2000 through 2017 suggest the proportion of whales, regardless of species, entangled in pot/trap gear has increased over time, although net gear entanglements have decreased in prevalence. In recent years, there has been an increase in reported interactions between fisheries and humpback whales in Central California, particularly with the Dungeness crab pot fishery. Humpback whales often interact with fishing gear due to the overlap of their migratory route and foraging grounds with fisheries on the U.S. West Coast. Between 2014 and 2023, humpback whales made up 66.8% of reported entanglements in the region. Although humpbacks continue to be entangled, the number of reports in the last five years (< 19 animals per year from 2019-2023) has shown a decline since the confirmed reports from 2015-2018 (30 to nearly 50 humpbacks annually) (NMFS 2024a).

Vessel collisions are also a threat to the recovery of ESA-listed humpback whales. Although Rockwood et al. (2017) estimated about 22 humpback whales are victims of ship strike each year in the U.S. West Coast EEZ, NMFS recognizes there is uncertainty surrounding the number of ship collisions and mortalities. Sample sizes are small and identified cases are likely biased towards species that are large and easy to identify. Of humpback whales identified to have been struck by a vessel, there are currently no reports of the vessel belonging to the PCGF fleet although such an interaction may have occurred in the past.

Humpback whales may also be affected by a number of other threats throughout their range, including harassment from vessels, oil spills, and other sources of strandings. Although harassment can occur from vessels approaching humpbacks, there have been no documented findings suggesting these activities are resulting in mortality or serious injury of individuals. Encounters with pollutants, especially during oil spill events, are another threat to humpback whales and their critical habitats. There are periodic strandings of humpback whales that cannot be attributed to specific threats such as vessel collisions or entanglements, although the reasons behind these events are unknown.

While the threat of climate change to ESA-listed DPSs humpback whales is uncertain, shifts in prey distribution and abundance due to climate change and other environmental conditions may lead to corresponding shifts in humpback whale distribution. This could increase PCGF risk to humpback whales by increasing the rate of overlap between fisheries and whales, as well as other threats described in the *Environmental Baseline* section. Although we cannot precisely estimate the magnitude of future changes and their impacts, significant changes to bycatch of humpbacks and other baseline threats would be necessary to appreciably reduce the likelihood of survival and recovery of ESA-listed DPSs, based on available information and current assessments.

In the *Cumulative Effects* section, we did not identify additional state or private activities that are reasonably certain to occur within the action area and could result in cumulative effects to ESA-listed species.

In the *Effects of the Action* section we evaluated the potential for impacts of the PCGF to ESA-listed humpback whales from entanglement in fishing gear, prey removal, vessel collisions, and pollution. After evaluating the vessel activities expected to occur as a result of the proposed action, we concluded that the effects of vessel collisions, oil spills, and marine debris adversely affecting humpback whales were improbable or minor. The removal of humpback whale prey by PCGF activities was also evaluated, and we concluded sardines, Pacific herring, and anchovies are not caught in amounts that would reduce the prey available by a detectable amount for humpback whales in the action area. Entanglement in fishing gear was identified as the primary source of potential adverse impacts associated with the proposed action. In addition to interactions with the sablefish pot fishery that we have previously anticipated, recent information has indicated that interactions with commercial PCGF hook-and-line and midwater trawl fisheries should be anticipated in the future as well. Because there are multiple DPSs present along the U.S. West Coast, we first considered the impacts of the proposed action on humpback whales in the action area, then apportioned the potential impacts to the ESA-listed DPSs.

After considering past entanglements, available bycatch estimates, and trends in overlap of fishing effort and predicted humpback whale density, we estimate up to 6.62 humpback whales (from any of the three DPSs off the West Coast, both listed and unlisted) could be entangled in any given year, with the possibility of 6.25 killed or seriously injured in any given year as a result of the proposed action, if the maximum number of entanglements anticipated happened across all components of the PCGF in the same year (which is unlikely). We also anticipate that the annual average over any five-year period will not exceed 2.67 individual(s) entangled, leading to no more than 2.30 serious injuries or mortalities over that same five-year period. For the purposes of this biological opinion, we assume all age-classes and sexes are equally vulnerable and of equal significance. We expect these mortalities or serious injuries could occur to any individual in the population.

While risk reduction measures are part of the proposed action, including minimization of the extent of surface gear used, and voluntary reduction in the use of one vertical end line, the contribution of these measures towards reduced entanglement risk is unknown or uncertain. In particular, it is not yet clear to what extent PCGF fixed gear fishers will take advantage of the opportunity to remove one end line. New gear marking measures are likely to be effective in 2026, which are expected to help improve our ability to identify gear belonging to the PCGF that may be involved in entanglements reported opportunistically. Data collection from these events can help improve bycatch/risk evaluations, and reinforce confidence that unidentified gears involved in reported entanglements do not belong to the PCGF. Though this action is not expected to reduce the likelihood of entanglements with PCGF gear in the near-term, over time implementation of these measures will improve approaches for evaluating entanglement risk associated with this and other U.S. West Coast fisheries. This will facilitate future risk reduction efforts that are focused towards the appropriate sources of entanglements.

2.7.1.1 Mexico DPS Humpback Whales

As described in the *Status of the Species* (Section 2.2.2.1.1), there are no recent estimates of the entire Mexico DPS specifically, but the best available information indicates that there are at least 7,500 individuals in the Mexico DPS humpback whales. The most recent estimate of the Mainland Mexico - U.S. West Coast stock is 3,477 (CV = 0.101), and the most recent 2022 SAR (Carretta et al. 2023b) calculated PBR of 43 whales per year, although this only accounts for individuals from the Mexico DPS that forage off the U.S. West Coast, and does not include the portion that forages in other places such as Alaska.

We estimated the potential for incidental capture and M/SI of Mexico DPS humpback whales due to entanglements in PCGF pot, hook-and-line, and midwater trawl gear. As described in Section 2.5.3.1, we estimated that in total up to 3.28 Mexico DPS humpback whales may be entangled/hooked/captured in PCGF gear in any year, or up to 1.34 per year on average over any 5-year period, and up to 3.1 may be killed in any year, or up to 1.16 per year on average over any 5-year period, as a result of the proposed action. Over time, this mortality would represent at most an impact of no more than 0.04% of the DPS abundance in any year, and no more than 0.02% of the DPS abundance per year over any 5-year period.

Throughout the action area, Mexico DPS humpback whales encounter other fisheries as well. As summarized in the *Environmental Baseline* (Section 2.4.2), there were 136 observed entanglements/interactions between commercial fisheries and humpback whales between 2016-2020 in California, Oregon, and Washington. From these interactions, there is an estimated mean M/SI of 11.4 Mexico DPS humpback whales per year. Non-commercial fisheries make up a small portion of reported fishery interaction cases but, due to minimal mandated accounts of effort and entanglements, the true impact of recreational fisheries may be higher. Between 2016 and 2020, recreational fisheries in California, Oregon, and Washington, which includes tribal and non-tribal fisheries, had an estimated mean annual M/SI of 0.56 Mexico DPS humpback whales.

Other sources of mortality for Mexico DPS humpbacks within the action area include vessel strikes. From 2016 through 2020, there were 14 confirmed humpback whale vessel strike cases reported, leading to an estimated M/SI of 13.2 whales over five years or an average of 2.6 whales seriously injured or killed per year. Rockwood et al. (2017) estimated as many as 22 humpback whales may be killed each year from ship strikes in the U.S. West Coast EEZ, and based on DPS proportions that would result in an estimated 10.15 of these whales belonging to the Mexico DPS, although there is evidence to suggest these are overestimates (Garrison et al. 2022). While this threat persists, the current level of ship strikes is not believed to be impeding the recovery of ESA-listed humpback whale DPSs (NMFS 2022c), and risks may be further reduced by voluntary speed reduction measures in California coastal waters.

Based on the current status and trajectory of Mexico DPS humpback whales as described in the *Status of the Species* (increasing up to 8% a year), and considering sources of ongoing mortality and serious injury as described in *Environmental Baseline*, we conclude the additional DPS-level mortality that could occur as a result of the proposed action (i.e., the loss of a little more than one individual annually, on average, over time) is not likely to reduce the abundance or reproduction of this species to an extent that it would appreciably reduce the likelihood of the survival and recovery of the DPS.

2.7.1.2 Central America DPS Humpback Whales

As described in the *Status of the Species* (section 2.2.2.1.2), the Central America DPS has an estimated population of 1,496 whales (CV = 0.171), with a minimum population estimate of 1,284 whales. Based on this information, the most recent 2022 SAR (Carretta et al. 2023a) calculated PBR of 3.5 whales per year in U.S. waters.

One of the primary factors in the recent listing decision to retain an endangered status for this DPS is the risk of extinction due to its relatively small population size. Since then, NMFS has determined the population has grown, although it remains relatively small and is not increasing at the same rate as the Mexico DPS. This remains an area of uncertainty and requires further study, given the variable growth rates among humpback whale populations but observed population increases off the U.S. West Coast. While a recovery plan for the newly listed Central America DPS has not been developed, an outline for the recovery of both Central America and Mexico DPSs was created in 2022 which does highlight fishery entanglement, vessel strikes, and low abundance as the primary threats to the Central America DPS.

We considered possible effects of the proposed action on Central America DPS humpback whales due to entanglements in PCGF pot, hook-and-line, and midwater trawl gear. As described in Section 2.5.1, we estimated that in total up to 2.21 Central America DPS humpback whales may be entangled/hooked/captured in PCGF gear in any given year, or 0.90 per year on average over any 5-year period, and up to 2.09 may be killed annually, or up to 0.77 per year on average over any 5-year period, as a result of the proposed action. This mortality would represent at most an impact of no more than 0.14% of the DPS abundance in any year, and over time, no more than 0.05% of the DPS abundance per year over any 5-year period. In reality, the PCGF will likely account for an even smaller amount of human-caused mortality of the Central America DPS population over the duration of the proposed action because our anticipated bycatch levels and associated expectations for mortality are maximums that are unlikely to occur every year.

As described in the *Status of the Species* (section 2.2.2.1.2), the Central America DPS has an estimated population of 1,496 whales. Given this information, we expect that interactions with the PCGF could result in the removal of up to 0.1% (2.09/1,496) of the Central America DPS during any year, and over time, no more than 0.05% (0.77/1,496) of the Central America DPS each year over any 5-year period.

Throughout the action area, Central America DPS humpback whales interact with other fisheries as well. As summarized in the *Environmental Baseline* (Section 2.4.2), there were 136 observed entanglements/interactions between commercial fisheries and humpback whales in California, Oregon, and Washington between 2016 and 2020. These interactions resulted in a mean annual M/SI of 8.1 for Central America humpback whales. Non-commercial sources make up a small portion of mortality and serious injury for humpback whales. Between 2016 and 2020, there were nine observed interactions in California, Oregon, and Washington, resulting in an estimated mean annual M/SI of 0.35 for Central America DPS humpbacks.

Vessel collisions are another threat to Central America humpbacks within the action area. From 2016 to 2020, there were 14 confirmed humpback whale vessel strike cases reported. Rockwood et al. (2017) estimated as many as 22 humpback whales may be killed by vessel strikes on the U.S. West Coast each year, of which an estimated 6.45 whales would belong to the Central

America DPS, although there is evidence to suggest this is an overestimate (Garrison et al. 2022). Despite the presence of this threat and the lower rate of growth of this DPS, the population continues to grow. The mitigation of serious injury or mortality from vessel strikes may be due in part to the implementation of actions reducing vessel speeds across the U.S. West Coast waters, including zones of seasonal vessel speed reductions.

Given the current status and trajectory of Central America DPS humpback whales as described in the *Status of the Species* (increasing at a rate estimate at 1.6%), and considering sources of ongoing mortality and serious injury as described in the *Environmental Baseline,* we conclude that the additional DPS-level mortality that may occur as a result of the proposed action (i.e., the loss of less than one individual annually, on average, over time) is not likely to reduce the abundance or reproduction of this species to a level that would appreciably reduce the likelihood of the survival and recovery of this DPS.

2.7.2 Leatherback Sea Turtles

As discussed in the *Status of the Species* (section 2.2.2.2), leatherback sea turtles are globally listed as endangered. The species is composed of seven populations, but the proposed action only has the potential to adversely affect the West Pacific and East Pacific populations, although we have assumed that the potential risk to the Eastern Pacific Ocean (EPO) population to be extremely low. As described in the *Status of the Species* and *Effects of the Action* sections above, no leatherback sea turtles sampled off the U.S. West Coast have ever been genetically assigned to the East Pacific population. It is therefore unlikely that PCGF activities would interact with an East Pacific population individual, and we assume any potential interactions with the fishery would only involve individuals from the West Pacific population. In addition, as described above, critical habitat was revised in 2012 (77 FR 4170) for leatherbacks to include additional areas along the U.S. West Coast which provided added protection of the habitat PBFs, primarily their main prey resource, jellyfish.

The Western Pacific population of leatherback sea turtles primarily nest at beaches in Indonesia and the Solomon Islands, and long-term monitoring surveys at Jamursba-Medi and Wermon beaches have provided important information for understanding the abundance of nesting females, trends, and hatchling success. The best current estimated adult female abundance in the West Pacific population is 1,054 individuals (Martin et al. 2020a). Assuming a 73% female sex ratio yields an estimated 1,443 adult leatherbacks in the West Pacific population, and based on this and life history parameters, survival rates, life stage ratios, and nutritional demands, NMFS estimates the juvenile and adult population size of this population to be 100,000 leatherback turtles (Jones et al. 2012, Martin et al. 2020a, NMFS 2023d). Based on information from these nesting beaches, the Western Pacific population has been exhibiting low hatching success and decreases in nesting population trends. Recent preliminary data from the two index beaches indicates nest numbers were relatively stable from 2017 to 2021 (Lontoh et al. in prep); however, the data are not available in sufficient detail to update the Martin et al. (2020a) model. Using the median trend in annual nest counts from Jamursba-Medi (2001-2017) and Wermon (2006-2017), Martin et al. (2020a) estimated the combined nest count trends for the two index beaches to be declining by 6% annually. However, nest success rates have increased from 35% prior to 2017 to over 50% from 2017 to 2019 due to increased conservation efforts (Pakiding et al. 2020).

A recent discovery of a previously undocumented nesting area on Buru Island, Indonesia and relatively new sites on the Solomon Islands suggest that additional undocumented nesting habitats may exist on other remote or infrequently monitored islands of the Western Pacific (NMFS and USFWS 2020). We are seeing a positive growth trend using a newly established monitoring program (since 2017) on Buru Island, Indonesia which estimates approximately 103 adult female nesters. Over the six years of data collected by this monitoring program (which may span two remigration intervals for leatherbacks), Buru Island is showing an increasing trend of 10.1% per year, which is a positive sign for this subpopulation.

For the East Pacific population, NMFS and USFWS (2020) calculated a minimum total of 1,007 nesting females based on monitoring data from nesting beaches in Costa Rica, Nicaragua, and approximately 70-75% of the total nesting areas in Mexico. The total adult population was estimated at 1,274 individuals in 2020, which includes both males and females and extrapolations based on juvenile to adult ratios. Based on an assumption of adults comprising a mean of 2.1% of the total population size, this suggests 60,611 individuals for the East Pacific population in 2020. However, there are secondary beaches that may not be surveyed as regularly so the abundance and trends of this population are uncertain. The trend at nesting beaches in Mexico and Costa Rica show an annual decline of -4.3% (given the worst-case scenario) and a -15.5%, respectively (NMFS 2023d).

As described in the *Environmental Baseline* (section 2.4.3), a number of threats are likely contributing to the ongoing decline of Pacific leatherback populations. Fishery interactions through bycatch and directed harvest are major threats to leatherback sea turtles throughout their range. They are vulnerable to a variety of fisheries in coastal areas and the high seas of the Pacific Ocean, and the true magnitude of fishery interactions with leatherback turtles is unknown. Within U.S. domestic fisheries, leatherbacks have been reported interacting with longline fleets based out of Hawaii and American Samoa (which are estimated to capture no more than 37 leatherback turtles per year, combined), and the tuna purse seine fishery operating in the Western and Central Pacific Ocean. The summer nesting component of the Western Pacific population is especially at risk of interacting with U.S. and international pelagic longline fleets due to the overlap of the fleets’ fishing grounds and the turtles’ migratory path to foraging grounds in central California. Although we know of two bycatch hotspots in the Pacific Ocean (one in central North Pacific and a second in eastern Australia (Hays et al. 2023)), the true magnitude of leatherbacks caught as bycatch is difficult to estimate due to low observer coverage and inconsistent reporting in international fisheries. Leatherback turtles also occur as bycatch in small-scale coastal fisheries, but there is also little information about these events.

Within the action area, much of the foraging habitat for leatherback sea turtles on the U.S. West Coast overlaps with fishing grounds within the EEZ, posing a risk of interactions with domestic fisheries. Fourteen strandings of leatherbacks reported since 1963 had evidence of fishery interactions, and genetic analysis on all stranded turtles determined they were from the West Pacific population. The drift gillnet fishery had the highest proportion of interactions with leatherback sea turtles and, with the establishment of the PLCA off of California, there was up to an 80% decline in fishery interactions with the drift gillnet fishery. The most recent interaction between the PCGF and leatherbacks was in 2008 where one turtle was found entangled and deceased in sablefish trap gear offshore of Fort Bragg, CA (NMFS 2012b).

Leatherback turtles may also be affected by a number of other threats throughout their range, including from entrainment in power plants, interactions with marine debris, pollutants, and vessel collisions. According to NMFS stranding data, one leatherback turtle was entrained in a power plant since 1975. Marine debris can pose a significant threat to leatherbacks, especially when ingested or entangled on the body; and two stranded leatherbacks have been reported on the U.S. West Coast with plastic in their digestive systems (although the plastic was not identified as the primary cause of mortality), and the true extent of such incidents is unknown. Other forms of pollution such as contaminants from terrestrial sources have the potential to affect the survival and productivity of leatherback turtles, as some chemicals identified in runoff flowing into coastal areas where leatherbacks forage are known endocrine disruptors. Additionally, agricultural runoff and/or other inputs may lead to HABs and domoic acid poisoning in leatherbacks, as was observed in 2008 (Harris et al. 2011).

On their nesting beaches, leatherback turtles and their eggs are also subject to legal and illegal harvest despite protections in place for turtles and eggs. Leatherback turtles are also occasionally found injured or killed by vessels on the U.S. West Coast, although there have been no reported strandings of leatherbacks associated with vessel strikes since 2017, and voluntary speed reduction zones for whales off the California coast may be reducing the risk of such interactions. There are also current, ongoing impacts from offshore energy exploration, development, and operations on leatherbacks off the U.S. West Coast, which may include vessel traffic, increased noise pollution, and exposure to pollutants. Small numbers of leatherbacks may also be intentionally captured and sampled for scientific research, although these activities are expected to result in such low levels of mortality (i.e., one over a 10-year period) that such activities are not considered a factor limiting recovery of the species.

In 2021, NMFS featured leatherback sea turtles under the Species in the Spotlight Action Plan, which aims to provide immediate, targeted efforts to halt declines and stabilize populations of the species most at-risk of extinction in the near future. Under the plan, NMFS outlined actions needed in the next five years to address the most urgent threats to the species which (1) include protecting and managing leatherback populations in the marine habitat, and (2) monitoring and reducing incidental mortality in commercial and recreational fisheries. This plan also expands to improving protections of nesting beaches and continued long-term monitoring, especially at index nesting beaches.

Although we cannot precisely estimate the magnitude of future changes and their impacts, climate change is likely to have widespread impacts on nesting grounds, foraging areas, and migration patterns for leatherback turtles. Changes in temperatures on nesting beaches may alter hatching success or hatchling sex ratio, further straining the recovery of the species. Climate change may also affect ocean temperatures and currents, which leatherbacks rely on to navigate towards foraging and nesting grounds during their long migrations. This could increase risks to leatherback turtles by shifting prey or fishery distributions, or exacerbate other threats described in the *Environmental Baseline*.

In the *Cumulative Effects* section, we did not identify additional state or private activities that are reasonably certain to occur within the action area and could result in cumulative effects to ESA-listed species.

In the *Effects of the Action* section we evaluated the potential for impacts of the PCGF to ESA-listed leatherback sea turtles from entanglement in fishing gear, prey removal, vessel collisions, and pollution. After evaluating the vessel activities expected to occur as a result of the proposed action, we concluded that the effects of vessel collisions, oil spills, and marine debris as a result of the PCGF would be improbable or minor. The removal of leatherback prey by PCGF activities was also evaluated, and we concluded jellyfish and other invertebrate species are not caught in amounts that would reduce prey available by a detectable amount to leatherbacks in the action area.

Our analysis determined the primary impacts of the proposed action on ESA-listed leatherback sea turtles would be from entanglement interactions with PCGF fishing gear, specifically sablefish pot gear. Although there have not been documented interactions between leatherback sea turtles and the PCGF in recent years, the risk of entanglements persists because of the overlap in leatherback foraging grounds and fishing grounds utilized by the PCGF. We estimated the annual impact to the West Pacific population from the PCGF to be no more than 1.67 turtles entangled and killed in any given year, or no more than an average of 0.86 turtles over any 5-year period. Given this information, we expect that entanglements with PCGF sablefish pot gear could lead to removal of 0.1% (1.12/1,054) of the total Western Pacific adult female population in any given year, and no more than an average of 0.06% (0.58/1,054) of the Western Pacific adult female population per year over any 5-year period. No additional leatherback entanglements are anticipated from any other sectors of the PCGF.

Previous consultations on the other fishery actions that affect Western Pacific leatherbacks have considered the impact of small numbers of leatherback mortality. The 2023 drift gillnet biological opinion concluded that up to 1 death of leatherbacks per year was likely below a level that would appreciably affect survival and recovery (NMFS 2023d). Other actions looking at the effect of losing one female considered the prospect that conservation actions in recent years were likely to facilitate the chance that increases in young turtles would act as a buffer to provide more recruits into the adult population, in context with the very small level of impact expected. In the NMFS (2012a) biological opinion on the Hawaii-based SSLL longline fishery, two different modeling approaches considered the impact of annually removing four adult females from the population per year using analyses by Van Houtan (2011), and neither of these models offered evidence that an appreciable difference of relative extinction risk was detectable from the removal of four adult females. The 2023 biological opinion on the DGN fishery also concluded that the loss of one adult female per year from the DGN fishery presented negligible additional risk to survival and recovery of the Western Pacific leatherback sea turtle population. We note that the limited risk to the population from the DGN will be eliminated during this Proposed Action, starting in 2028. Recent PVAs that have assessed the removal of leatherbacks in the Hawaii and American Samoa-based longline fisheries (Martin et al. 2020a, Siders et al. 2023; NMFS 2023c, 2023d) have yet to quantitatively conclude discernible changes in the risk of extinction to leatherbacks in the Western Pacific as a result of the levels of impact considered in those longline fisheries.

The expected impacts to this leatherback population from the PCGF estimated in this Biological Opinion are less (in some cases substantially) than what has been quantitatively analyzed in the models and analyses described above. As a result, we conclude that the resultant impact of repeating any of these modeling exercises considering the removal of one female approximately every two years (0.59 per year) would predictably also conclude that no discernable risk of extinction would be evident from analysis of the impact of the PCGF. These results are consistent in that none of the modeling or analytical results have yet to quantitatively describe changes in extinction risks to leatherback in the Pacific attributed to the type of low level of impact anticipated under this Proposed Action.

In order for the Western Pacific population of leatherback sea turtles to remain viable, it is reasonable to expect that the dominant factors currently (and historically for such a long-lived species) affecting survival must improve. As described in the *Status of the Species* (section 2.2.2.2), significant conservation actions have been taken throughout the range of Western Pacific leatherbacks to address and reduce these threats from historical levels that were driving the significant population declines that have been documented. Recent data from the nesting beaches may be pointing to early signs that conservation actions are having some positive influence as survival rates appear to be improving.

The NMFS and USFWS (1998) recovery plan for leatherback sea turtles in the U.S. Pacific Ocean contains a number of goals and criteria that should be met to achieve recovery for this species. A number of these goals are being addressed through the research efforts determining stock structure of populations and monitoring their status, at least for populations that range into U.S. waters. It seems likely that any abundance goals for leatherback populations, including the WPO, rest on the productivity of nesting beaches in concert with increased survival rates of individuals throughout their range and life-cycle.

The optimal chance of leatherback sea turtle recovery in the Pacific rests in the reproductive capability and the relatively high fecundity of sea turtles. Each female leatherback produces around 400 eggs each season they reproduce (Tapilatu and Tiwari 2007; Hitipuew et al. 2007; Dutton et al. 2007). Regardless of how many times a female does reproduce, only one out of all these offspring hatchlings needs to survive as an adult female to achieve replacement, although we should not discount the importance of male survival to ensure reproductive capacity into the future. The current sex ratio of this population has been estimated at 73% female. While skewed sex ratio could be a problem in general, it may also underlie the potential for relatively high productivity and population growth rates should other factors affecting survival across their life-cycle become more favorable. The mating system of sea turtles is both polyandrous (1 female fertilized by more than 1 male) and polygynous (1 male mates with more than 1 female), and occurs in areas where turtles congregate near natal home ranges (see Bell et al. 2010 review). Males from some sea turtle species have been found to return to waters adjacent to some nesting beaches more often than females, but it is unclear whether potentially reduced males due to climate change variability (hotter sand temperatures produce more female hatchlings) may impact the maintenance of breeding rates (Hays et al. 2010). It seems possible that fewer males than females may be needed for adequate mating, with the added benefit that an increased percentage of females could lead to more nesting activity and egg production.

Studies have concluded that there was no evidence for depensation (reduced fertility due to small population size) for various green and loggerhead sea turtle populations that were examined, even for very small turtle populations (Bell et al. 2010). These factors suggest that recovery potential exists for small turtle populations that are much smaller than the current WPO leatherback population, and a number of small populations of turtles have shown signs of recovering fairly quickly after conservation efforts have been implemented (see Bell et al. 2010 for review). It has also been documented that much smaller populations of much less productive species have rebounded quickly given the right conditions (e.g., Mediterranean monk seals; Martinez-Jauregui et al. 2012).

After analyzing the risk of the PCGF to leatherback turtles, and based on the current status and trajectory of ESA-listed leatherbacks as described in the *Status of the Species*, and considering sources of ongoing mortality and serious injury as described in *Environmental Baseline*, we conclude the additional mortality of a small number of individuals (less than two annually) that could occur as a result of the proposed action is not likely to reduce the abundance or reproduction of the West Pacific population of leatherback sea turtles. Based on this, we further conclude these impacts on this one population of leatherback turtles is not likely to reduce the overall numbers, reproduction, and geographic distribution of the species as a whole to the extent it would appreciably reduce the likelihood of survival and recovery of the species. Given the current global status and range of threats leatherback turtles face throughout their range, we conclude the additional estimated mortality that would occur as a result of the proposed action is not likely to reduce the abundance or reproduction of this species to an extent that would appreciably reduce the likelihood of the survival and recovery of the species.

2.8. Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and the cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the Mexico DPS of humpback whales, the Central America DPS of humpback whales, or leatherback sea turtles, or destroy or adversely modify their designated critical habitats.

2.9. Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS. As noted further below, some forms of take associated with this action and addressed elsewhere in this biological opinion are not covered by this exemption.

A marine mammal species or population which is listed as threatened or endangered under the ESA is, by definition, also considered a strategic stock and depleted under the MMPA. Section 7(b)(4) of the ESA provides for an incidental take statement for threatened and endangered marine mammals only if authorized pursuant to section 101(a)(5) of the MMPA. The marine mammal portion of this ITS is effective for the duration of any applicable authorization under section 101(a)(5) of the Marine Mammal Protection Act, confirmed in writing as necessary by the Protected Resources Division of the NMFS West Coast Region.

2.9.1 Amount or Extent of Take

In the opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

We anticipate that take of humpback whales would occur through entanglement with PCGF fishing gear including pot, hook-and-line, and midwater trawl gear, as a result of the proposed continued operation of the PCGF. The expected bycatch of humpback whales in the PCGF that we anticipate is described in Table 26:

Table 26. Take of ESA-listed humpback whale DPSs in the PCGF, by gear type.

	Mexico DPS		**Central America DPS**	
	Annual Max	**Max 5-year Running Ave**	**Annual Max**	**Max 5-year Running Ave**
Total Bycatch in PCGF Sablefish Pots	2.29	1.03	1.55	0.69
Anticipated M/SI in PCGF Sablefish Pots	2.11	0.95	1.43	0.63
Total Bycatch in Commercial PCGF Hook-and-Line Gear	0.47	0.1	0.29	0.06
Anticipated M/SI in Commercial PCGF Hook-and-Line Gear	0.47	0.1	0.29	0.06

Total Bycatch in PCGF Hake Midwater Trawl	0.52	0.21	0.37	0.15
Anticipated M/SI in PCGF Hake Midwater Trawl	0.52	0.11	0.37	0.08
Total Bycatch in the PCGF	**3.28**	**1.34**	**2.21**	**0.90**
Anticipated M/SI in the PCGF	**3.1**	**1.16**	**2.09**	**0.77**

We estimate up to 6.62 humpback whales (from any of the three DPSs off the West Coast, both listed and unlisted) could be entangled in any given year, with the possibility of 6.25 killed or seriously injured in any given year as a result of the PCGF. We also anticipate that the annual average over any five-year period will not exceed 2.67 individual(s) entangled, leading to no more than 2.30 serious injuries or mortalities over that same five-year period.

We anticipate that take of leatherback sea turtles would occur through entanglement with sablefish pot fishing gear, specifically in the OA sector, as a result of the continued operation of the PCGF. The expected bycatch of leatherback sea turtles in the PCGF that we anticipate is described in Table 27:

Table 27. Take of leatherback sea turtles in the PCGF, by gear type.

	Leatherback Turtles	
	Annual Max	**Max 5-year Running Ave**

Total Bycatch in PCGF Sablefish Pots	1.67	0.86
Anticipated M/SI in PCGF Sablefish Pots	1.67	0.86

Our expectation is that information on the amount and extent of humpback whales and leatherback sea turtles incidentally taken in the PCGF will come primarily from the bycatch estimates produced by the NWFSC. Secondarily, opportunistic reports of humpback whale and leatherback sea turtle entanglements reported to the NMFS WCR Marine Mammal Stranding Program and Turtle Stranding Program will be available to help ground truth these estimates, especially as a potential indicator of obvious discordance between estimated and known actual incidents of bycatch. From either source, information to determine the DPS of any humpback whale bycatch in the PCGF may not be available. As a result, we also rely upon the number of all humpback whales that are reported entangled (estimated or observed) and subsequently killed or seriously injured as a result of the PCGF, and our assumptions about the distribution of humpback whale DPSs along the U.S. West Coast and PCGF fishing effort described in this opinion, to inform monitoring for the numbers of humpback whales that may be associated with each respective ESA-listed humpback whale DPS.

If four or more humpback whales from the Mexico DPS are observed or estimated to have been incidentally captured in the PCGF in any one year, or if the 5-year running average of the Mexico DPS bycatch exceeds 1.34 per year, then we would conclude that the incidental take threshold for Mexico DPS has been exceeded. If three or more humpback whales from the Central America DPS are observed or estimated to have been incidentally captured in the PCGF in any one year, or if the 5-year running average of the Central America DPS whale bycatch exceeds 0.90 per year, then we would conclude that the incidental take threshold for Central America DPS has been exceeded. However, given that the DPS of whales that are observed or estimated to have been incidentally entangled in the PCGF may not be readily discernible, we also acknowledge that the DPS for a specific entanglement may be unknown. Therefore, if seven or more humpback whales are observed or estimated to have been incidentally captured in the PCGF in any one year, or if the 5-year running average of humpback whale bycatch exceeds 2.67 per year, then we would conclude that the incidental take threshold of both the ESA-listed Mexico DPS and Central America DPS humpback whales would have been exceeded.

If two or more leatherback sea turtles are observed or estimated to have been incidentally captured in the PCGF in any one year, or if the 5-year running average of leatherback sea turtle bycatch exceeds 0.86 per year, then we would conclude that the incidental take threshold of Western Pacific leatherback sea turtles would have been exceeded.

2.9.2 Effect of the Take

In the opinion, NMFS 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 the Mexico DPS of humpback whales, the Central America DPS of humpback whales, or leatherback sea turtles, or destroy or adversely modify their critical habitats.

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" refer to those actions the Director considers necessary or appropriate to minimize the impact of the incidental take on the species (50 CFR 402.02).

The reasonable and prudent measures (RPMs) included below, along with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. NMFS concludes that the following RPMs are necessary and appropriate to minimize or to monitor the incidental take of ESA-listed humpback whales and leatherback sea turtles resulting from the proposed action.

(1) NMFS shall monitor the PCGF to ensure compliance with the regulatory and conservation measures included in the proposed action and the identified amount or extent of incidental take, including collection and evaluation of data on the capture, injury, and mortality of humpback whales.

2.9.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the National Marine Fisheries Service must comply with the following terms and conditions. The National Marine Fisheries Service has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

The following terms and conditions implement reasonable and prudent measure 1:

(1) NMFS SFD, in coordination with the NWFSC WCGOP, shall ensure observer coverage and/or other monitoring methods in the PCGF maintains the capability to provide scientifically defensible humpback whale and leatherback bycatch estimates for all PCGF fixed gear pot, fixed gear hook-and-line, and midwater trawl sectors to confirm that the anticipated incidental take threshold for PCGF fisheries is not exceeded. When feasible, NMFS should consider additional monitoring options to reduce uncertainty in humpback whale and leatherback sea turtle bycatch estimates, and increase the understanding of the fishery dynamics in PCGF fixed gear pot, fixed gear hook-and-line, and midwater trawl fisheries.

(2) NMFS shall support monitoring of the implementation of gear marking

regulations for PCGF fixed gear pot and bottom longline gear that are expected to be implemented by 2026.

(a) After three years of implementation of the regulations, NMFS SFD shall assess the relative operational effectiveness of these gear marking requirements, and confer with NMFS PRD on development of any recommendations for modification to improve future implementation.

(3) NMFS shall monitor PCGF fixed gear set gear configurations to:

(a) Determine the number of sets that use one or two vertical end lines, in order to track usage of the voluntary risk reduction measure that requires only use of one vertical end line that is expected to be implemented by 2026.

(b) Determine the extent of use of different types of pots, along with other associated information on the type of gear used in association with different types of pots.

(c) NMFS shall also evaluate if information collected on gear configurations can be incorporated into bycatch estimates for PCGF fixed gear fisheries.

(4) NMFS SFD, in coordination with the NWFSC WCGOP, shall investigate the feasibility of monitoring PCGF fixed gear hook-and-line effort such that independent accounting of fishing effort and observer coverage with different hook-and-line gear types can be generated.

(5) NMFS SFD, in coordination with the NWFSC WCGOP, shall report on at least a biennial basis (once every 2 years) on the annual effort and bycatch estimates associated with PCGF fisheries as follows:

(a) Fixed gear pot sets, by sector.

(b) Fixed gear hook-and-line sets, by sector and, as possible, gear type.

(c) Midwater trawl tow hours, by sector.

(d) Reports shall be provided to NMFS Long Beach PRD Branch Chief (Dan Lawson, dan.lawson@noaa.gov), with the first report to be submitted no later than June 30th, 2027, which would include two years of PCGF data following completion of this Opinion. Subsequent reporting is required within at least every two years afterward.

(6) Incidental take of humpback whales and leatherback sea turtles documented through the WCGOP should be reported to NMFS Long Beach PRD Branch Chief (Dan Lawson, dan.lawson@noaa.gov) as soon as possible, following completion of the data collection, review, and observer debrief processes.

2.10. Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or regarding the development of information (50 CFR 402.02). Implementing these recommendations would provide information for future considerations of how to reduce the effects of the PCGF on Central America DPS and Mexico DPS humpback whales and leatherback sea turtles.

(1) NMFS should engage with the PFMC and other entities, including industry representatives, on how to encourage the use of risk reduction measures through implementation of best practices.

(2) NMFS should evaluate the expanded use and potential entanglement risk differences between slinky pots and traditional pots, as well as the potential for slinky pots in reducing the extent of injuries that may occur. NMFS will report findings and recommendations related to any potential benefits for reducing entanglements or injuries to the PFMC, when available.

(3) NMFS should encourage the testing of pop-up/on-demand gear in concert with the implementation of the voluntary risk reduction measure requiring use of only one vertical end line by developing the capacity to support gear testing. While having the option to have one end of the gear free from requirements to be attached to a buoy at the surface at all time is a risk reduction measure, the use of an on-demand/ropeless system could offer insurance against the potential for gear loss, or the extra time spent in recovery of gear, should the string break during hauling or setting of pots. These efforts could also evaluate the feasibility and develop strategies to advance the broader use of this technology in the future.

(4) NMFS should assess the overlap of humpback whales and midwater hake trawl gear in data from 2023 and 2024 (and beyond) to help evaluate the underlying dynamics associated with recent interactions in the midwater hake trawl fishery.

    (a) Following this evaluation, NMFS should provide findings and recommendations associated with minimizing the risk of future humpback whale interactions with midwater hake trawl to the PMFC, when available.

(5) NMFS WCR, in coordination with NMFS Science Centers (NWFSC and SWFSC), should investigate how to refine bycatch estimates for leatherback sea turtles and ESA-listed humpback whales in PCGF fisheries based on updated information about their presence, abundance, and distribution off the U.S. West Coast.

(6) Scientific tools and frameworks: To reduce real-time geographic overlap of humpback whales and PCGF fisheries, and therefore the risk of interactions with Central America DPS and Mexico DPS of humpback whales, NMFS should encourage the exploration and implementation of new and existing scientific tools and frameworks in coordination with the PFMC, including consideration of using:

    (a) Near-real time environmental data streams to predict humpback whale concentrations (e.g., predictive models used in Appendix A), forage conditions, habitat compression (e.g., Schroeder et al. 2022), and other ecosystem indicators.[14]

(b) Environmental data to predict patterns of fishing effort.

(c) Observational/survey data and other tools to identify spatial/temporal areas of concern to avoid in a dynamic management approach.

(d) Ongoing monitoring and evaluation of co-occurrence dynamics between ESA-listed species and PCGF fisheries.

2.11. Reinitiation of Consultation

This concludes formal consultation for the Continuing Operation of the Pacific Coast Groundfish Fishery (Reinitiation 2024) **–** Humpback whale (*Megaptera novaeangliae*) and Leatherback sea turtle (*Dermochelys coriacea*).

Under 50 CFR 402.16(a): “Reinitiation of consultation is required and shall be requested by the Federal agency where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified action.”

2.12.“Not Likely to Adversely Affect” Determinations

The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the coastal and marine environments that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species. The following ESA-listed species’ designated critical habitats are not likely to be adversely affected by the proposed action, for the reasons explained below.

Under the ESA, “effects of the action” are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR 402.02). When evaluating whether the proposed action is not likely to

[14] https://www.integratedecosystemassessment.noaa.gov/regions/california-current/the-ecosystem-context-reducing-west-coast-whale-entanglements

adversely affect listed species or critical habitat, NMFS considers whether the effects are expected to be completely beneficial, insignificant, or discountable. Completely beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Effects are considered discountable if they are extremely unlikely to occur.

2.12.1 Effects of the Proposed Action on Critical Habitat for Humpback Whales

Designated critical habitat for the Mexico DPS of humpback whales includes approximately 116,098 nmi^2 of marine habitat within the North Pacific Ocean, including areas within portions of the eastern Bering Sea, the Gulf of Alaska, and CCE (86 FR 21082; Figure 29). In general, off Washington and Oregon, the nearshore boundaries are defined by the 50-m isobaths and the offshore boundaries are defined by the 1,200-m to 2,000-m isobaths (southern Oregon). Critical habitat also includes waters within the U.S. portion of the Strait of Juan de Fuca to Angeles Point, Washington. Off California, the nearshore boundary is defined from 15-50-m isobaths and the offshore boundary is defined between 2,000-m to 3,700-m isobaths, depending on the latitude. Designated critical habitat for the Central America DPS includes approximately 48,521 nmi^2 of marine habitat within the North Pacific Ocean that overlaps with the same areas off Washington, Oregon and California that are designated for the Mexico DPS (86 FR 21082; Figure 30).

There is only one PBF determined to be essential to the conservation of both DPSs of ESA-listed humpback whales, which is defined as: “prey species, primarily euphausiids and small pelagic schooling fishes of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth” (86 FR 21082).

Humpback whales from both DPSs travel to U.S. coastal waters to access energy-rich feeding areas and demonstrate high fidelity to specific locations, indicating the importance of these feeding areas. Although humpback whales are generalist predators with varying prey availability, their diet within the CCE includes Pacific sardine (*Sardinops sagax*), northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasii*), euphausiids (specifically *Euphausia*, *Thysanoessa*, *Nyctiphanes*, *Nematoscelis*), capelin (*Mallotus villosus*), juvenile walleye pollock (*Gasdus chalcogrammus*), Pacific sand lance (*Ammodytes personatus*), and occasionally juvenile rockfish (*Sebastes*) (86 FR 21082). Humpback whales switch between prey based on abundance and quality, resulting in a diet composition that varies spatially and temporally. Humpback whales rarely feed in breeding grounds or during migrations, necessitating adequate prey resources within feeding areas to build fat stores for survival, growth, reproduction, lactation, seasonal migrations, and other life functions. Thus, whales must accumulate enough energy to cover the costs associated with migration and reproductive activities (NMFS, 2019). Designated critical habitat for these DPSs overlaps with the PCGF, particularly the trawl fisheries (e.g., CS bottom trawl, midwater hake and midwater rockfish, and tribal shoreside sectors) that may unintentionally capture prey identified as essential for the recovery of the Mexico and Central America DPSs of humpback whales (i.e., Pacific sardines, northern anchovies, and herring).

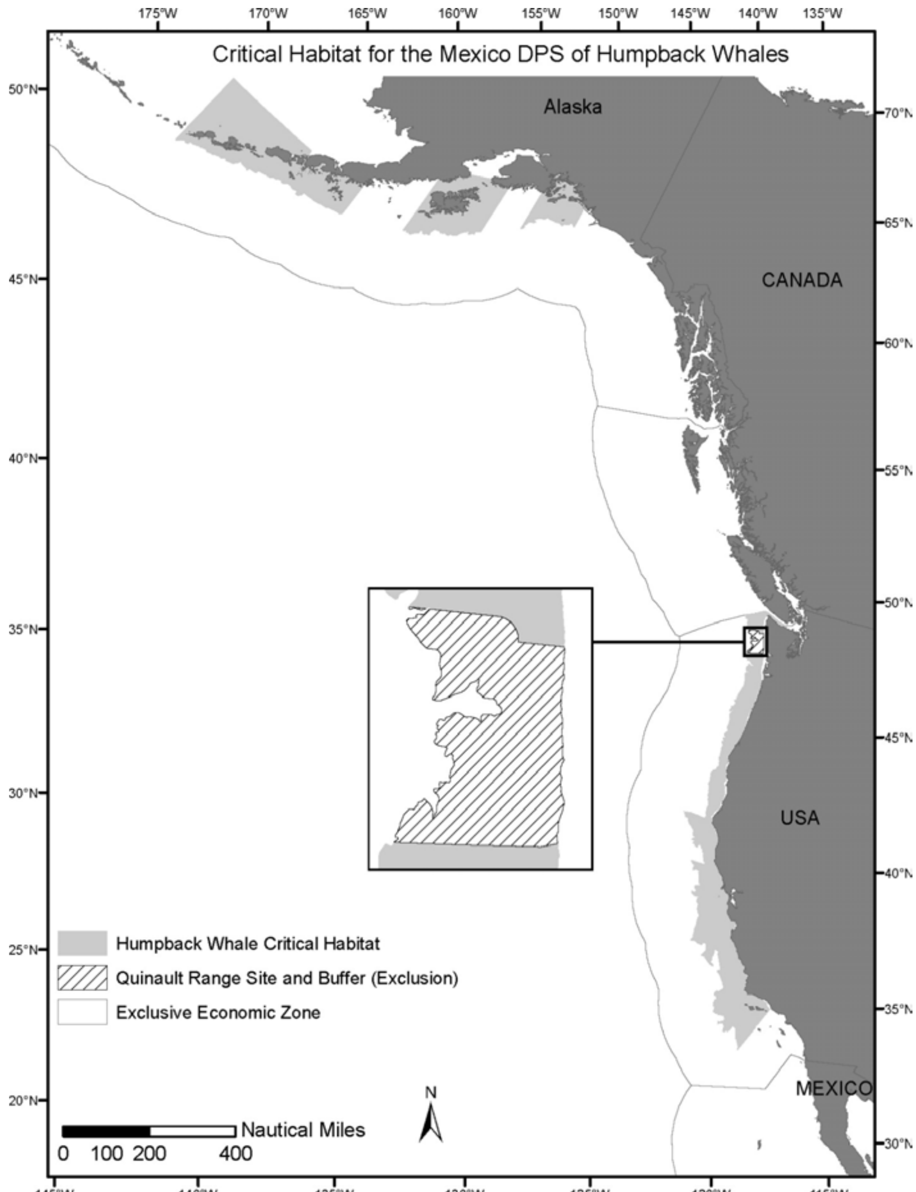

Figure 29: Critical habitat designated for the Mexico DPS of humpback whales along the Pacific Coast.

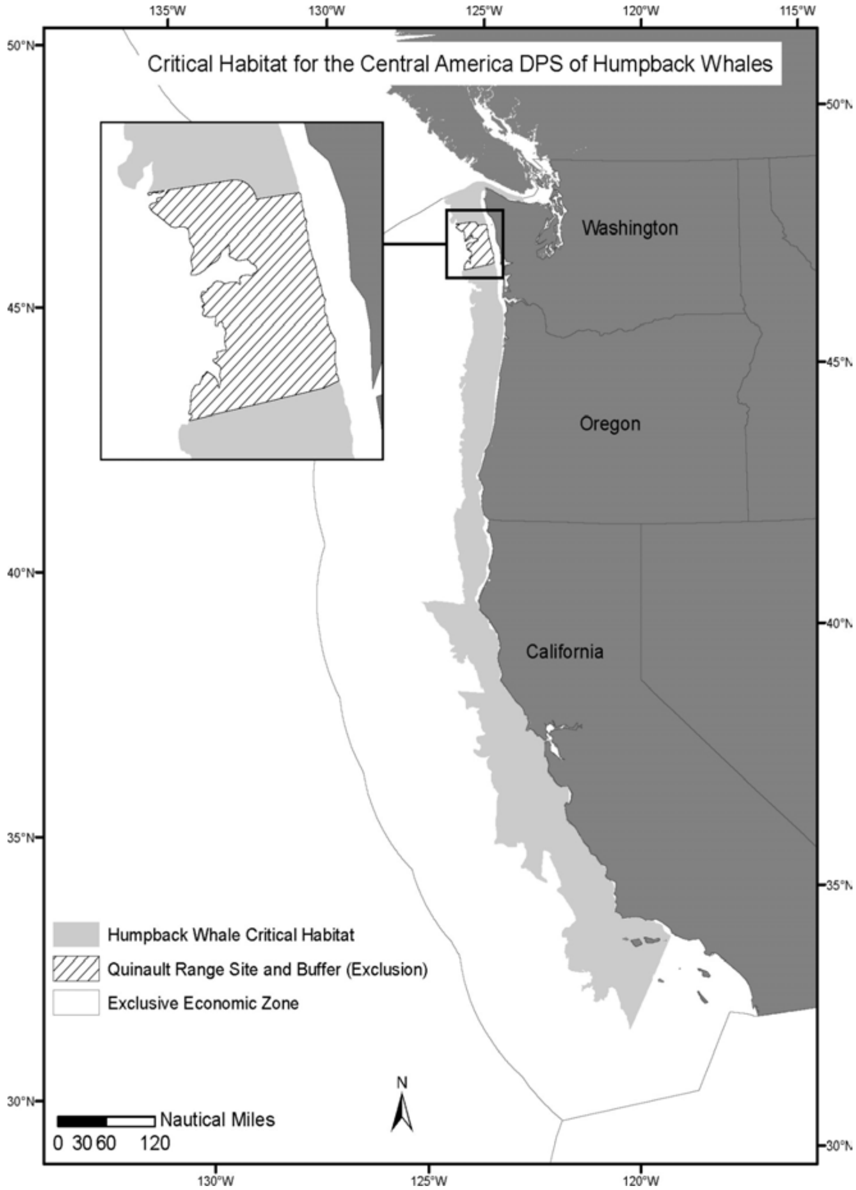

Figure 30: Critical habitat designated for the Central America DPS of humpback whales along the Pacific Coast.

Analysis

In this section, we will evaluate all the consequences to designated critical habitat for the Central America and Mexico DPSs of humpback whales caused by the proposed action, including other activities caused by the proposed action. From 2002-2022, WCGOP GEMM data identified 695 marine species caught in the PCGF, with 232 caught in excess of one metric ton. Other than euphausiids, primary prey species for humpbacks including Pacific sardines, Pacific herring, and northern anchovy, have been documented as bycatch in the PCGF. Humpbacks are generalists, targeting and switching between a variety of prey depending on availability influenced by oceanographic conditions. Unlike most baleen whales which forage primarily on euphausiids (krill), humpbacks will shift trophic selections, depending on oceanographic conditions, between krill and small schooling fish (primarily anchovies and sardines).

Scientists estimate large baleen whales consume approximately between three to four percent of their body weight daily. Assuming a large humpback whale weighs ~40 tons, during a typical summer feeding day one whale may consume between 1-1.5 tons of food (Clapham and Baxter 2013). Given that humpback whales generally feed off the U.S. West Coast from April through November (~8 months), one humpback whale can eat up to 240 tons of food during the foraging season within the action area.

Along the U.S. West Coast there are identified parent and core Biologically Important Areas (BIAs) for humpback whales, which both occur from March to November and span coastal waters from the Channel Islands to Canada (Calambokidis et al. 2024). The BIAs are based on observed high concentrations of feeding animals, SWFSC survey data, and whale tagging data. The larger parent BIA is smaller than the area designated as critical habitat due to national security considerations, but still spans 140,000 km^2 representing 20% of the area of the U.S. West Coast EEZ, and encompasses 93% of sightings of feeding whales, 91% of the sightings from SWFSC surveys, and a median 98% of the areas used by tagged humpback whales (Calambokidis et al. 2024). The core BIA represents 27% of the parent BIA, encompasses 75% of feeding sightings, 60% median of the area used by tagged whales, and 42% of the SWFSC sightings. In context with the identification of the updated BIAs, we also note that humpback whale abundance has increased approximately 8.2% annually in the California Current since 1989 (Caretta et al. 2023), suggesting that foraging conditions off the U.S. West Coast have been capable of supporting robust growth of populations that occur here.

Historical data from whaling ship logbooks in the 1920s show the majority of humpback whale stomachs contained primarily sardines and “shrimp” (presumed to be euphausiids) (Clapham et al. 1997). In the late 1950s and early 1960s, an examination of nearly 150 humpback whale stomachs found over 60% of the stomachs contained anchovies and 36% contained euphausiids (Rice 1963). Data from this study indicated a distinct shift in targeted prey when the biomass of one fish species was very low (e.g., sardines in the 1950s and 1960s). Scientists collected 259 skin samples from whales throughout the CCE (1993-2012) and used stable isotope analysis to evaluate the relative contribution of euphausiids versus fish to the diet (Fleming et al. 2016).

Shifts in stable isotope signatures over the 20-year period corresponded to shifts in relative prey abundance and changing oceanographic conditions within the CCE. Specifically, krill dominated humpback whale diets during positive phases of the PDO, with cool SST and strong upwelling contributing to high krill biomass (Fleming et al. 2016). Conversely, schooling fish dominated diets during years characterized by negative North Pacific Gyre Oscillation index shifts, delayed seasonal upwelling, and warmer temperatures. These results suggest dominant prey in humpback whale diets oscillated between krill and fish during the 20-year period, depending on the relative abundance of each prey item driven by bottom-up environmental circumstances.

Neither the WCGOP or GEMM databases have documented any bycatch of euphausiids in the PCGF, likely because euphausiids are typically not caught in the size of trawl nets (or other gear) used in the PCGF, or are too small to be counted or measured as bycatch. In March 2006, the CPS FMP was amended to prohibit harvest of all species of krill in the U.S. EEZ. While not specific to humpback whales, this amendment was passed to prevent the development of a commercial fishery which could potentially deplete krill stocks and thereby impact many other predators in the ecosystem. Similarly, commercial fisheries are prohibited from developing new fisheries targeting other currently unfished and unmanaged forage fish off the U.S. West Coast. Despite these management measures, during years favorable to small schooling fish the PCGF (primarily trawl fisheries) could potentially catch and remove prey species targeted by humpbacks.

To adequately analyze the effects of the proposed action on designated critical habitat, we reviewed the GEMM database, which includes expanded estimations by fishery sector of all species that were observed in the catch. From 2002-2022, several sectors in the PCGF caught sardines as bycatch: hake CP and MS, CS bottom and midwater trawl, CS pot, LE TL hook-and-line, LE hook-and-line, OA hook-and-line and pot, tribal at-sea hake, and tribal shoreside sectors. The tribal shoreside fishery caught the majority of sardines. Between 2002 and 2022, the tribal shoreside fishery caught between 0 mt and 1,128 mt (2012) of sardines, averaging ~119 mt annually. In recent years, sectors with notable levels of sardine bycatch include the at-sea hake MS (4.4 mt in 2022; 9.4 mt in 2021), midwater hake (11 mt in 2021), and at-sea hake CP (9.6 mt in 2021). From 2002-2022, the at-sea hake MS caught an average of 0.83 mt of sardines annually, the midwater hake sector caught an average of 1.2 mt of sardines annually, and the at-sea hake CP sector caught an average of 0.68 mt of sardines annually.

Most PCGF sectors caught northern anchovy in low numbers (0.01 to 1 metric tons per year). There are a few anomalies, such as in 2016 when the tribal shoreside fishery caught 112 metric tons of northern anchovy, while in other years, northern anchovies were not part of the discarded catch. Overall, the PCGF has recently had very low, if any, bycatch of northern anchovies.

Most PCGF sectors caught Pacific herring as bycatch, ranging from 1 to 190 mt per year. The most Pacific herring caught in a fishery in one year was 190 mt in 2019 in the midwater hake fishery. The midwater hake fishery averaged 82.3 mt of Pacific herring per year from 2018-2022. When humpbacks feed on small schooling fish off the U.S. West Coast, they primarily target sardines and anchovies; however, they favor Pacific herring in Alaskan waters where the species is more plentiful.

Organic pollutants, including petroleum products (or oil spills) used by fishing vessels in the PCGF, may directly impact prey that humpbacks rely on, killing organisms, reducing their fitness through sub-lethal effects, and potentially disrupting the structure and function of marine communities and ecosystems. Given the continual and dispersed movement of vessels within the action area, we do not anticipate petroleum releases into the marine environment will cause acute or chronic exposure to these organisms within the pelagic ecosystem, particularly because the prey are mobile.

In summary, (1) the bycatch of humpback whale prey species by the PCGF is limited in amount, (2) humpbacks can switch to other schooling fish or euphausiids (when available), (3) and humpback whale abundance has been increasing, due in part to the foraging conditions along the U.S. West Coast. In Section 2.5.1.5 *Risk of Prey Removal*, we determined the potential removal of prey by the PCGF represents a negligible portion of the prey needs of the humpback whale DPSs in the action area that would not result in impaired feeding opportunities or adverse effects to the health of humpback whales. We conclude that PCGF prey removals will have insignificant effects on the abundance of prey available in both the Central America and Mexico humpback whale DPSs' critical habitat. As summarized in Section 2.5.1.6 *Risk of Pollution and Contaminants*, we anticipate any effects of pollution through petroleum use or minor oil spills will be insignificant on the quantity or quality of prey resources targeted by humpback whales, the PBF for critical habitat within the action area. Based on this analysis, NMFS finds the proposed action is not likely to adversely affect critical habitat for the Central America DPS and Mexico DPS of humpback whales.

2.12.2 Effects of the Proposed Action on Critical Habitat for Leatherback Sea Turtles

On January 26, 2012, NMFS issued a final rule revising the critical habitat for leatherback sea turtles, designating areas within the Pacific Ocean (77 FR 4170). Previously, critical habitat for this species was limited to the island of St. Croix, U.S. Virgin Island for the Northwest Atlantic leatherback population. The new designation for Pacific leatherbacks includes approximately 17,000 mi^2 (43,798 km^2) along the California coast from Point Arena to Point Arguello east of the 3,000 meters depth contour; and 25,000 mi^2 (64,760 km^2) from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 meters depth contour (Figure 31).

The leatherback sea turtle Critical Habitat Review Team (CHRT) identified one essential PBF necessary for the conservation of leatherbacks in the U.S. West Coast: the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae, more commonly known as brown sea nettles (e.g., Chrysaora, Aurelia, Phacellophora, and Cyanea)(77 FR 4170). These prey must be of sufficient condition, distribution, diversity, abundance, and density to support individual and population growth, reproduction, and development. Leatherbacks are specialists, primarily feeding on gelatinous zooplankton such as jellyfish or pyrosomes. Changes in the abundance, distribution, or density of these prey items could significantly impact their migration pathways, foraging grounds, and overall health. Leatherbacks undertake large trans-ocean migrations to the CCE to forage in highly productive environments to support their growth, development, and ultimately return migration to reproduce. Populations exhibit high fidelity to feeding grounds, which indicates the importance of the CCE to continuously provide a productive and sustainable environment for endangered leatherbacks to survive.

The waters off California are a primary foraging area for leatherbacks (Benson et al., 2007a), particularly within upwelling shadows and retention areas (Graham, 1994). The region near the 2000-3000m isobaths create a quasi-stationary front where warm offshore waters meet cooler coastal upwelled waters, concentrating sea nettles. Point Arguello acts as a biogeographic barrier causing deviations in physical, oceanic, and biological processes north and south of it. Specifically, Point Arguello separates the newly upwelling waters of the central California coast which produce abundant prey of proper distribution, diversity, and density for foraging that is essential to the conservation of the species, from the warmer, and less productive waters of the Southern California Bight.

From Cape Flattery, WA to Cape Blanco, OR, important habitats include the Columbia River Plume and Heceta Bank, OR. Large densities of primary prey species occur seasonally north of Cape Blanco (Shenker, 1984; Reese et al., 2005; Suchman & Brodeur, 2005). Other jellyfish species, such as moon jellies (*Aurelia labiata*) and egg yolk jellies (*Phacellophora camtschatica*), dominate south of Cape Blanco (Reese et al., 2005; Suchman & Brodeur, 2005). Cape Blanco provides a 'break' in physical, biological, and oceanic properties due to substrate and current pattern variances (Barth et al., 2000; Peterson et al., 2002). The area from Cape Flattery to Cape Blanco produces abundant prey of sufficient condition, distribution, diversity, and density for foraging that is essential to the conservation of the species.

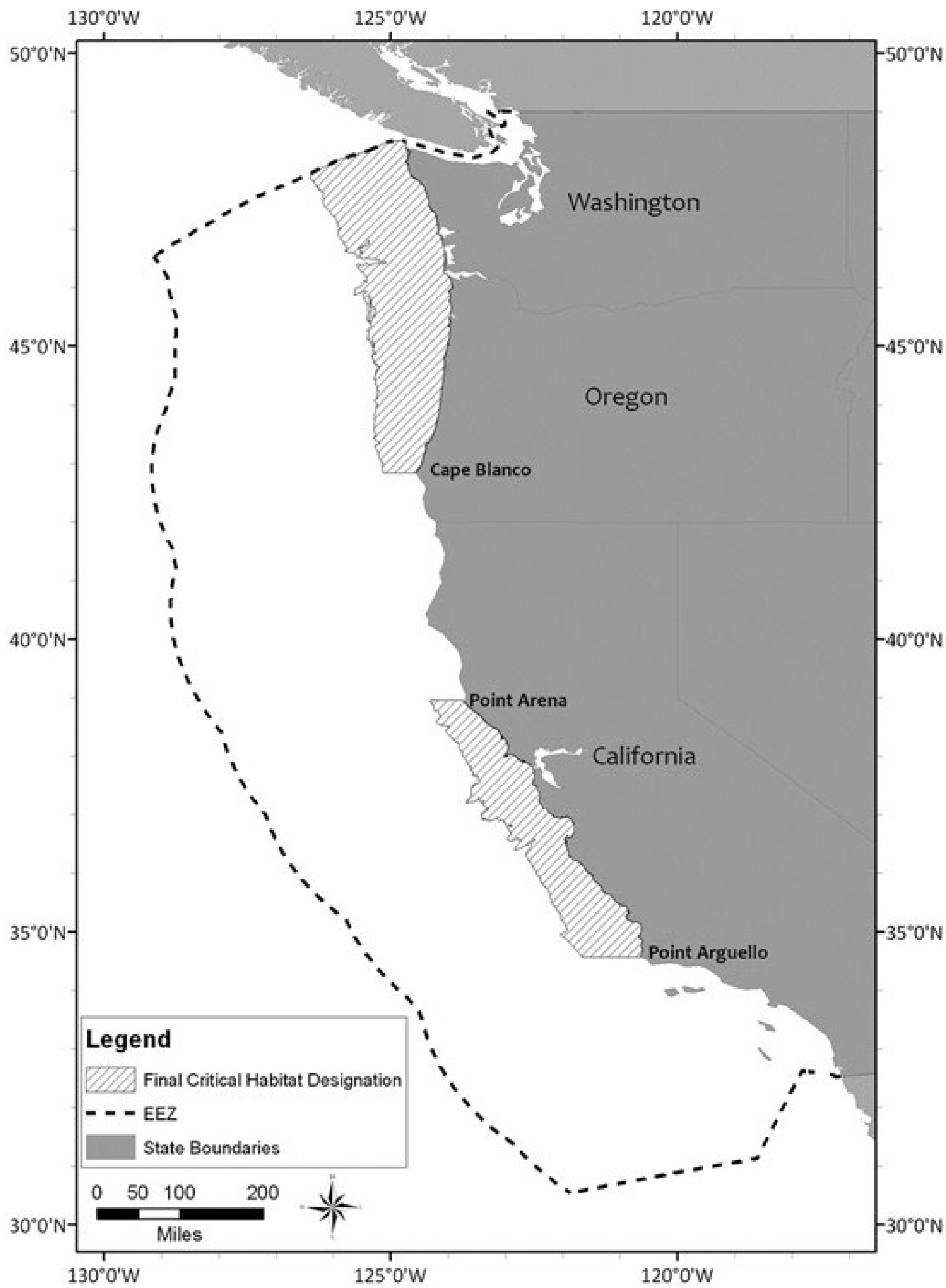

Figure 31. Leatherback sea turtle designated critical habitat along the Pacific Coast

Analysis

The primary prey species of leatherback sea turtles are jellyfish, especially brown sea nettles and moon jellies, but also includes organisms from the phylum Cnidaria, the family Scyphomedusae, the order Semaeotomeae, and the genuses of Chrysaora, Aurelia, Phacellophora, and Cyanea, as well as tunicates, broadly identified as salps or pyrosomes. These subcategories constitute the gelatinous prey items that are caught in the PCGF which are analyzed for impacts to leatherback critical habitat. Leatherbacks are specialists that only consume gelatinous zooplankton, therefore lacking foraging ability to switch to different prey items if there is a change in the abundance, distribution, or density of jellyfish or tunicates.

Estimates suggest an individual leatherback in the Pacific will eat approximately ~1,000 mt of jellyfish in a lifetime (Jones et al. 2012). Pacific leatherbacks migrate within the action area for three to five years at a time to forage, migrate out of the action area during winter time to warmer waters, and return back to their nesting beaches every two to four years. Assuming a leatherback female lives for 45 to 50 years on average and reaches sexual maturity at 17 years (range =

12-28, Avens et al. 2020), that leaves 33 years for an individual to migrate between foraging and nesting grounds, taking up to a single year for every trans-Pacific migration, and ultimately two years to return to the action area (Benson et al. 2020). By the time the female returns, she will be 19 years old and, conservatively, may stay for five years to forage before migrating again.

Assuming this process continues, and the individual survives until age 45-50, she would spend approximately 20 years within the action area foraging, without factoring in the amount of time the animal is away in warmer waters in the winter time. Spending 20 out of 50 years foraging, or roughly 40% of their lifetime, we estimate around 400 mt of jellyfish (out of ~1,000 mt consumed in a lifetime) will be consumed by an individual in their lifetime in the CCE, or 20 mt annually. Martin et al. (2020a) conservatively estimated there to be adult nesting 1,054 females (888-1,256) within the Western Pacific population. NMFS estimates, based on Martin et al. (2020a) and Jones et al. (2012), that the entire population (including juveniles and males) is around 100,000 individuals (47,000-195,000). With respect to the number of individuals off the

U.S. West Coast, biologists estimated an annual average of 55 turtles foraged off of Central California from 2004-2017 (NMFS 2020e). Benson et al. (2020) documented peak abundance in 2016 with 106 leatherbacks (95% CI: 51-221) off Central California, but noted that there is no current estimate for the number of unique individuals foraging off the U.S. West Coast. Assuming an average of 55 turtles a year are present off the U.S West Coast, about 1,100 mt of prey items would be required to sustain the population on average each year.

Within the action area, leatherbacks have been documented feeding on gelatinous zooplankton with sea nettles contributing the most (72%) to diets of leatherbacks off of California followed by filter feeding thaliaceans (18%), Aurelia (5%), and Phacellophora (3%) (Hetherington et al. 2019). Scyphozoan abundances are influenced by upwelling or lack thereof on the California coast, where periods of strong upwelling coincide with increases in scyphozoans, and reduced or delayed upwelling can concentrate leatherbacks in areas with higher abundances of *C. fuscescens*

(Benson et al. 2007a). Delayed or reduced upwelling also coincides with increases in salps and pyrosomes, which are the next large contributors to their diet (Hetherington et al. 2019). There is evidence to suggest pyrosomes are experiencing range shifts within the CCE, which may cause them to become a larger proportion of leatherback diets (Sutherland et al. 2018). Given the variability of the PDO and its impact on upwelling in the action area, leatherbacks may be able to transition from scyphozoans to thaliaceans, and vice versa, to adapt to future environmental changes.

According to the WCGOP, it is difficult to measure bycatch of gelatinous zooplankton in the PCGF as many individuals are damaged by fishing gear, making it difficult to discern individual counts, identify species, or weigh items. Unidentified tunicates have been documented as bycatch in the PCGF, but all reported values from 2002-2022 are under 1 mt (NWFSC, GEMM). PCGF sectors identified to catch tunicates include the CS bottom and midwater trawls, CS hook-and-line and pot, LE TL pot, LE hook-and-line and pot, LE trawl, and OA pot. Chrysaoraand Aurelia have been caught a few times for PCGF research purposes, but their limited catch is negligible.

Analyzing the GEMM database, there is documented catch of jellyfish and tunicates, with individual species aggregated into these categories. From 2002-2022, between 5 and 820 mt of jellyfish were caught annually, and from 0 to 5 mt of tunicates. These numbers are fairly negligible, especially compared to the amount of jellyfish required to sustain a leatherback sea turtle annually within the action area, and the estimated number of jellyfish off the U.S. West Coast. Although the total biomass of jellyfish species in the action area off the U.S. West Coast is difficult to estimate, a mean areal density of 251,522 ± 57,504 jellyfish per square nautical mile (jellies/nm^2) has been calculated in the central California foraging area of leatherback turtles based on acoustic backscatter survey data (Graham 2009). While this estimate refers to more species than just sea nettles or moon jellies, these species are significant contributors to the total jellyfish population in the CCE within designated critical habitat for leatherbacks along the U.S. West Coast, which is a significant component to why this area appears to be preferred foraging habitat for leatherbacks in the summer and fall. Sea nettles can achieve very large sizes of up to 30 inches in diameters (bell size), weighing many kilograms. Moon jellies are smaller, but still get as large as 15 inches in diameter. There is no standard conversion of jellyfish biomass to the number of individuals for these species to make specific quantitative relationships between. But we can use the density provided by Graham (2009) to estimate how many jellyfish might be found in the entire area designated as critical habitat for leatherbacks. Conservatively applying the low end of the Graham (2009) jellyfish density estimate in central California (251,522 - 57,504 = 194,018 jellies/nm^2) to the total square mileage of leatherback critical habitat (approximately 42,000 m^2), we estimate at least 3 billion jellyfish are in leatherback critical habitat. It is unknown if the density of jellyfish is similar through the entire leatherback critical habitat area, especially outside of Central California, and what proportion sea nettles and moon jellies constitute throughout. However, based on the best available information we estimate that there are likely hundreds of million, if not billions, of these individuals scattered throughout this area. The potential capture and removal of 820 mt (820,000 kg) during a single year most likely represents a very small fraction of the total jellyfish population available to leatherbacks. The average weight of these jellyfish species is not clear, but even if the average sea nettle and moon jellyfish are only 0.1 kg (likely an underestimate), the PCGF is capturing only on the order of 0.3 percent of the available jellyfish likely to be important food for leatherbacks within designated critical habitat (8,200,000 jellyfish out of 3 billion). Therefore, even if jellyfish were caught at their upper observed rate of 820 mt annually, this likely would have an insignificant effect on the abundance or distribution of jellyfish in the action area.

Organic pollutants, including petroleum products (or oil spills) used by fishing vessels in the PCGF, may directly impact the prey that leatherbacks rely on, kill organisms, reduce fitness through sub-lethal effects, and potentially disrupt the structure and function of marine communities and ecosystems. Specifically, coastally-associated gelatinous zooplankton have been shown to bloom and increase in the presence of pollution or crude oil: Aurelia in Tokyo and Osaka Bays, the Black Sea, and the Gulf of Mexico (Purcell et al. 2001; Arai 2001), ctenophores in the Black and Caspian Seas (GESAMP 1997; Faasse & Bayha 2006; Fuentes et al. 2010), and Aurelia and Mnemiopsis in the Gulf of Mexico (Almeda et al. 2013). However, coastal pollution has also been associated with the loss of diversity in gelatinous zooplankton (Purcell et al. 2001; Arai 2001), with less known about the effects of oil pollution on offshore pelagic species. Given the continual and dispersed movement of vessels within the action area, we do not anticipate that petroleum releases from PCGF vessels into the marine environment will cause acute or chronic exposure to these organisms, particularly because the prey are mobile.

In summary, the bycatch of leatherback turtle prey species by the PCGF is anticipated to be minimal relative to prey abundance, and leatherbacks can switch from cnidarians to tunicates when environmental variables affect prey population abundances. Consequently, we expect the removal of leatherback prey by the PCGF would have insignificant impacts on the abundance, density, or distribution of available prey in the action area. As summarized in Section 2.5.2.6 *Risk of Pollution and Contaminants*, we anticipate the effects of pollution from petroleum use or minor oil spills would have insignificant impacts to the abundance, distribution, or condition of prey resources targeted by leatherback sea turtles within the action area. Based on this analysis, NMFS finds that the proposed action is not likely to adversely affect designated critical habitat for leatherback sea turtles.

3 DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

3.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the National Marine Fisheries Service. Other interested users could include others interested in the conservation of the affected ESUs/DPS. Individual copies of this opinion were provided to the National Marine Fisheries Service. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

3.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

3.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

4 References

Federal Register Notices

June 2, 1970 (35 FR 8491). Final Rule: Conservation of Endangered Species and Other Fish and Wildlife.

December 2, 1970 (35 FR 18319). Final Rule: Conservation of Endangered Species and Other Fish and Wildlife – List of Endangered Foreign Fish and Wildlife.

May 31, 2001 (66 FR 29502). Final Rule: Regulations Governing the Approach to Humpback Whales in Alaska.

April 2, 2004 (69 FR 17329). Final rule: Fisheries Off West Coast States and in the Western Pacific; Western Pacific Pelagic Fisheries; Pelagic Longline Fishing Restrictions, Seasonal Area Closure, Limit on Swordfish Fishing Effort, Gear Restrictions, and Other Sea Turtle Take Mitigation Measures.

May 11, 2006 (72 FR 27408). Final Rule: Magnuson-Stevens Act Provisions; Fisheries off West Coast States; Pacific Coast Groundfish Fishery.

January 26, 2012 (77 FR 4170). Final Rule: Endangered and Threatened Species: Final Rule to Revise the Critical Habitat Designation for the Endangered Leatherback Sea Turtle.

November 4, 2013 (78 FR 66139). Final Rule: Endangered and Threatened Species; Delisting of the Eastern Distinct Population Segment of Steller Sea Lion Under the Endangered Species Act; Amendment to Special Protection Measures for Endangered Marine Mammals.

February 11, 2016 (81 FR 7414). Final Rule: Listing Endangered and Threatened Species and Designating Critical Habitat; Implementing Changes to the Regulations for Designating Critical Habitat.

September 8, 2016 (81 FR 62260). Final Rule: Endangered and Threatened Species; Identification of 14 Distinct Population Segments of the Humpback Whale (Megaptera novaeangliae) and Revision of Species-Wide Listing.

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November 19, 2019 (84 FR 63966). Final Rule: Magnuson-Stevens Act Provisions; Fisheries Off West Coast States; Pacific Coast Groundfish Fishery; Pacific Fishery Management Plan; Amendment 28

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June 24, 2021 (86 FR 33142). Notification of Agency Decision: Fisheries Off West Coast States; Coastal Pelagic Species Fisheries; Amendment 18 to the Coastal Pelagic Species Fishery Management Plan.

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January 24, 2023 (88 FR 4162). Notice: Draft 2022 Marine Mammal Stock Assessment Reports.

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December 1, 2023 (88 FR 83830). Final Rule: Magnuson-Stevens Act Provisions; Fisheries Off West Coast States; Pacific Coast Groundfish Fishery; Pacific Coast Groundfish Fishery Management Plan; Amendment 32; Modifications to Non-Trawl Sector Area Management Measures.

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5 Appendices

Appendix A Co-Occurrence Analysis

Introduction:

The bycatch of humpback whales and leatherback sea turtles has been historically documented in the Pacific Coast Groundfish Fishery (PCGF). Documentation of these events has come through the West Coast Groundfish Observer Program (WCGOP), which provides both human and electronic observation methods to monitor both target catch and bycatch during fishing trips. Across these sources, there have only been a small number of observed entanglements since the inception of the observer program in 2002. Additionally, opportunistic sightings of entangled whales and turtles on the water by commercial or recreational fishermen, whale watching boats, beach stranding responders, and other professional or public ocean users have been reported and ultimately attributed to specific sectors of the PCGF. Given the limited observations and low estimates of bycatch based on observer data that have been produced to date (Somers et al. *In Prep*), we wanted to develop additional methods to evaluate the entanglement risk commercial sectors of the PCGF poses to Endangered Species Act (ESA)-listed humpbacks and leatherbacks, to help inform expectations for future occurrences. Using fishing effort data collected by the WCGOP (which was further aggregated by gear type and sector), along with available species distribution models (habitat suitability for leatherbacks (Lezama-Ochoa et al. Under Review) and density distribution for humpbacks (Forney et al. In Prep)), we overlaid past effort data and species distribution predictions from 2014-2023 to assess the co-occurrence of the PCGF and ESA-listed species. To do this, we also incorporated intensity of observed fishing effort and the species distribution models to analyze where overlap was expected and most likely to result in higher entanglement risk across the different sectors and gear types of the PCGF. We further evaluated variability and trends in those risks over the most recent decade (2014-2024), to help characterize entanglement risk we expect in the future as a result of PCGF fishing activities. We aim to use this information for the following purposes:

- Identify how co-occurrence has changed throughout the different sectors of the PCGF, and trends in magnitude and distribution of co-occurrence throughout and across years.
- Consider how trends in co-occurrence correspond with reported entanglements, predicted bycatch, and history of opportunistic entanglement sightings.
- Utilize the spatial distribution of co-occurrence to apportion anticipated take of humpback whales among the appropriate Distinct Population Segments (DPSs) (in concert with other available information and the best available science).
- Utilize the variability and trends in co-occurrence dynamics over space and time to anticipate expected future extent and intensity of risk.

These objectives will allow us to better evaluate the risk individual sectors and gear types of the

PCGF pose to ESA-listed humpback whales and leatherback sea turtles, make inferences about what future risk the PCGF activities pose to these species, and ultimately update our expectations for subsequent entanglements that may occur in the future as part of the proposed action.

Observed Entanglements

Since the deployment of WCGOP observers in 2002, three observed entanglements of humpback whales in the PCGF sablefish pot fishery have been confirmed: one in the Limited Entry (LE) sablefish pot fishery (2014); one in the Open Access Fixed Gear (OA) sablefish pot fishery (2016); and one in the LE sablefish pot fishery (2023) which involved both sablefish slinky pot and Pacific halibut longline gear (which is non-PCGF effort/gear). From 2011-2024 there have been two other humpback whale entanglements reported to NMFS through opportunistic observations identified as involving sablefish pot gear, which occurred in 2016 and 2017. There was also another opportunistic sighting of a humpback in sablefish pot gear in 2006, prior to the IFQ rationalization program within the PCGF. In total, in the entanglement history of humpback whales relevant to PCGF pot fisheries there have been six reports of humpbacks entangled in sablefish pot gears, five of which have occurred since 2011, three of these instances were observed by fishery observers, and three were opportunistic sightings (i.e. not observed by fishery observers).

We acknowledge that a humpback whale interaction with PCGF vertical-jig hook-and-line gear within the OA sector was reported by a WCGOP observer in 2021, but entanglement of the animal was ultimately not confirmed. Therefore, there are no confirmed observed instances of humpback whale entanglements in PCGF hook-and-line gear. However, within the entanglement mortality and serious injury (M/SI) database of humpbacks (i.e. 2007-2023) maintained by NMFS marine mammal stock assessment authors, there have been six mentions of monofilament line within the entanglement description of a reported event, including the described 2021 event. There is no way to determine whether these monofilament lines reported in the entanglement database are related to the PCGF specifically.

In August of 2023, a live humpback was reported captured alive within a midwater trawl net targeting Pacific whiting off Coos Bay, Oregon, and was observed through electronic monitoring (EM). The humpback was cut free and released alive and reported directly by the fishing vessel to the NMFS West Coast Entanglement Response Program. In June 2024, there was another observation of a dead humpback whale captured by a midwater hake vessel off of Westport, Washington, documented through the EM program. There have been other unconfirmed humpback whale interactions that have occurred through EM monitoring of midwater Hake vessels, including two humpbacks in 2020. Multiple NMFS SWFSC and WCR Marine Mammal Stranding Program staff reviewed the EM videos from the 2020, and could not determine whether those whales was likely dead or alive at the time of capture.

There has only been one confirmed leatherback entanglement in the PCGF, which occurred in the OA sablefish pot fishery in 2008. This entanglement was also reported to the NMFS WCR Sea Turtle Stranding Program. There have been no observed or opportunistic reporting events of leatherback turtles entangled in PCGF hook-and-line or midwater trawl gear.

Methodology:

To generate a fine scale evaluation of entanglement risk dynamics for humpback whales and leatherback sea turtles in the PCGF fisheries, we overlaid WCGOP fishing effort data aggregated by relevant gear type and sector, with available species models, which included a density distribution model for humpbacks and a habitat suitability model for leatherbacks. To do this, we first took available fishing effort data and converted it into a spatial density model representing the total fishing effort for different gear types of the PCGF (e.g., pot, midwater trawl, and hook-and-line) as monitored and tracked by the WCGOP within gridded 2 km cells.

Fishing Effort

For the pot and hook-and-line sectors, fishing effort was calculated as the number of individual observed sets of pots or sets of hook-and-line gear using WCGOP data from 2014-2023[15]. While there are a number of other effort metrics collected and available, including information on landings that are commonly used to characterize fishing effort in the PCGF, we concluded that the number of sets of these gear types is the best way to represent fishing effort as it relates to entanglement risk given that: (1) it most closely captures the number of vertical lines in the water that pose risk and are most likely to entangle marine mammals and turtles; and (2) generally, we expect that sets for these gear types have involved a similar number of lines (mostly two, possibly one) no matter how many pots or hooks are used in association with each set or the amount of landings that are generated from each set, which are both factors that are highly variable within and across sectors, and over time (Somers et al. 2023). The exclusion of 2023 EM data (due to the unavailability at the time of publication) does not affect the hook-and-line sector as there is no EM coverage within the hook-and-line sector. However, there is EM coverage within the CS pot sector, therefore the 2023 EM data for the CS pot sector is not fully represented in this analysis. The only sector within the pot fisheries that rely on EM for monitoring observership is CS, and data for LE and OA sectors for 2023 include all observer coverage of fishing effort.

The number of sets for each sector was calculated by identifying and summing unique haul IDs, and organizing by unique year, month, and sector. For example, the number of sets for the CS sector in January of 2014 were aggregated together. If there were multiple CS sets observed at 32.12°N and -117.25°N in January of 2014, those were summed and consolidated into a single data point for the spatial model of fishing effort. If 32.12°N and -117.25°N only contained one

CS observed set, then only that set represented the data point for the spatial model. While performing the co-occurrence analysis, fishing effort was consolidated into 2-kilometer resolution grid cells where single data points were created summing all fishing that was observed in a 2-by-2-kilometer spatial distance using latitude and longitude values. This 2-kilometer resolution is what our overlap analysis was performed at, with all quantitative information displayed in this appendix and in the opinion, occurring at this resolution. Then, to abide by confidentiality requirements of the Magnuson-Stevens Act (MSA) of spatially representing fishing data, any visual representation of fishing or overlap on a map in this appendix and opinion was scaled to a 10 km resolution. With the larger aggregation of data, the values were also filtered so that points that contained two vessels or fewer were excluded from visual representation. Therefore, any visual representation of fishing effort or overlap on a map in this appendix or within the opinion may slightly differ to what is described in the tables or main text due to the filtering of data for confidential representation. For pot fishing, the number of sets was aggregated by sectors: LE, OA, and CS; for each month (January-December) from 2014-2023.

For hook-and-line fishing, the number of sets was aggregated by sectors: LE, Limited Entry Trip Limit (LE TL), OA, and CS. Given the limitations of fishing seasons within some sectors, if there was no observed effort during a month, that month was deemed to represent "zero co-occurrence" for that sector. Theoretically, if every sector was active with observed sets in every month of every year of the time series, the total would be n = 480; for pot fishing the unique number of sector-year-month combinations was n = 219, and for hook-and-line was n = 305. The hook-and-line fisheries encompass a wide variety of gear types including: longline, vertical hook-and-line, stationary hook-and-line, rod-and-reel, stick, and troll. Hook-and-line means one or more hooks attached to one or more lines and they can be mobile (troll) or stationary (longline). Vertical hook-and-line gear such as vertical jig involves a single line anchored at the bottom and buoyed at the surface. The majority of hook and line catch in the PCGF is with bottom longline gear. However, in recent years there has been a growing component utilizing variations on vertical line gear, rod-and-reel gear, and stick gear.

For the midwater trawl sector there are two components within the gear type: the shoreside (SS) and at-sea (AS) sectors. The shoreside component is derived into smaller sectors: Hake (non-EM), Hake (EM), Rockfish (non-EM), and Rockfish (EM). Throughout this appendix we will refer to them as the Hake and Rockfish sectors by combining both the human-observed and EM-observed subsectors. The AS component is divided into catcher-processor (CP) and mothership (MS) sectors. Throughout this appendix the SS and AS components of the midwater fishery will be separated to compare effort and overlap. Fishing effort for all sectors was represented by the observed tow durations of midwater trawls in hours generated from WCGOP data from 2014-2023[16]. The exclusion of 2023 EM data is substantial in the case of trawl gear, as a vast majority

[16] 2023 EM data was not available at the time of analysis of this opinion. Therefore, any data presented in this report that encompasses 2023 will not contain any observed EM effort.

of the fisheries for both Hake and Rockfish are monitored through EM. The Hake and Rockfish sectors monitored by human observers are represented in their totality, however, a large sector of the fisheries in 2023 is not accounted for in this analysis due to the lack of EM data at the time of publication (and therefore not included in the SS analysis).

We concluded that tow duration was the best way of representing trawling effort as it pertains to entanglement risk because it describes the amount of time trawl nets would be towed through the water column, and therefore the amount of time a net could capture or entangle a marine mammal or turtle. Other metrics of effort such as landings can vary dramatically from set to set; tow or haul duration (will be referred to as both in this appendix and are synonymous) is the most standardized way of calculating trawl effort. Tow duration is already calculated by WCGOP in their datasets (Somers et al. 2023), and is reported as or was converted to decimal hours from the start/end times of the midwater trawls. Similar to hook-and-line and pot, every unique haul ID was identified, and trawl hours were aggregated by unique year, month, and sector groupings. For trawl fishing, this includes the following sectors: Midwater Hake, Midwater Rockfish, CP, and MS for each month (January-December) from 2014-2023. We chose to analyze midwater trawling without including bottom trawling, as there have been no known capture/entanglements between humpback whales and leatherback sea turtles with bottom trawl gear.

In addition to calculating observed pot gear sets, hook-and-line gear sets, and trawl hours, we wanted to represent to the best of our ability the totality of fishing effort associated with each sector, beyond just the observed fishing effort. The WCGOP calculates observer coverage rates based on the metric tons of catch observed relative to the total metric tons of landings for every gear type, sector, and year within the PCGF. Observed landings is the only metric available for all vessels and effort associated with the PCGF, hence landings are used to calculate observation rates by WCGOP instead of other metrics such as numbers of sets or tow hours. Despite this, in the sectors where the WCGOP produced observation rates based on observed landings and observed hauls respectively, the observed proportion rates based on landings and based on hauls were highly correlated and similar, thus justifying the use of observation rate calculated from landings despite utilizing sets and trawl hours for our fishing effort metrics.

Given the variation in PCGF observer coverage rates across different sectors of the PCGF, from 2-100% (Somers et al. 2022), it is difficult to evaluate the relative co-occurrence of sectors directly when the available data may represent only 2% of the effort that occurred in that sector, versus other sectors where observer coverage represents higher proportions, For example, the CS sector of the PCGF has nearly 100% observer coverage either through EM or human observers, therefore the WCGOP dataset encapsulates nearly 100% of the fishing effort and data of this sector. Conversely, the WCGOP dataset for the OA sector only captures 2-12% of total fishing effort, resulting in very few data points, and making it difficult to accurately analyze this sector’s total risk for entanglement, the variability of that risk over time, and compare to other sectors such as CS. Therefore, to represent total fishing effort, we divided the observed number of sets or trawl hours for each sector by the proportion of the landings observed in that year (i.e., observer coverage rate estimated by WCGOP) in each sector. For example, for sablefish pot gear, if the 2014 May LE sector observer data consisted of three fishing sets across a range of latitude and longitude values (e.g. 1, 2, and 3 observed sets per individual area), and the observer coverage rate for LE pots in 2014 was 5%, then each of those values would be divided by 0.05 to generate a total estimate of 20, 40, and 60 sets for this area to accurately represent 100% of fishing effort in that respective sector and year. Since observer coverage rates are provided on an annual basis, the same rate for that year would be applied for every month within that year. Thus, following the previous example, the number of sets made in each area would be divided by 0.05 for every month in 2014 to generate estimates of total effort for LE fishing effort in our spatial effort model.

Species Distribution Models

The humpback whale model differs from the leatherback model as it is a species density distribution model, and therefore estimates the number of whales per square kilometer, whereas the leatherback habitat suitability model estimates habitat quality, ranging in value from 0-1 (0 indicates unsuitable habitat and 1 represents highest quality habitat). Both approaches rely on environmental variables to predict where species are most likely to occur; however, the humpback model further associates those predictions with densities of whales from survey data.

The humpback whale density distribution model is currently associated with a manuscript that is in preparation for peer review (Forney et al. in prep), but a prior version of the model has also been used in previous analysis published by NMFS Science Centers (Samhouri et al 2021, Riekkola et al. 2023). While this model is the best available predictive tool for the type of spatial and temporal overlap analysis we are conducting, we acknowledge that there is potential for the humpback whale density distribution model to underestimate the density/distribution of humpback whales found off the U.S. West Coast. This is because the model has been validated (in part) utilizing whale watching data, which tends to not observe many whales in the winter due to weather, business restrictions, and from regional air surveys and small boat surveys which are limited by the same constraints (Karin Forney, personal communication, August 8th, 2024; Forney et al. In Prep). Therefore, this co-occurrence analysis could ultimately underestimate entanglement risk in some time or areas, which we considered accordingly. This model is built using Southwest Fisheries Science Center (SWFSC) line-transect survey data from 1991-2014, and uses satellite and Regional Ocean Modelling System (ROMS) data as covariates (mixed layer depth, sea surface height, sea surface temperatures, and standard deviations of these variables) to produce a prediction value (whales/km^2) every two days in an approximately 3 km (0.027°) resolution grid, and was run for the 2014-2023 period we analyzed. These spatial coordinate values were then averaged across each month in the time series to produce humpback whale density estimate predictions for every unique month and year combination (n = 120).

The original leatherback habitat suitability model (Welch et al. 2020) was fitted using satellite-linked tracking data collected during the Tagging of Pacific Predators program from 2001-2011 (Block et al. 2011), and incorporates daily environmental data at 0.1° resolution from the Regional Ocean Modelling Systems (ROMS) configured for the California Current Ecosystem (CCE). Since the original model was fit, new Argos satellite tracking data spanning 2011-2020 has been collected and updated to the model (Lezama-Ochoa et al in review). These variables are used to hindcast species distributions based on the day's environmental covariates to produce habitat suitability maps, generating daily prediction values in a 0.1° grid, which were then run for the period 2014-2023. These daily prediction values occur from 0-1, with zero indicating unsuitable habitat in an area, and one representing the highest quality leatherback habitat suitability areas. These spatial coordinate daily predictions for habitat suitability values were then averaged across each month to produce habitat suitability scores for each unique month and year combination across the entire U.S. West Coast (i.e., monthly habitat suitability prediction data frame; n = 120). Again, this model is a habitat suitability estimator, and therefore is not indicative of actual leatherback density in the study area; instead it is a tool that displays where leatherbacks would be more or less likely to be found based on the availability of suitable habitat. This will be important to understand in our analysis, as the Western Pacific population of leatherbacks has declined in recent decades, and therefore individual leatherbacks have been observed less frequently off the U.S. West Coast (especially in the Pacific Northwest) in recent years despite there being suitable habitat for them. Therefore, this model will be a conservative predictor of potential overlap with leatherbacks in this analysis, despite the presence of suitable habitat.

Co-Occurrence Analysis

To calculate the overlap between fishing effort and the species models (i.e., co-occurrence or overlap which are considered synonymous and will be utilized throughout the appendix interchangeably), we converted each of the unique monthly leatherback habitat suitability prediction values, whale density prediction values, and fishing effort values for the pot, hook-and-line, and trawl sectors into individual gridded data layers. All layers (both species distribution models and each fishing effort rasters), were converted to the same spatial resolution (2 km grid cells) and extent (latitude = 32 to 49°N and longitude = -115 to -126°W). Once all data layers were converted to the same resolution, they were overlaid to produce an output layer that only contained values present in both parent data layers (e.g. pot effort and humpback density or trawl effort and leatherback habitat suitability). There was no determined minimum threshold for overlap. For example, if there was a grid that contained a fishing effort of 0.1 and a species model of 0.001, there would be a resulting output overlap and it would count towards the total overlap calculations. The values of grid cells in the output layer were produced by multiplying the parent raster values. To follow with the previous example, if at latitude 42°N and longitude -120°W there were 5 pot sets and 0.1 whales/km^2, then the corresponding output grid cell would have a value of 0.5 (5*0.1 = 0.5) and the output would include all of the grid cells with overlap. The values of all of the resulting cells were also summed across months or years to compare trends over time. It is important to note that these resulting overlap values are unitless and cannot be directly compared against other overlap values from different fishing effort and species overlaps. This process of utilizing the product of two data layers (species models and fishing effort) has been documented in Redfern et al. (2020), Samhouri et al. (2021), Womersley et al. (2022), and Riekkola et al. (2023). This approach assumes that entanglement risk increases linearly as species density or suitability and occurrence of fishing gear increases. This risk metric through the multiplication of species and fishing data is not a measure of absolute risk of entanglement, but rather allows us to measure the relative change in risk across seasons, years, and fishing gear within each co-occurrence analysis. This overlap analysis process was completed for the following combinations of layers:

- Humpback whale density and pot sets
- Humpback whale density and hook-and-line sets
- Humpback whale density and midwater trawl hours
- Leatherback habitat suitability and pot sets
- Leatherback habitat suitability and hook-and-line sets
- Leatherback habitat suitability and midwater trawl hours

For each of these combinations, the co-occurrence values were also categorized by month, sector, year, and value of overlap, which were analyzed accordingly to evaluate spatiotemporal trends and how those trends may help inform expectations for future entanglement risks with humpbacks and leatherbacks.

Further, for the evaluation of Amendment 32 we visually evaluated mapping of:

- Humpback whale density and Amendment 32 opening areas
- Leatherback habitat suitability and Amendment 32 opening areas

Amendment 32 Analysis

Amendment 32 to the PCGF fisheries management plan (FMP) recently opened up areas within a Rockfish Conservation Area (RCA) that were previously closed to non-trawl fishing off the coasts of Oregon and California to vessels that gear switch under the Individual Fishing Quota (IFQ) Program. These recently reopened areas include areas located within designated critical habitat for humpback whales and leatherback sea turtles. This opened up fishing opportunities in Oregon and northern California waters from 75-100 fathoms, and in central California from 75-125 fathoms, to be possibly exploited by PCGF pot and hook-and-line fishing which has been previously closed for decades. We evaluated what the potential implications of these changes could mean for humpback whale and leatherback sea turtle entanglement risk for the relevant fixed gear fisheries.

Humpbacks are known to seasonally occupy the West Coast EEZ specifically in nearshore habitats close to the newly reopened areas of Amendment 32. Whale season on the U.S. West Coast, according to the most recent SAR (Caretta et al. 2023), occurs from April-December, which coincides with peak PCGF fixed gear fishing from April-November. Further, there was an unconfirmed entanglement of a humpback whale in vertical jig gear in 2021, which is one of the new gear types that is allowed in these newly reopened areas from Amendment 32. Therefore, we wanted to assess the risk of possible future pot and hook-and-line fishing in the newly opened areas by analyzing average monthly humpback whale density values from 2014-2023. Humpback whale density models were averaged to produce values for every unique year and month (n = 120). Then, the model was averaged every month (January-December) across years to produce output values along the California Current Ecosystem (CCE) for humpback whale density for every month (n = 12). We then generated 75, 100, and 125 fathom contour lines that spanned the newly reopened areas, and overlaid them on top of the monthly humpback whale density outputs to analyze how these newly reopened areas may overlap with humpback whales. This allowed us to determine if these new areas were: (1) likely to be utilized by pot/trap and hook-and-line fisheries due to the past history of effort, and (2) likely to interact with predicted distributions of humpback whale density.

Leatherbacks have been known to previously aggregate in or near these newly opened areas, around 200-2000m in Oregon and < 200m in central California (Benson et al. 2011). Leatherback habitat suitability along the U.S. West Coast tends to peak in summer and fall, coinciding with the peak in PCGF fixed gear fishing effort. Therefore, we wanted to assess the risk of possible future pot and hook-and-line fishing in these newly opened areas given average monthly leatherback habitat suitability values from 2014-2023. Thus, leatherback habitat suitability models were averaged to produce values for every unique year and month (n = 120), and then every month (January-December) across years was averaged together to produce output values along the CCE for leatherback habitat suitability for every month (n = 12). We then generated 75, 100, and 125 fathom contour lines that spanned the newly reopened areas, and overlaid them on top of the monthly leatherback habitat suitability outputs to analyze how these newly opened areas overlap with leatherback habitat suitability.

Results

Fishing Effort

We analyzed fishing effort for all three relevant gear types of the PCGF: pot, hook-and-line, and midwater trawl, along with their individual sectors. We wanted to establish a baseline of how fishing effort has changed amongst these gear types and their individual sectors over space and time during the last decade, to help provide context and insight for the co-occurrence analysis as to how fishing effort dynamics are contributing to overlap and entanglement risk. We chose to analyze the most recent decade as it will give us the most modern look at what is happening within each fishery. Additionally, this time period from 2014-2023 covers a wide variety of anthropogenic and natural environmental variation including the marine heatwave, El Niño and La Niña, and the COVID-19 pandemic thus providing a plethora of variability to strengthen our estimates of what is likely to occur in the future.

Pot

Figure A-1 displays sablefish pot fishing effort represented by the number of observed pot sets scaled up to represent the estimated 100% fishing effort based on observer coverage rates. Throughout this appendix we will refer to PCGF pot effort as sablefish pot effort as this fishery accounts for the vast majority if not the entirety of the PCGF pot fishery. There is no knowledge to date of commercial fishermen who fish for other groundfish species using pots that are managed under the groundfish FMP. Table A-1 displays the estimated number of pot sets for each sector: CS, LE, and OA for every year, 2014-2023, scaled up based on annual observation coverage rates for that year and sector. Figure A-2 displays the values from Table A-1 into a line plot to visually display the estimated number of pot sets by sector over the time series. Spatial trends we detected include: a northward shift in pot effort over the years resulting in less fishing occurring in southern California, especially in the CS sector; OA sector effort fixating on central and northern California over time; and the distribution of LE sector effort remaining relatively consistent over the years[17]*. A majority of fishing effort across all years is concentrated along the Oregon coast, with other small concentrations occurring north of the Columbia River in southern Washington, and off of Cape Mendocino, San Francisco, and Monterey Bay/Big Sur, CA (Figure A- 1).

The OA sector of the PCGF contains the lowest observer coverage, and the most minimal data in regards to fishing effort across sectors (CS and LE). Therefore, it makes it difficult to draw any concrete conclusions on fishing effort and therefore overlap within the OA sector as only around 5% on average of the fishery is observed. It is also possible that even when accounting for the low observation and scaling fishing effort based on observer coverage rate, that observers could be deployed only in a small subsection of the total effort that occurred in the OA sector. Thus, observer coverage could be influencing the trends that we see both in OA fishing effort and overlap with protected species. Especially when observed effort is scaled up so heavily to account for the low observer coverage, a single observation of overlap could heavily skew the results This differs for the CS sector as nearly 100% of this sector is monitored through human

[17] While we did examine this data using the same visual and data analysis formats, we are unable to effectively illustrate these patterns visually without compromising confidentiality. The * will represent this situation throughout the Opinion and Appendix A, where appropriate.

observation or EM, therefore almost the entirety of effort and distribution is accounted for in this analysis. Although the LE sector has on average 40% observer coverage since the inception of the WCGOP, this is substantially more coverage than OA and can even exceed 50% coverage in some years. Thus, with more data and a broader distribution we can be more confident in the fishing effort and overlap trends displayed in this analysis for the LE sector.

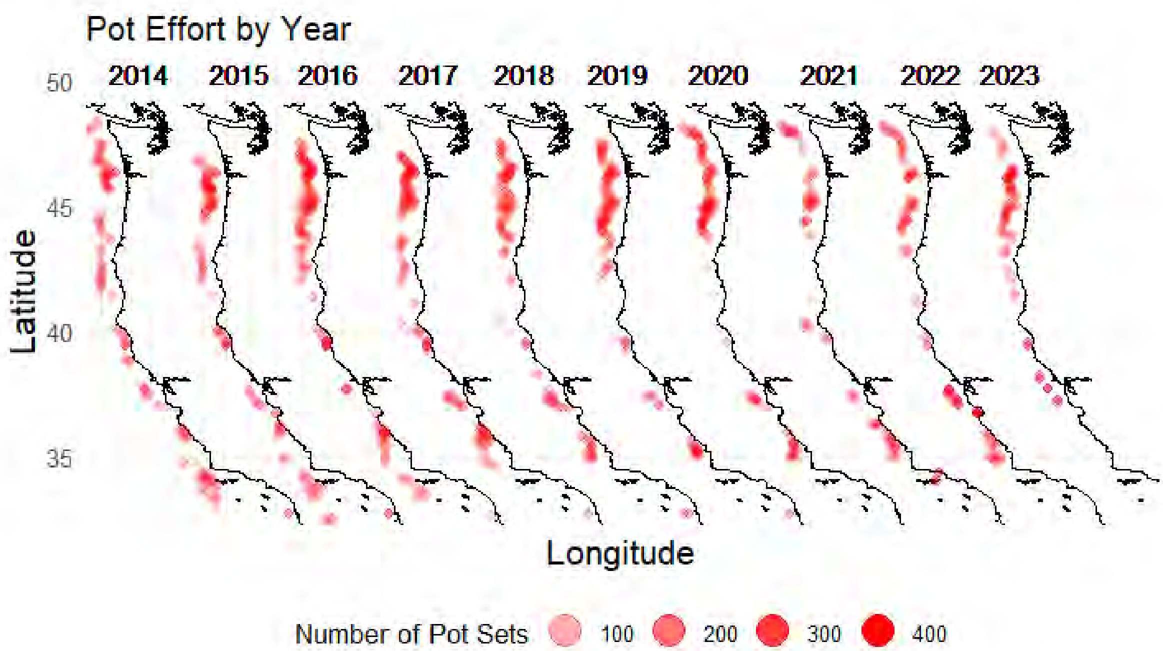


Figure A-1: Pot sets scaled up by sector to represent 100% of fishing effort based on observed WCGOP data, plotted by year (2014-2023), and labeled by magnitude of pot sets.*

Sablefish pot effort across sectors was the highest in 2016 (Table A-1). However, peak effort does vary by sector, with the LE effort peaking in 2023, OA in 2022, and CS in 2017 (Table A-1). Pot fishing effort oscillated in magnitude but remained relatively stable from 2014-2023 (Figure A-2).

Table A-1: Estimated number of pot sets for each sector per year. Estimated number of pots is derived from the WCGOP observed pot sets and scaled up based on observer coverage rates for that unique year and sector.

Year	LE	OA	CS	Total
2014	629	788	1,284	2,701
2015	490	914	1,275	2,679
2016	828	1,043	1,600	3,471
2017	581	1,050	1,798	3,429

Year	LE	OA	CS	Total
2018	726	890	1,320	2,936
2019	904	636	1,575	3,116
2020	981	367	1,417	2,764
2021	703	500	1,006	2,209
2022	642	1,525	974	3,141
2023	1,168	1,220	479	2,867

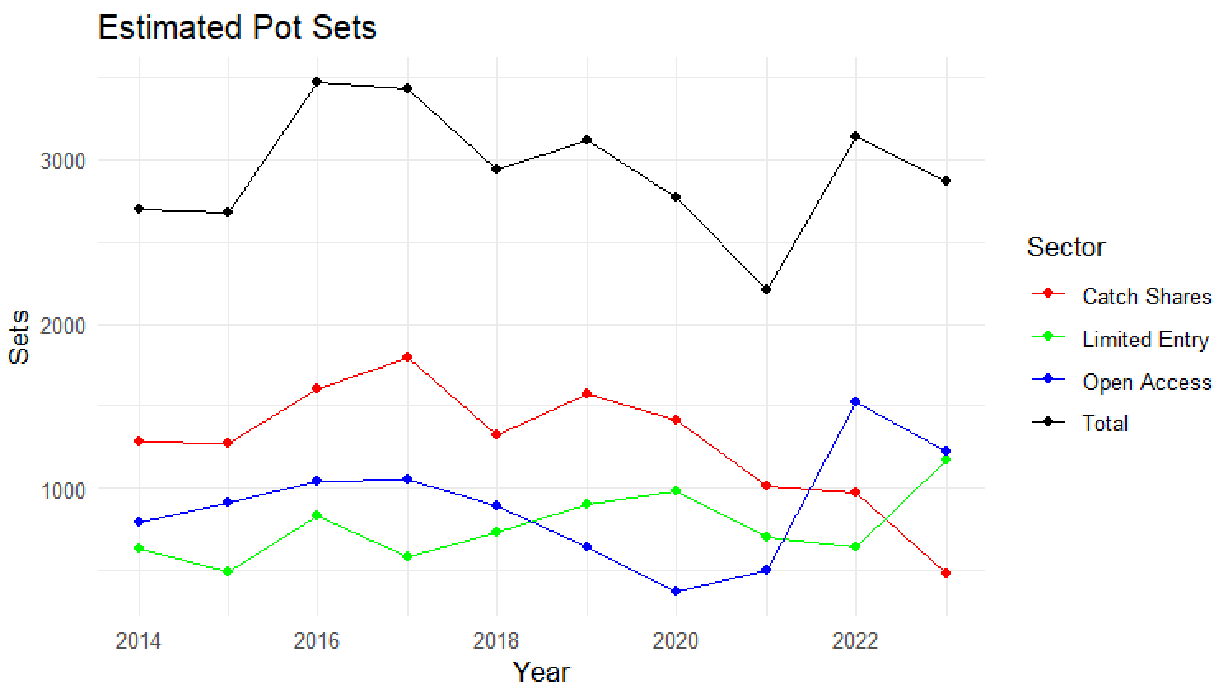


Figure A-2: Estimated pot sets by sector for the years 2014-2023. Lines are colored by sector and the black line represents the total sets summed for all sectors.

Pot fishing also displays temporal differences throughout the year, especially as certain sablefish pot fishing sectors are only allowed to fish during certain months of the year. There was a concentration of fishing effort occurring from April-October, reflecting the seasonality of the LE fishery (Figure A-3; Table A-2). The OA sector operates year-round, but effort is also concentrated in the same months as LE (Table A-2), with effort mostly around northern and central California throughout the year.* The CS sector fished mostly in Oregon and Washington waters with some effort in central California in recent years.* CS effort occurred throughout most of the year.

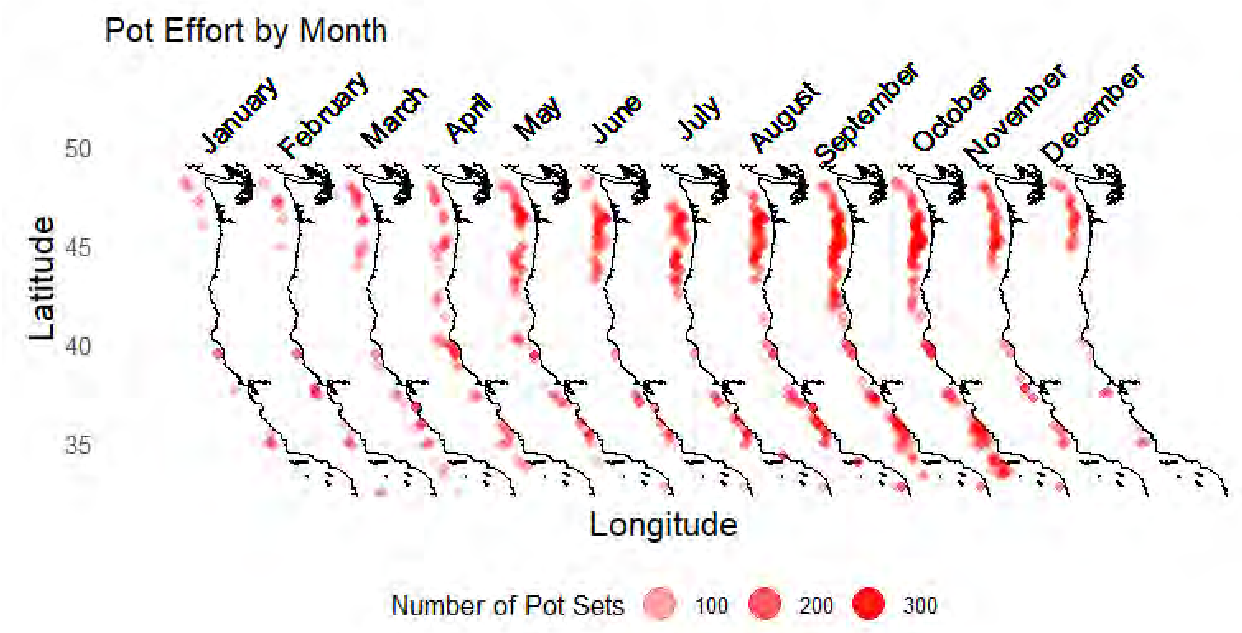


Figure A-3: Pot sets scaled up by sector to represent 100% of fishing effort based on observed WCGOP data, plotted by month which includes data from all years, 2014-2023, and labeled by magnitude of pot sets.*

Pot effort across sectors was highest in October (Table A-2). However, this varied by sector with LE effort peaking in October, OA in August, and CS in October (Table A-2). Total effort does display a distinct peak in effort occurring from July-December, but individual sectors do oscillate back and forth throughout the year (Figure A-4). The LE sector is the only sector that contained months with no fishing which occurred in January, February, and March (Table A-2).

Table A-2: Estimated number of pot sets for each sector per month for all years (2014-2024). Estimated number of sets is derived from the WCGOP observed pot sets and scaled up based on observer coverage rates for the unique year and sector in which that data was observed.

Month	LE	OA	CS	Total
January	NA	244	237	481
February	NA	495	415	910
March	NA	606	716	1,322
April	462	626	544	1,632
May	1314	779	756	2,849
June	416	827	961	2,204

July	674	723	1,281	2,678
August	704	1743	1,451	3,898
September	1898	982	2,120	5,000
October	1954	798	2,470	5,222
November	195	722	1,089	2,006
December	34	387	688	1,109

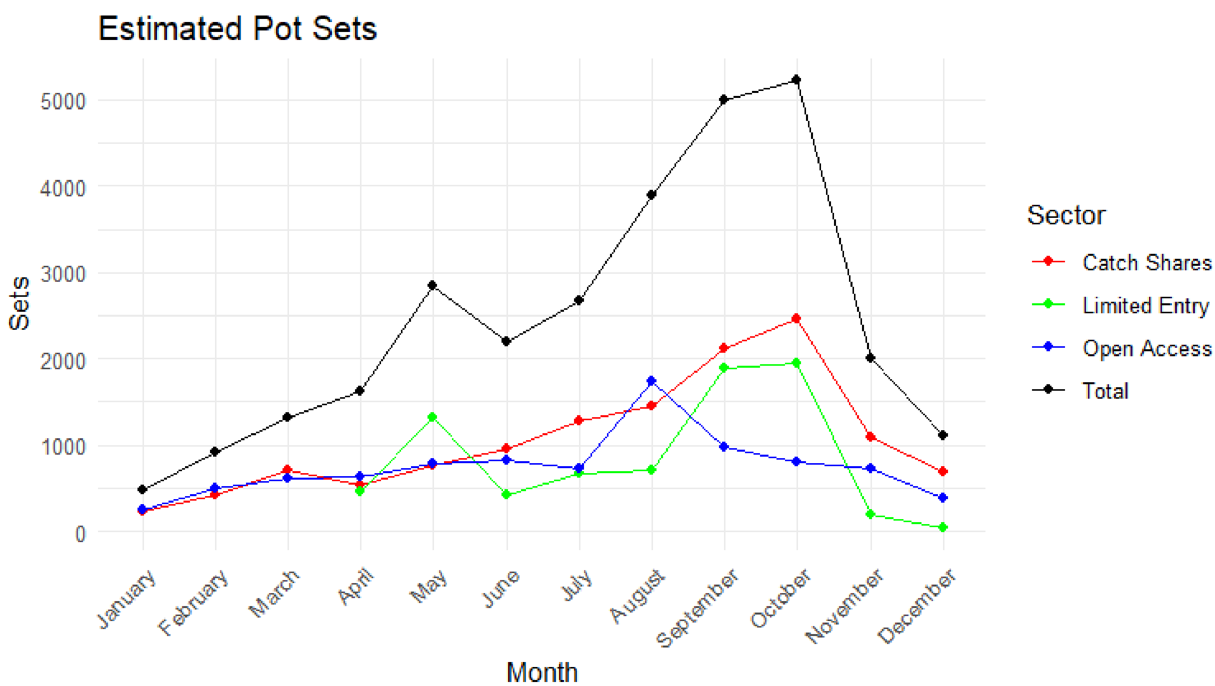


Figure A-4: Estimated pot sets by sector and month for the years 2014-2023. Lines are colored by sector and the black line represents the total sets summed for all sectors.

Hook-and-Line

Similar to pot fishing, the CS hook-and-line sector also has near 100% of observer coverage during this time series therefore the effort and overlap analysis for this sector is deemed to be fairly accurate and indicative of total risk for the sector, except for 2023 where there is no EM data available or utilized in this analysis. The OA and LE TL sectors both have very minimal observer coverage; around ~4% for both OA and LE TL. Therefore, scaling up based on their observer coverage to account for total fishing effort and applying this to our overlap analysis can present bias, both spatially if observers only cover limited distributions of the fishing effort, and overall with limitations on available fishing effort. The LE sector has an even lower average observer coverage rate to LE pot of ~30%. Thus, although the LE sector still contains more data than OA and LE TL sectors, there are some limitations to scaling up to represent total fishing effort. However, since around a third of fishing is still observed, we think it is safe to assume that the distribution of LE hook-and-line fishing effort is likely covered accurately, but still presents challenges when analyzing overlap.

Figure A-5 displays estimated hook-and-line fishing effort represented by the number of observed hook-and-line sets that were scaled up to represent the estimated 100% fishing effort. Hook-and-line sets are most concentrated along northern California and the Oregon coasts, with a smaller concentration occurring near Cape Elizabeth and La Push, WA (Figure A-5). In recent years there was a decrease in hook-and-line effort around the Columbia River mouth and within the Southern California Bight (Figure A-5). Hook-and-line fishing distribution appears to stay relatively consistent across years, space, and sectors and spans the entire coastline from southern California to northern Washington (Figure A-5).

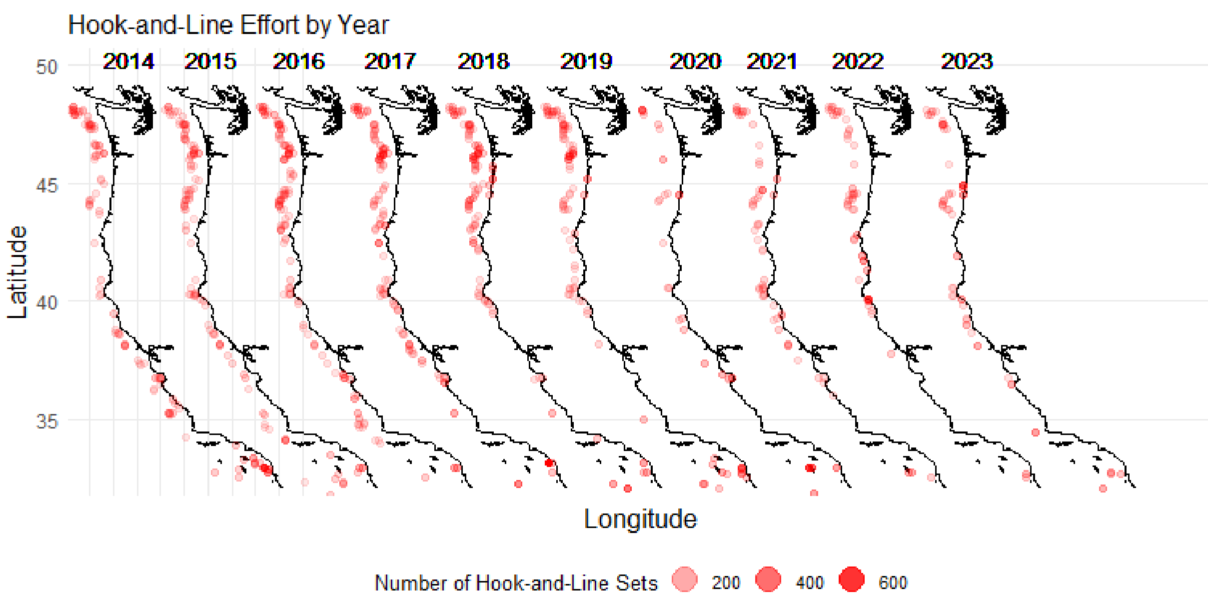


Figure A-5: Hook-and-line sets scaled up by sector to represent 100% of fishing effort based on observed WCGOP data, plotted by year (2014-2023), and labeled by magnitude of pot sets.*

LE TL and CS sector effort has declined over time, and this has decreased hook-and-line effort that occurs in the Southern California Bight*. Particularly, CS fishing ceased altogether in 2020, and LE TL substantially declined from 2021 onwards (Table A-3), Figure A-6). The OA sector has increased in annual sets especially in the most recent years, 2022 and 2023 (Table A-3, Figure A-6). LE fluctuates throughout time but has remained relatively stable in the number of sets since 2020 (Table A-3, Figure A-6). Overall, hook-and-line fishing effort peaks in 2017 with

LE peaking in 2016, LE TL in 2014, OA in 2022, and CS in 2016 (Table A-3). Overall, the number of hook-and-line sets remained stable, but have decreased in annual effort in the most recent years, 2020-2023 compared to the beginning of the time series, 2014-2016 (Figure A-6).

Table A-3: Estimated number of hook-and-line sets for each sector per year. Estimated number of sets is derived from the WCGOP observed hook-and-line sets and scaled up based on observer coverage rates for that unique year and sector.

Year	LE	LE TL	OA	CS	Total
2014	1,869	3,080	780	252	5,981
2015	1,532	2,057	1,080	186	4,854
2016	2,006	1,725	1,560	350	5,641
2017	1,876	2,366	1,975	149	6,367
2018	1,930	2,125	2,080	145	6,280
2019	1,771	2,175	2,000	155	6,101
2020	1,354	2,200	1,133	0	4,687
2021	1,387	1,050	1,180	0	3,617
2022	1,214	600	2,700	0	4,514
2023	1,326	725	2,500	0	4,552

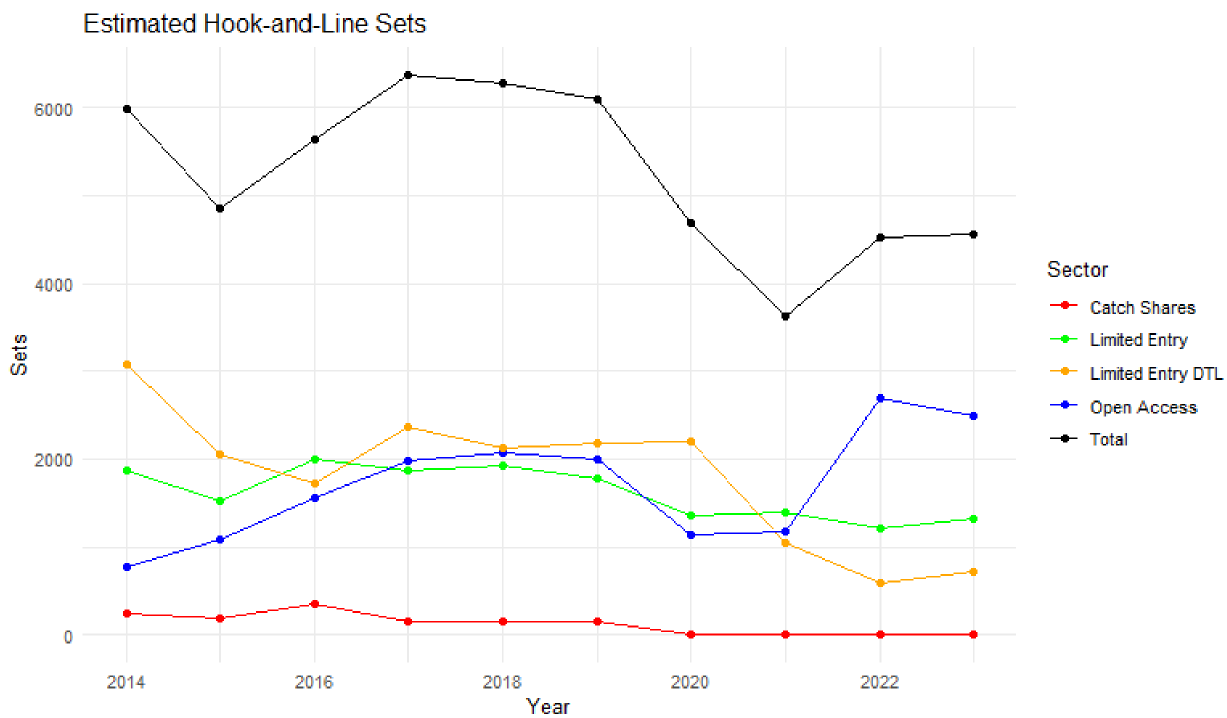


Figure A-6: Estimated hook-and-line sets by sector for the years 2014-2023. Lines are colored by sector and the black line represents the total sets summed for all sectors.

Hook-and-line fishing also displays temporal differences throughout the year, especially as certain sectors are only allowed to fish during certain months of the year. Here, we see the largest magnitude of fishing effort occurring from April-October, reflecting the seasonality of the LE fishery (Figure A-7, Figure A-8). LE fishes in broad distribution from the U.S.-Canada border to Point Conception*. OA operates year-round, but OA effort is also concentrated in the same months as LE (Table A-4, Figure A-8). The OA sector also displays a board distribution, fishing from the Columbia River mouth down to the U.S.-Mexico border*. LE TL fishes year-round in the Southern California Bight, and is the predominant sector to fish in that area year-round*. CS fished mostly near central California waters* and from September-November, but in recent years has ceased fishing effort (Table A-4, Figure A-8).

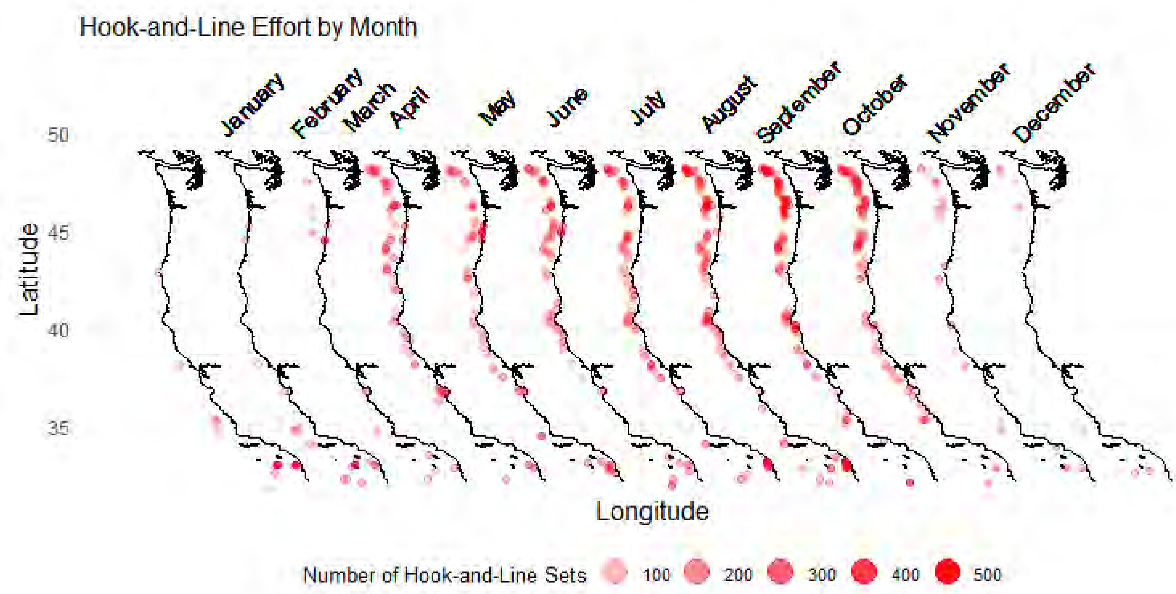


Figure A-7: Hook-and-line sets scaled up by sector to represent 100% of fishing effort based on observed WCGOP data, plotted by month which includes data from all years, 2014-2023, and labeled by magnitude of pot sets.*

Hook-and-line fishing effort across sectors and years peaked in August, with the LE sector peaking in September, LE TL in August, OA in August, and CS in October (Table A-4). LE and CS are the only sectors that do not display fishing effort year-round (Table A-4). Fishing effort across sectors peaks from March-November (Figure A-8).

Table A-4: Estimated number of hook-and-line sets for each sector per month for all years (2014-2024). Estimated number of sets is derived from the WCGOP observed hook-and-line sets and scaled up based on observer coverage rates for that unique year and sector in which the fishing occurred.

Month	LE	LE TL	OA	CS	Total
January	0	1,636	550	30	2,217
February	5	1,891	665	56	2,616
March	38	841	1,282	35	2,196
April	2,006	1,105	1,762	0	4,873
May	1,398	1,046	1,997	0	4,440
June	1,883	1,450	1,968	1	5,303

July	2,305	2,145	1,675	27	6,150
August	2,776	3,612	2,340	145	8,874
September	3,452	976	1,473	333	6,235
October	2,297	1,397	1,948	364	6,007
November	98	1,160	903	157	2,319
December	7	844	425	90	1,365

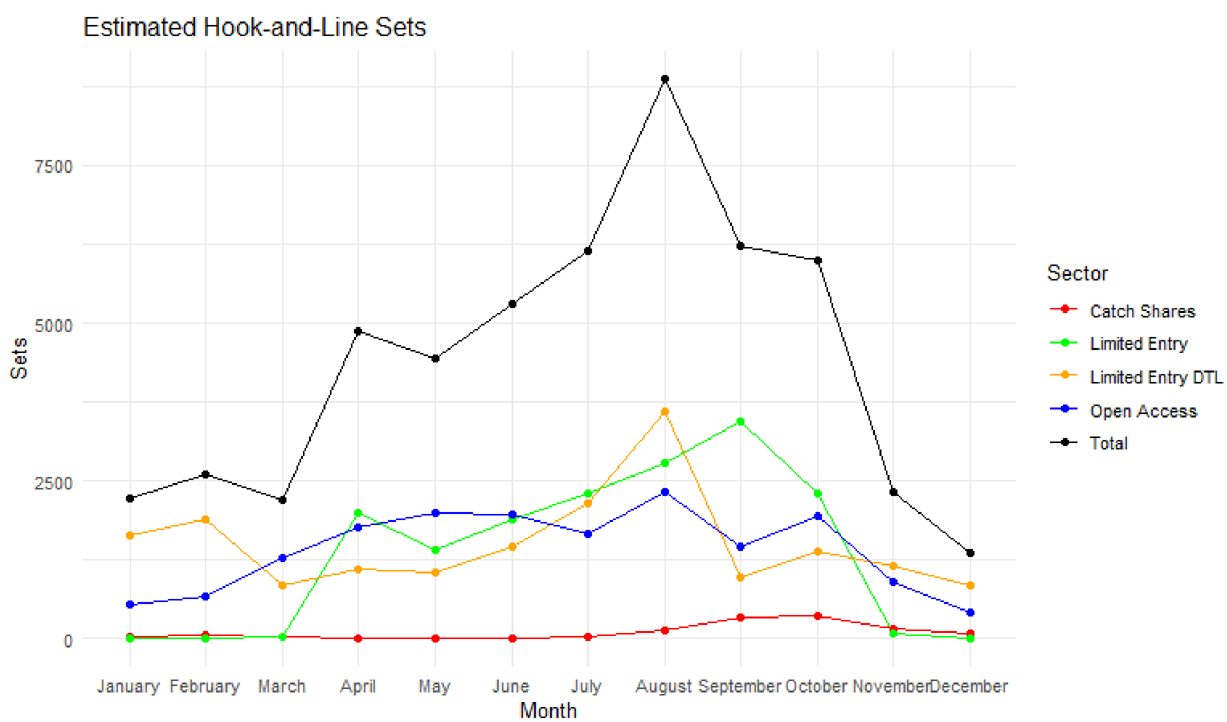


Figure A-8: Estimated hook-and-line sets by sector and month for the years 2014-2023. Lines are colored by sector and the black line represents the total sets summed for all sectors.

Midwater Trawl

Midwater trawling is split into different components within the PCGF, the shoreside (SS) and the at-sea (AS). The SS component is made up of Hake (non-EM), Hake (EM), Rockfish (non-EM), and Rockfish (EM). Throughout this appendix we will combine Midwater Hake non-EM and EM into a single sector called Midwater Hake, and do the same for Rockfish (non-EM) and EM into a sector, Midwater Rockfish. The available 2023 data will be included for the overlap and monthly analysis, but when looking at year to year trends since there was no EM data available for 2023 at the time of publication, it makes it difficult to compare incomplete 2023 data to other complete years. The AS component is made up of the

CP and MS sectors. These two components will be represented separately throughout the appendix, as some vessels within the AS sector (primarily CPs) tend to be much larger and louder, contain two observers with no EM observation, and target hake specifically. We display 023 data for the AS sector, as a majority of their effort is observed through human observation, and all the available data was provided for 2023.

Figure A-9 displays midwater trawl effort represented by the number of observed trawl hours based on observer coverage rates. The only exception to this being the unavailability of EM data for 2014 (EM recording had not begun yet), and for 2023, as this data was not available at the time of this opinion being drafted. All SS midwater trawling effort occurs north of 40°N, and therefore is heavily concentrated throughout these areas and did not display much difference in spatial distribution year to year.

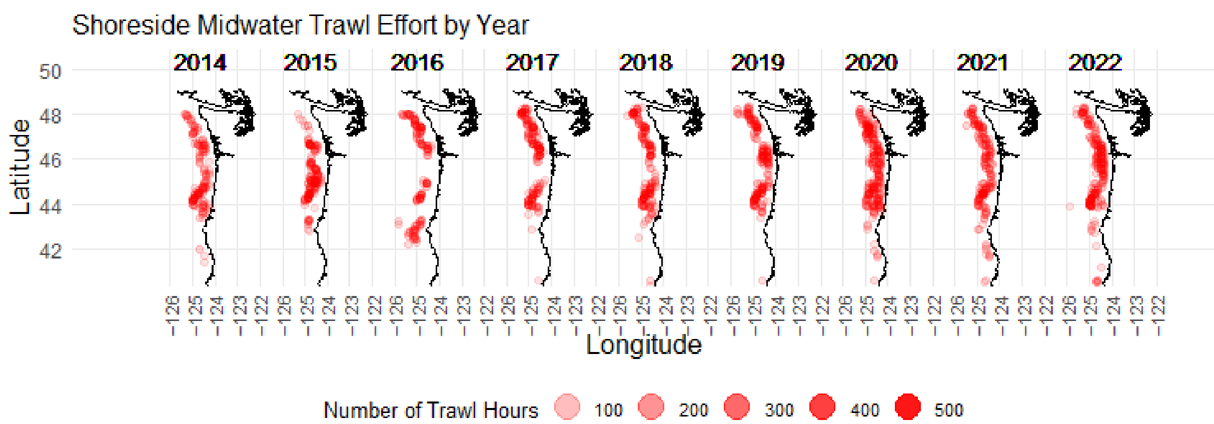


Figure A-9: Shoreside trawl hours representing 100% of fishing effort based on observed WCGOP data, plotted by year (2014-2022), and labeled by magnitude of pot sets.*

Figure A-10 displays AS midwater trawl effort represented by the number of observed trawl hours based on observer coverage rates. AS midwater trawl fishing effort distribution appears to stay relatively consistent across space given the effort is heavily concentrated in northern waters and fairly similar to SS (Figure A-10). The only major difference is that AS effort is concentrated even further north, with SS displaying some effort as far south around Cape Mendocino, and AS mainly occurring around and north of 42°N latitude (Figure A-9 and A-10). AS effort also occurs further inshore and only fished as far west as 127°W, whereas SS fished almost as far as 130°W*. AS effort in recent years does not appear to be as concentrated in the northern part of Washington around La Push as it was in previous years (Figure A-1).

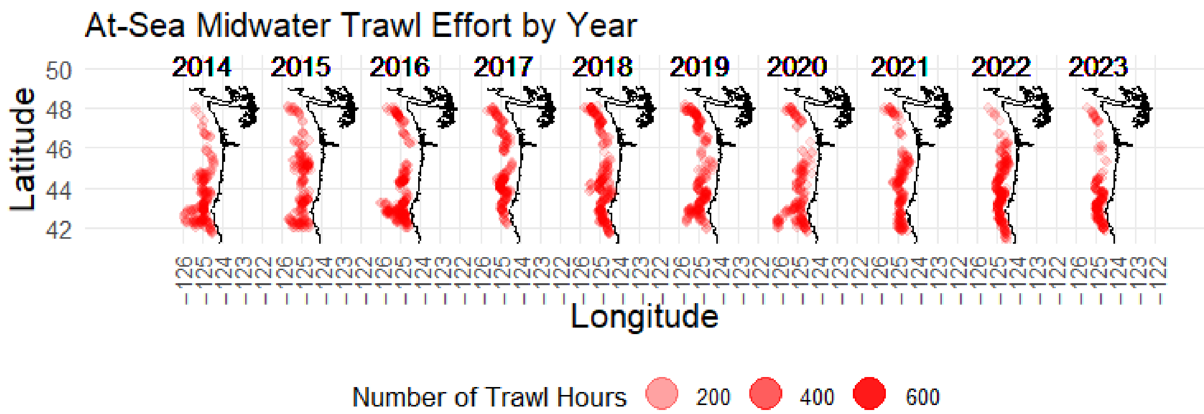


Figure A-10: At-sea trawl hours representing 100% of fishing effort based on observed WCGOP data, plotted by year (2014-2023), and labeled by magnitude of pot sets.*

SS midwater trawling in total has increased in the number of trawl hours throughout the time series (Table A-5). Both sectors, Hake and Rockfish, peak in trawl hours in 2022 (Table A-5). Total effort in hours has appeared to oscillate throughout time, but generally increased in recent years, particularly from 2019-2022, ultimately peaking in effort in 2020 (Table A-5, Figure A-11).

Table A-5: Observed SS midwater trawl hours for each sector per year derived from WCGOP observed midwater trawl hours There was no EM in 2015 and the data for 2023 was unavailable at the time of publication.

Year	Hake	Rockfish	Total
2014	4,733	268	5,001
2015	6,746	358	7,104
2016	5,275	239	5,514
2017	5,873	642	6,515
2018	6,054	1,137	7,191

2019	6,643	1,128	7,771
2020	8,623	8,82	9,504
2021	5,947	1,133	7,080
2022	7,297	1,311	8,608

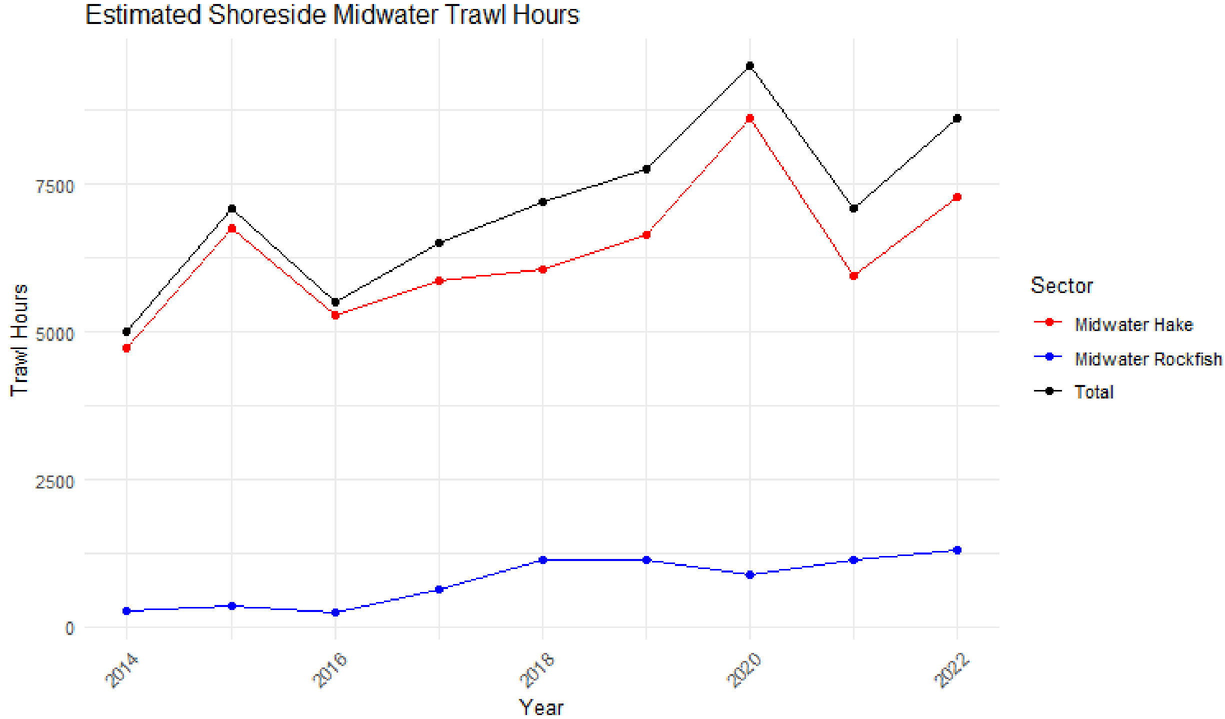


Figure A-11: Estimated shoreside midwater trawl hours by sector for the years 2014-2022. Lines are colored by sector and the black line represents the total sets summed for all sectors within SS.

AS midwater trawling in total fluctuates throughout the years in terms of total trawl hours (Table A-6), with 2022 displaying the highest effort of the decade across both sectors (Table A-6, Figure A-12). This varies slightly by individual sector with CP peaking in 2018 and MS peaking in 2022, displaying the oscillatory behavior of the total AS trawl hours throughout the time series (Table A-6).

Table A-6: Observed AS midwater trawl hours for each sector per year derived from WCGOP observed midwater trawl hours There was no EM in 2015 and the data for 2023 was unavailable at the time of publication.

Year	Catcher-Processor	Mothership	Total

2014	4,731	3,547	8,279
2015	5,691	2,135	7,826
2016	7,291	5,502	12,793
2017	5,716	3,661	9,376
2018	6,994	4,552	11,546
2019	6,221	3,748	9,969
2020	4,975	2,002	6,977
2021	4,891	2,636	7,528
2022	6,740	6,096	12,837
2023	5,088	2,977	8,065

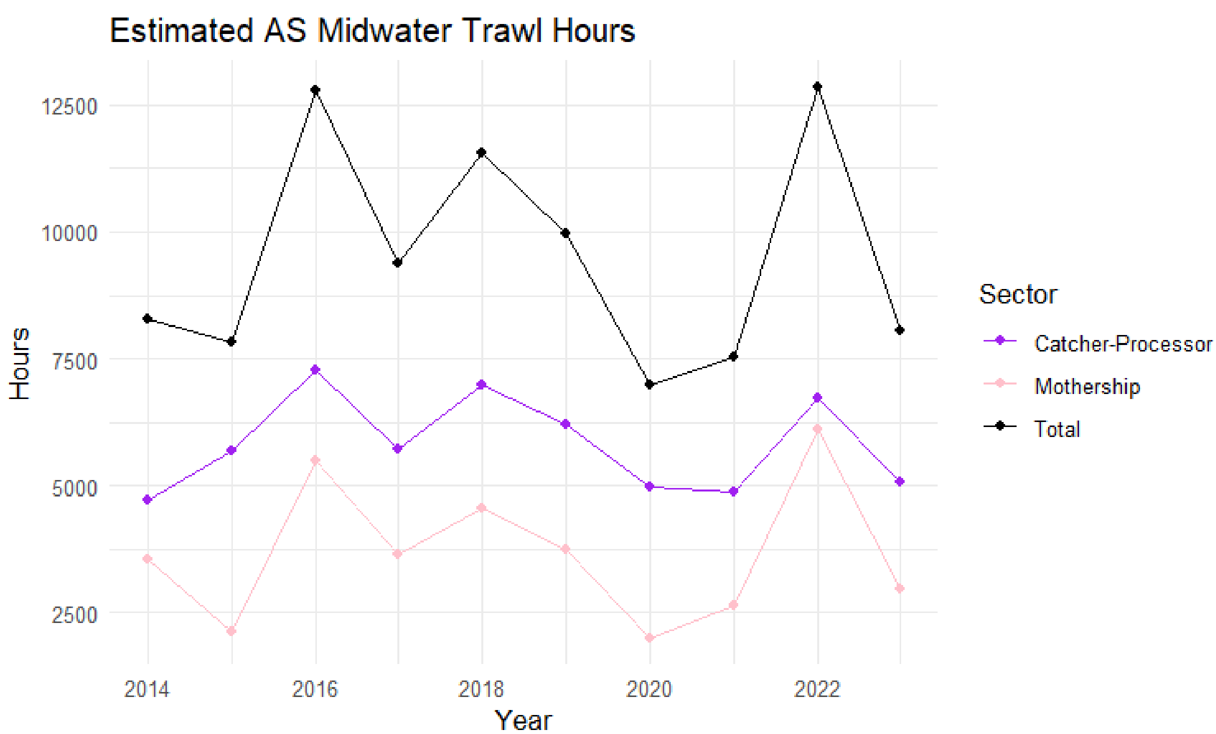


Figure A-12: Estimated AS midwater trawl hours by sector for the years 2014-2023. Lines are colored by sector and the black line represents the total sets summed for all sectors within AS.

SS trawling effort also displays a seasonal distribution with peak effort occurring from May-October (Figure A-13; Table A-7, Figure A-15). All sectors heavily overlap in their spatial distribution throughout the May-October season with most fishing remaining relatively the same spatially from month to month (Figure A-13).

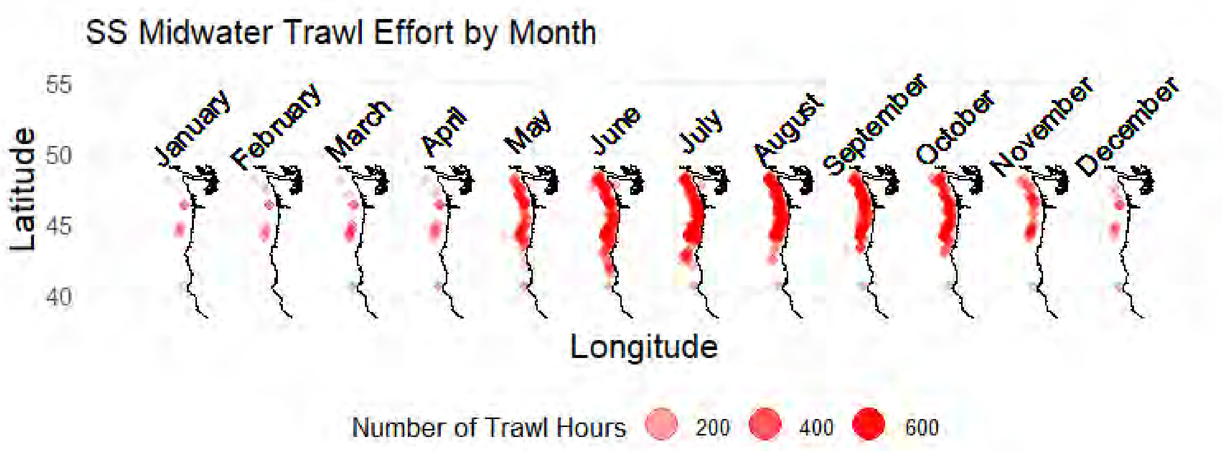


Figure A-13: Shoreside trawl hours from observed WCGOP data, plotted by month which includes data from all years, 2014-2023 (excluding 2023 EM), and labeled by magnitude of pot sets.*

Trawling effort displays a strong seasonal distribution with AS trawl effort only occurring from May-November, and no effort between December and April (Figure A-14). There also appears to be two peaks in effort, one in May and June and then again in October with July and August displaying decreased amounts of effort (Figure A-14, Figure A-16). The sub-sectors, CP and MS both follow these monthly trends.

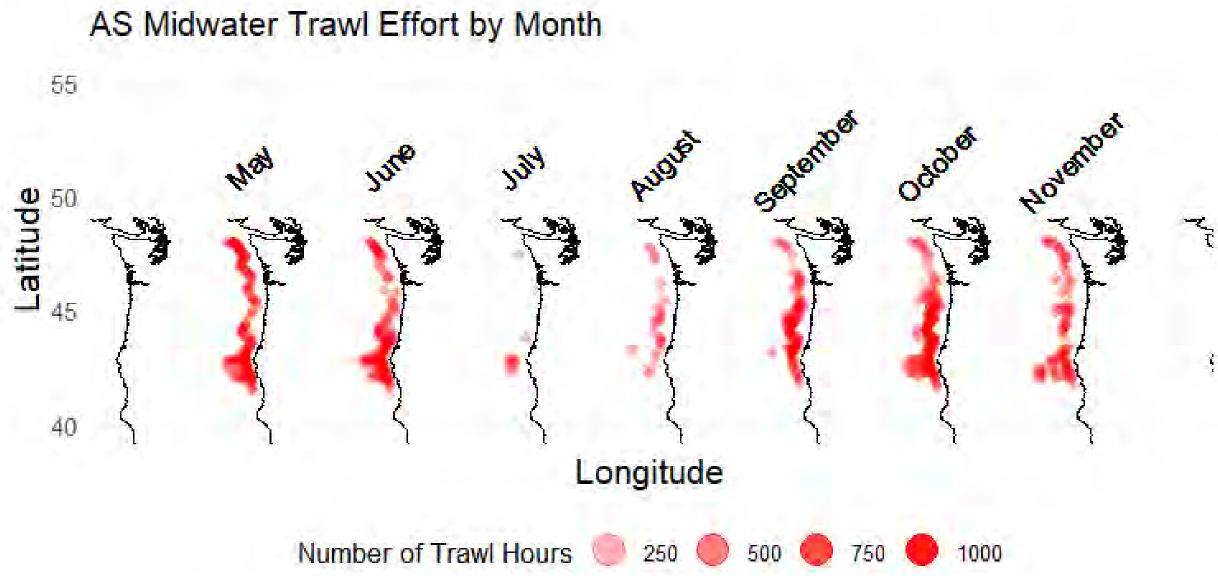


Figure A-14: At-sea trawl hours from observed WCGOP data, plotted by month for which there is fishing effort which includes data from all years, 2014-2023, and labeled by magnitude of pot sets.*

Peak effort occurs within various months for each sector. The Hake sector peaks in effort in August, and the Rockfish sector in November (Table A-7, Figure A-15). Overall, effort across sectors for the SS fishery peaks in July (Table A-7, Figure A-15).

Table A-7: Estimated number of shoreside midwater trawl hours for each sector per month for all years (2014-2023).

Month	Hake	Rockfish	Total
January	NA	333	333
February	NA	348	348
March	NA	727	727
April	NA	715	715
May	184	680	3,860
June	3,180	627	9,971
July	9,344	491	14,524

August	14,033	582	13,234
September	12,652	676	10,260
October	9,585	942	8,355
November	7,413	1,059	2,381
December	2	508	509

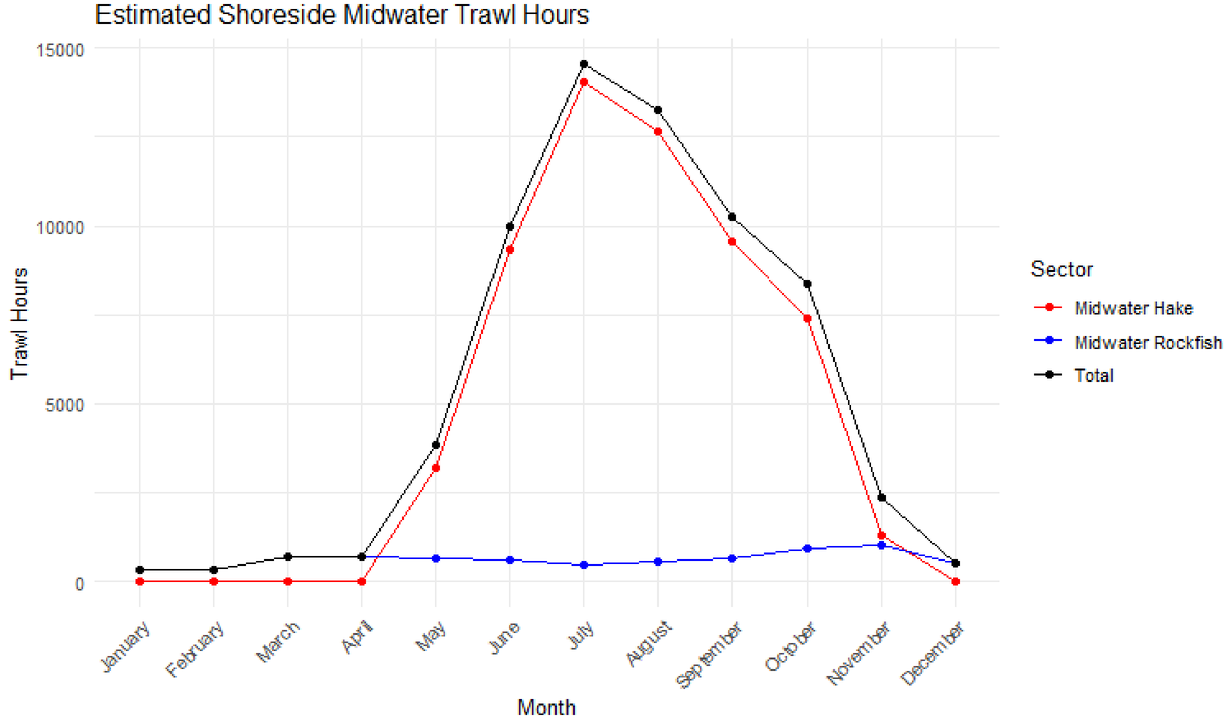


Figure A-15: Estimated shoreside trawl hours by sector and month for the years 2014-2023. Lines are colored by sector and the black line represents the total sets summed for all sectors.

Peak effort for the individual sectors of the AS fishery follow the same monthly trends. Both of their ultimate peaks in effort occur in October with the total effort peaking at 25,508 hours in October (Table A-8, Figure A-16).

Table A-8: Estimated number of at-sea midwater trawl hours for each sector per month for all years (2014-2023).

Month	Catcher-Processor	Mothership	Total
January	NA	NA	0
February	NA	NA	0
March	NA	NA	0

April	NA	NA	0
May	15,203	9,323	24,526
June	9,194	8,547	17,740
July	21	586	608
August	750	1,162	1,913
September	10,483	4,563	15,046
October	15,438	10,069	25,508
November	7,250	2,605	9,855
December	NA	NA	0

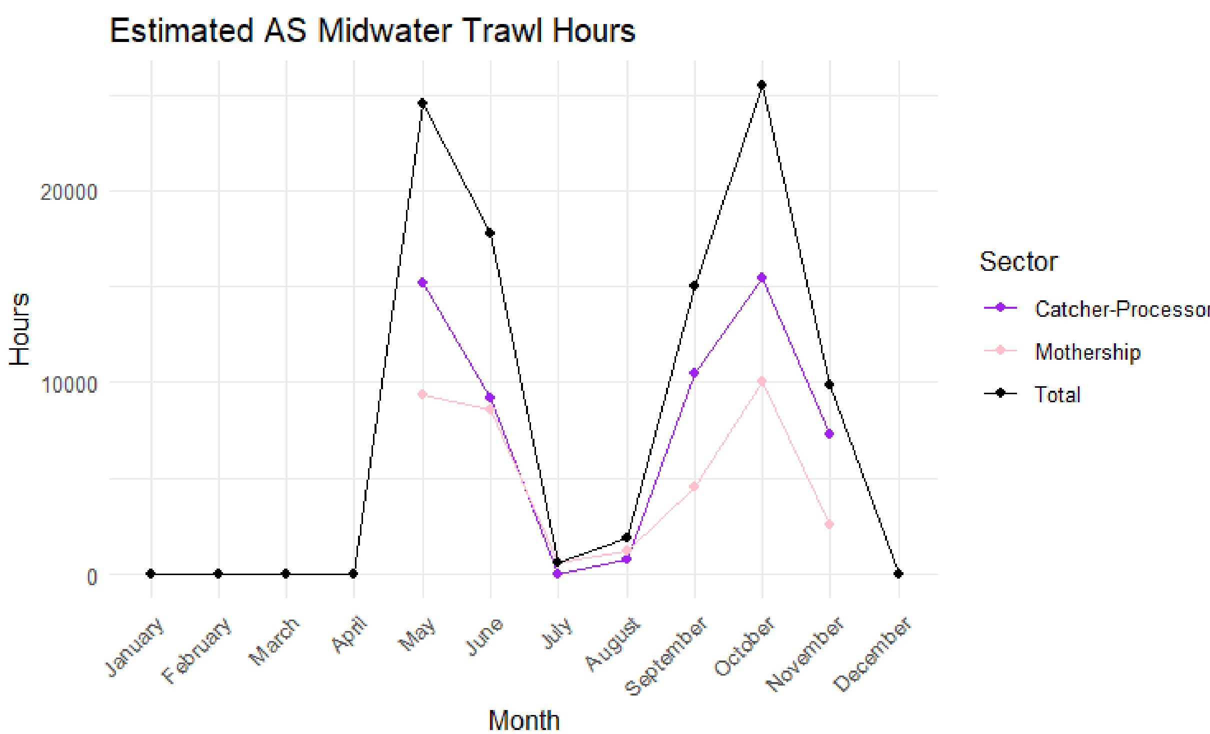


Figure A-16: Estimated AS trawl hours by sector and month for the years 2014-2023. Lines are colored by sector and the black line represents the total sets summed for all sectors.

Species Distribution Models

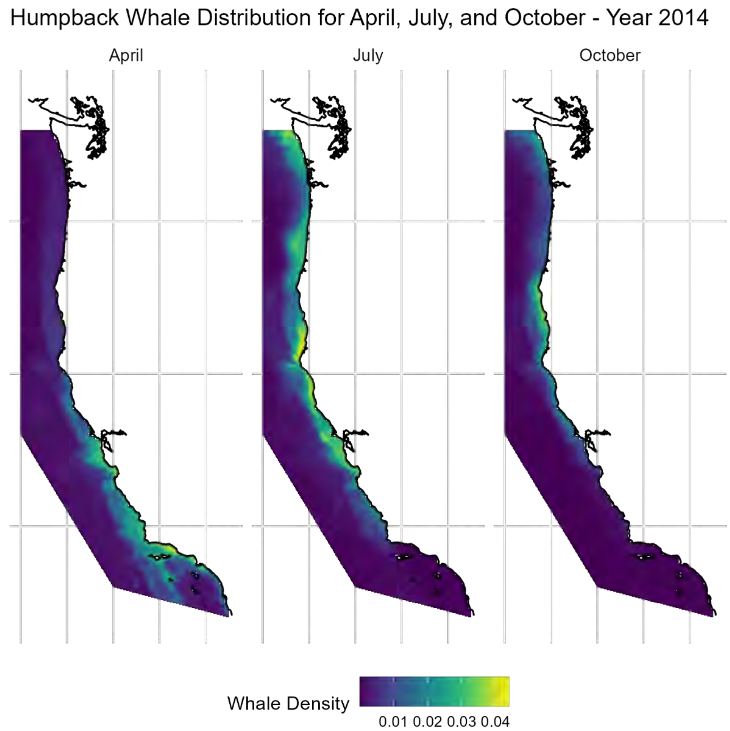
Similar to fishing effort, we wanted to establish a baseline of how predicted leatherback habitat suitability and humpback whale density has changed over space and time during the last decade, which will later provide evidence for the co-occurrence analysis as to how species distribution dynamics are contributing to overlap and entanglement risk.

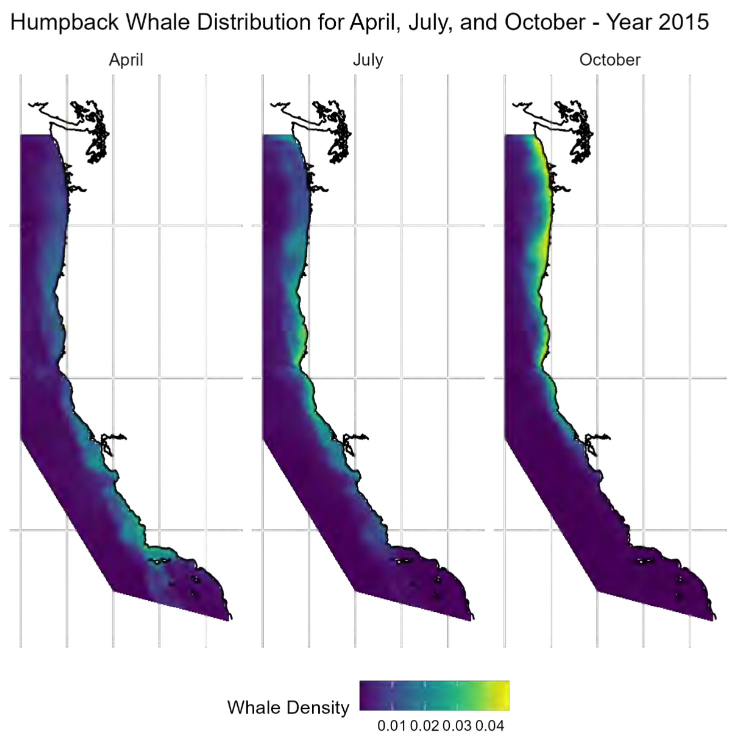
Humpback Whales

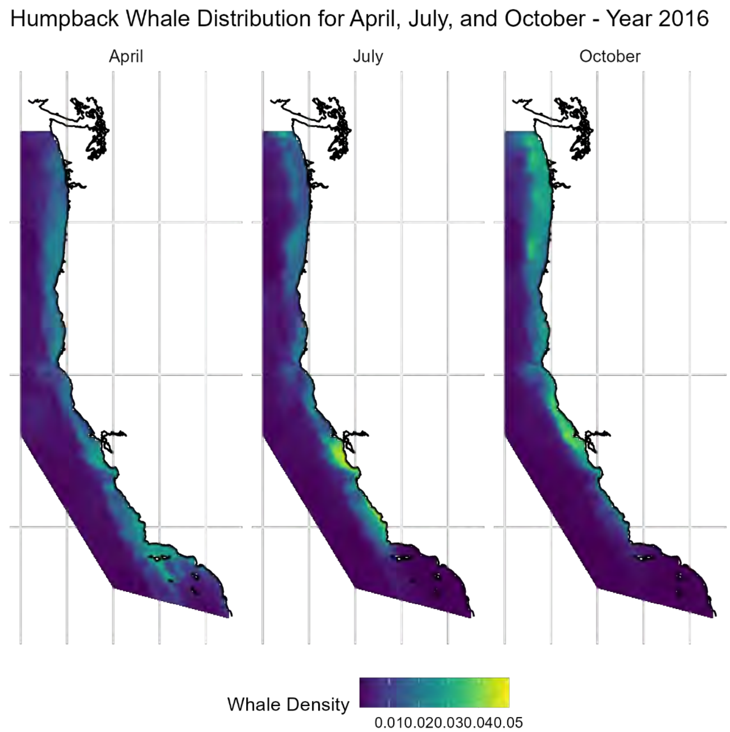
Humpback whales are generally understood to reside in larger numbers in the CCE for eight out of twelve months of the year, which coincides with April-December (Caretta et al. 2023), although we acknowledge that some individual whales can be found off the U.S. West Coast year-round. The figures below help to depict the general migration pattern through predicted humpback whale density in April (beginning of migration back to the CCE), July (middle of migration), and October (beginning of migration south to breeding grounds). This illustrates how concentrations of humpback whales along the U.S. West Coast generally migrate along the coast throughout the year. The main hot spots for whales during peak densities occur off northern California, specifically around Cape Mendocino, but can be found all the way through the Monterey Bay area, along the Oregon coast, and La Push in Washington (Figure A-17). These hot spots can vary throughout the year. For example, hot spots in central California such as Monterey Bay and the San Francisco Bay are at their “hottest” in the middle of summer around June-August (Figure A-18). Then hot spots along the coast of Oregon and Cape Elizabeth occur afterwards around October (Figure A-18).

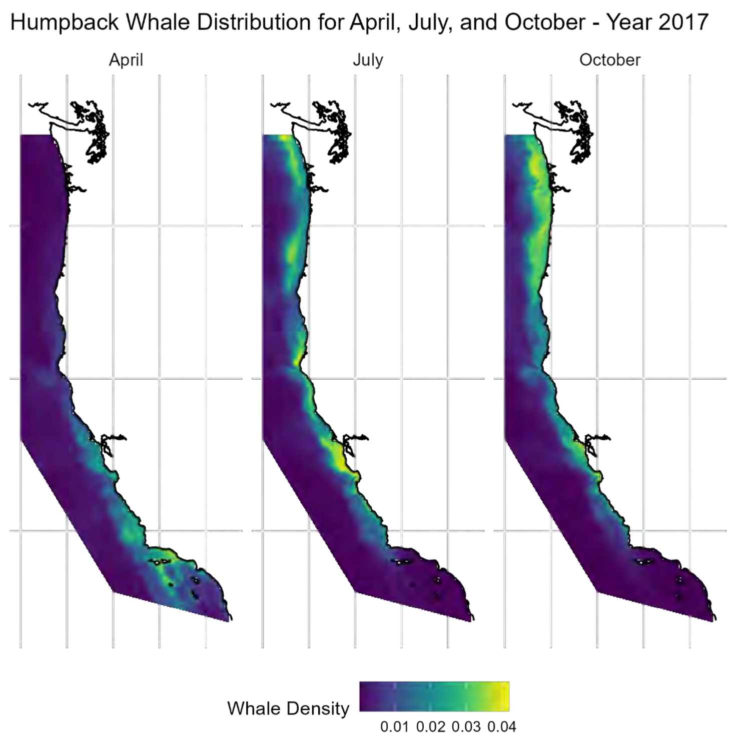
There has been a large amount of variability year-to-year, either in terms of when peak humpback density is predicted to occur within the EEZ, or where along the coast the whales are predicted to specifically aggregate in larger densities (Figure A-17). For example, during the marine heat wave from 2014-2018, whales appeared earlier in larger densities in comparison to other years outside of the marine heat wave period (Figure A-17). During these same years, the San Francisco Bay Area through Monterey Bay were predicted to be dense hotspots for humpback whale aggregation (Figure A-17). In the most recent years (2019-2023), whale density predictions suggest a later migration into the CCE during the year, were more distributed further offshore in July, and then become more aggregated closer to the coastline later in October (Figure A-17). Beyond those trends, the density distributions and apparent hotspots do appear to fluctuate along the coast every year.

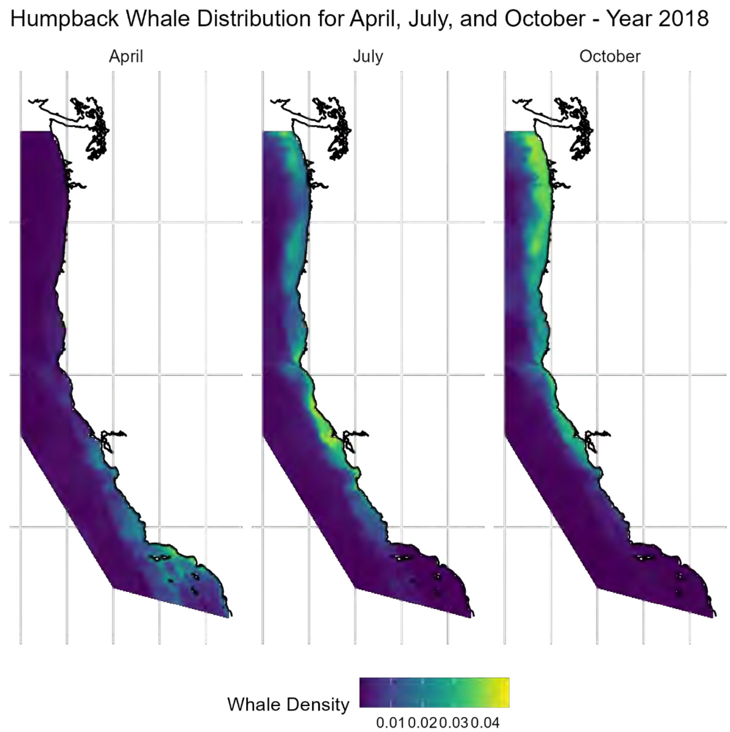
Density in April was predicted to be fairly consistent across years, except during the most recent years (2021-2023) when there appears to be fewer whales predicted to be present at this time (Figure A-17). Whales in April and earlier months are generally confined in distribution further south, in and around southern California (Figure A-18). Density distribution in July appears to have been variable from year to year, with some years having larger distributions further north at this time (2014, 2017, 2018, 2020, 2021, and 2022), and other years with predictions of not having many whales further north (2015, 2016, 2019, and 2023) at this time (Figure A-17). In July, there is almost always a dense aggregation predicted in either Monterey Bay, Cape Mendocino, or both (Figure A-17). However, how far north whales distribute and how early/late can vary year-to-year. For example, whales can be found in high densities in Washington waters in 2014, 2017, 2018, and 2020, but are virtually missing in 2015, 2016, and 2019 (Figure A-17). In October, humpbacks are predicted to aggregate closer to shore, specifically in Oregon and Washington waters (Figure A-18). In October, there are predictions for fewer whales in central and southern California with increased presence in Oregon and Washington waters (Figure A-18). October appears to be quite variable year to year with varying estimates for both distribution and abundance of humpbacks, for example densities in 2019 were quite minimal while in 2017 and 2022 there are much higher densities of whales (Figure A-17).

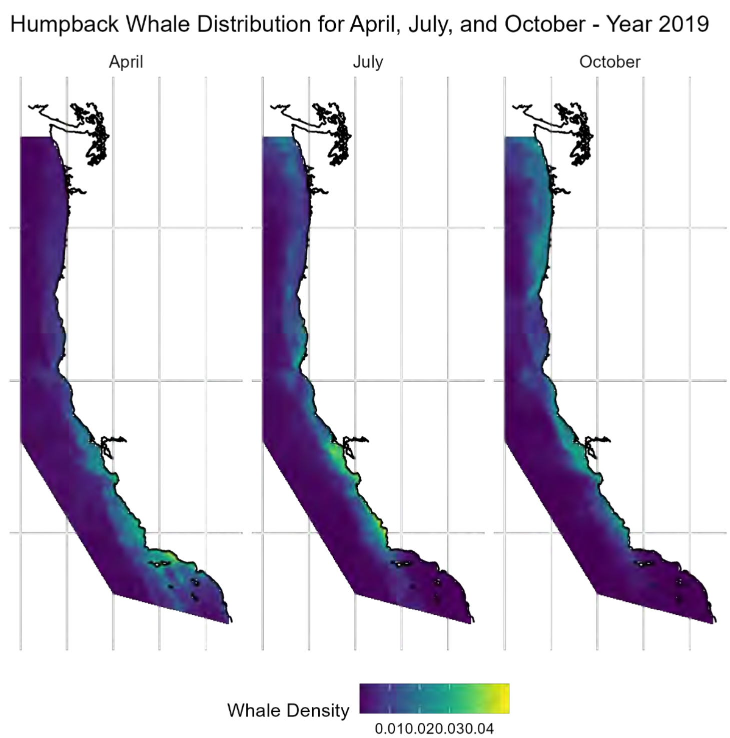




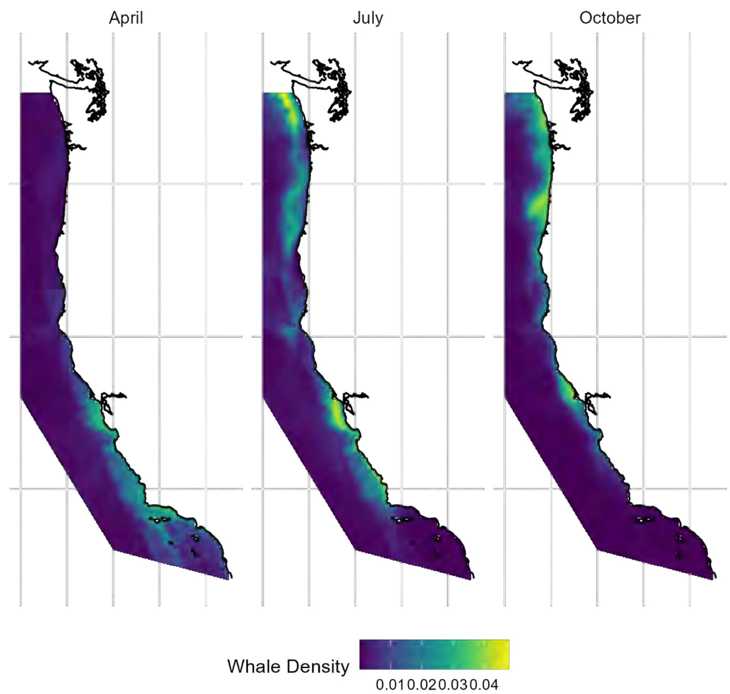

Humpback Whale Distribution for April, July, and October - Year 2016
April
July
October
Whale Density
0.010.020.030.040.05


Humpback Whale Distribution for April, July, and October - Year 2017
April
July
October
Whale Density
0.01 0.02 0.03 0.04

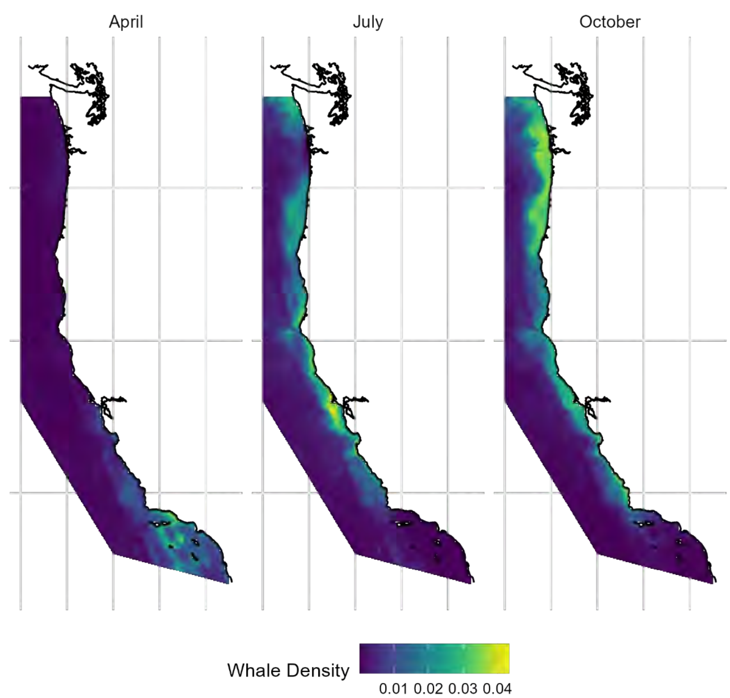

Humpback Whale Distribution for April, July, and October - Year 2018
April
July
October
Whale Density
0.01 0.02 0.03 0.04

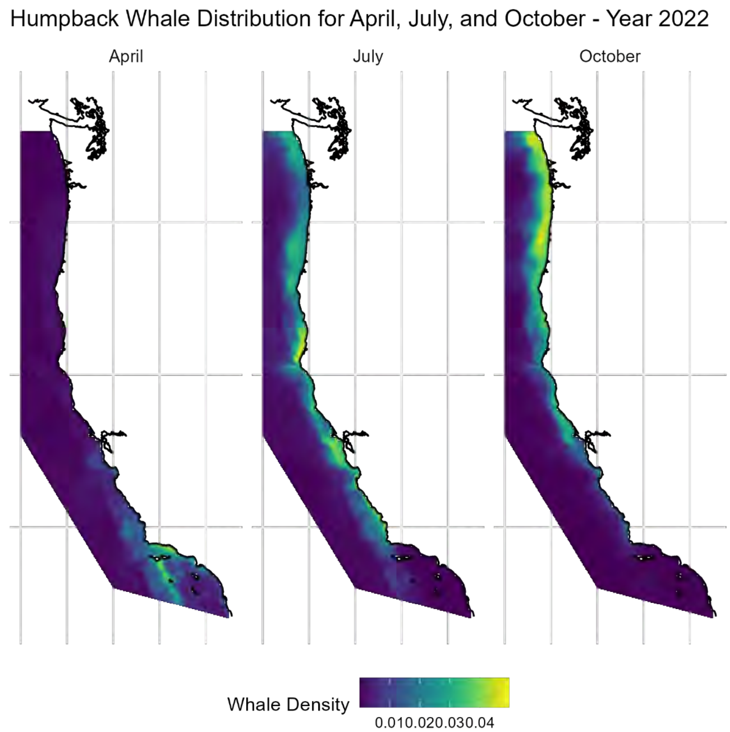

Humpback Whale Distribution for April, July, and October - Year 2019
April
July
October
Whale Density
0.01 0.02 0.03 0.04

Humpback Whale Distribution for April, July, and October - Year 2020



Humpback Whale Distribution for April, July, and October - Year 2021





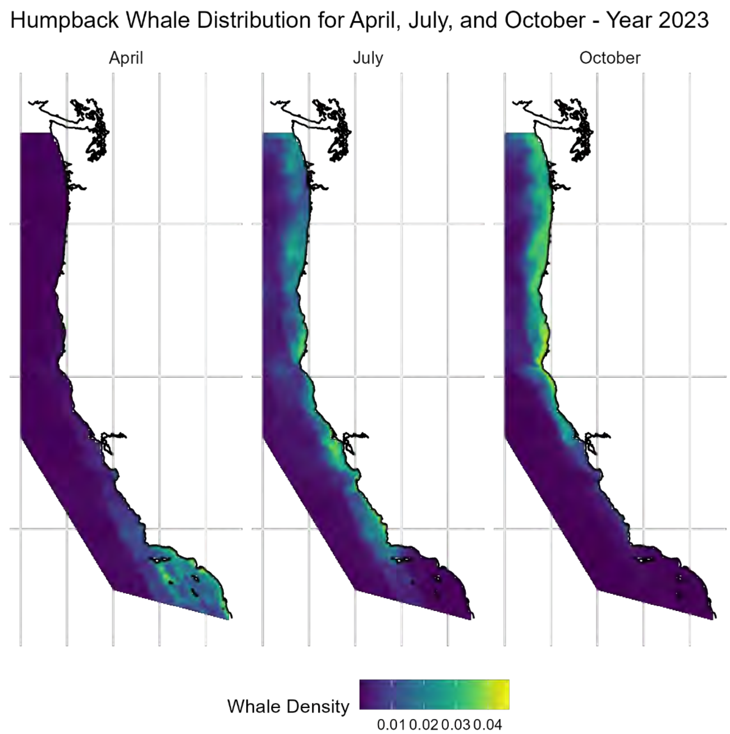


Figure A-17: Average humpback whale density (whales/km2) in the months of April, July, and October for each individual year (2014-2023).

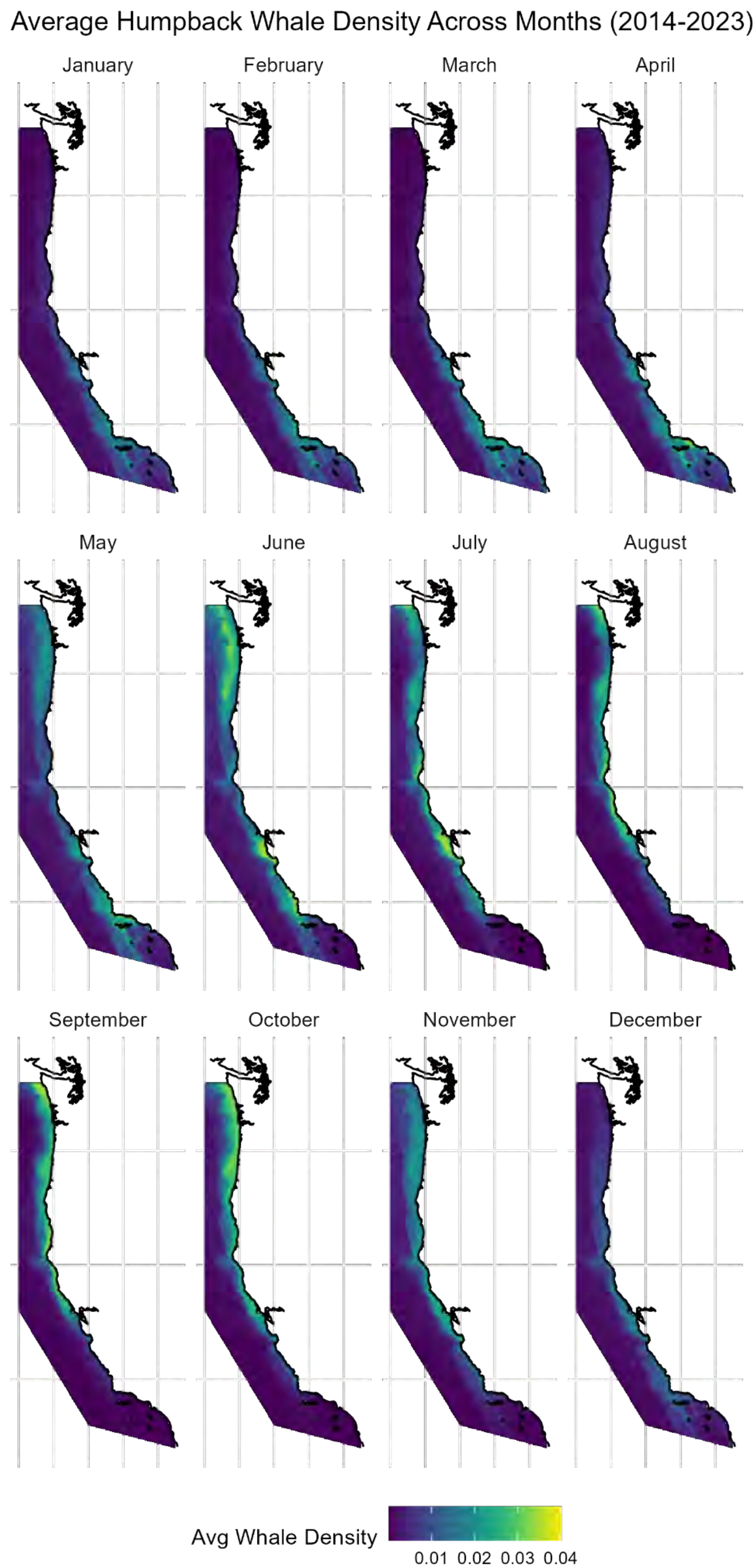
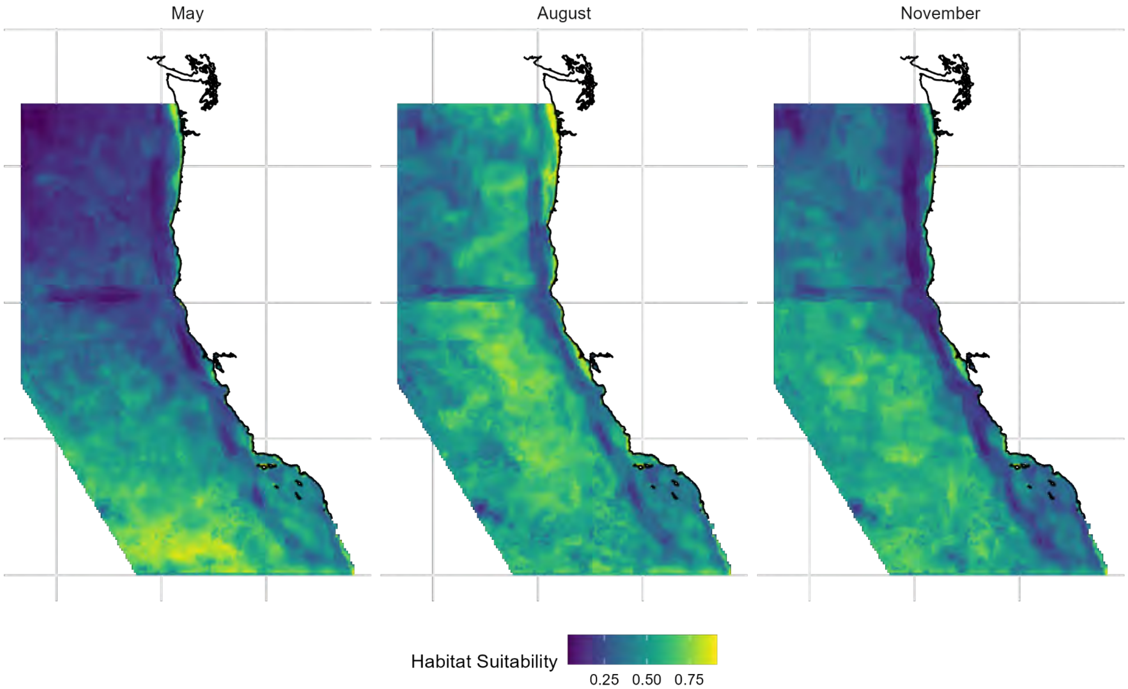


Figure A-18: Average humpback whale density (whales/km2) as an average of density values for months across all years (2014-2023).

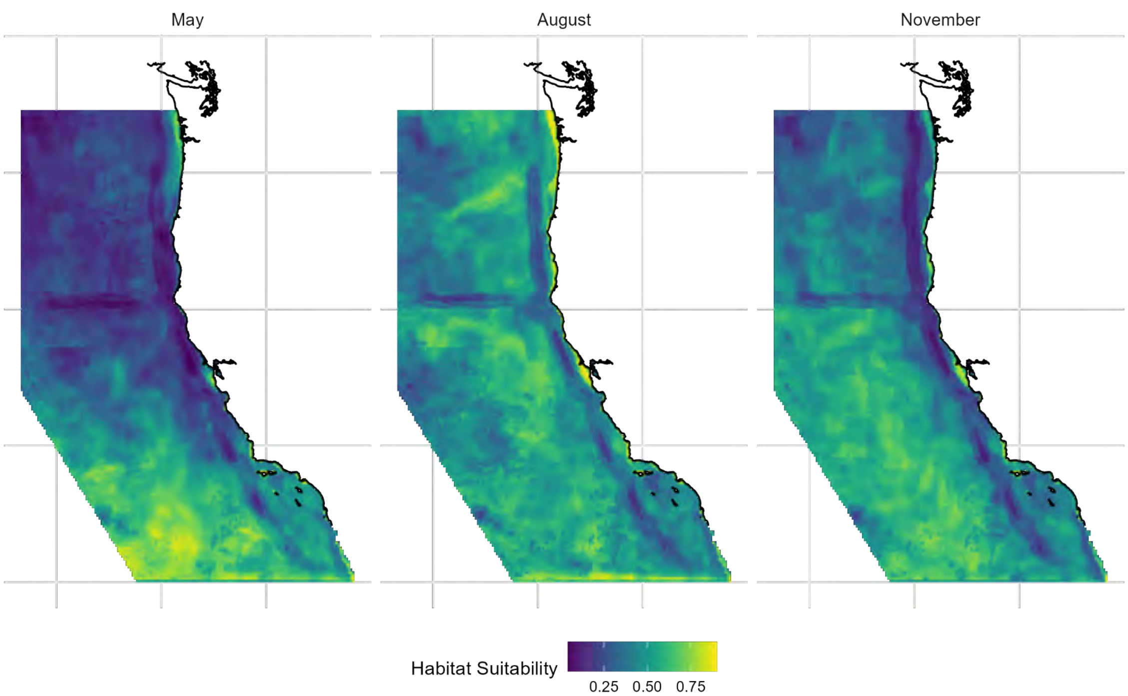
Leatherback Sea Turtles

Leatherbacks are similar to humpbacks as they are both highly migratory species and only reside within the CCE for a proportion of the year to forage, before returning to their breeding/wintering grounds. The figures below help to illustrate how the annual migration to and from the CCE is reflected by the predictions for habitat suitability in May (beginning of migration back to the CCE), August (middle of migration), and November (beginning of migration southeast to breeding/wintering grounds). Generally, predictions for suitable leatherback habitat are most favorable throughout the CCE during the summer and fall months, and least favorable in the winter and early spring (Figure A-20). Peak habitat suitability along the entire coast is predicted to occur in the late summer months of July, August, and into September (Figure A-20). This reflects and illustrates our general understanding of how leatherback turtles inhabit the CCE throughout the year to forage. There does not appear to be much annual variability in the general pattern of leatherback habitat suitability, as it follows relatively consistent trends in seasonal and temporal distribution (Figure A-19). The main hot spots for suitable habitat for leatherbacks turtles during peak densities occur off central California, specifically around Monterey Bay and San Francisco Bay, and along the northern Oregon coast especially around the Columbia River mouth, which suggests these regions are potential hotspots for entanglement risk, especially as they are areas with relatively high levels of fishing effort (Figure A-19 and A-20). In May, suitable leatherback habitat remains mostly offshore and within latitudes of central and southern California, although the predictions for habitat suitability in offshore areas is generally less than the habitat suitability predicted for the coastal hotspots later in the year (Figure A-20). May can vary year to year in how far north there is habitat suitability (Figure A-19). For example, in the years 2016 and 2020 there is higher suitability further forth and in 2021 and 2022 there is minimal suitability further north in the CCE (Figure A-19). In August, suitable habitat expands to the entirety of the West Coast, both nearshore and offshore, and becomes more coastally associated in denser aggregations in central California and Oregon (Figure A-20). August also displays the least variability of all the months represented in Figure A-19 on a year-to-year basis and displays high variability throughout the EEZ every year. By November, there is still a fair amount of suitable leatherback habitat, but this marks the beginning of migrations and we see that suitability begins to move again more offshore, resembling that of May habitat suitability (Figure A-20). Interannual variability in November is represented by the amount of suitable habitat along Oregon and Washington which differs year to year likely due to the slightly different timings of annual migrations (Figure A-19). Peak habitat suitability predicted in August doesn’t appear to vary much year-to-year (Figure A-19). During the heatwave years (2014-2018), habitat suitability predictions appear to be expanded further along the coast earlier, in April, and expand further north than in recent years (Figure A-19).

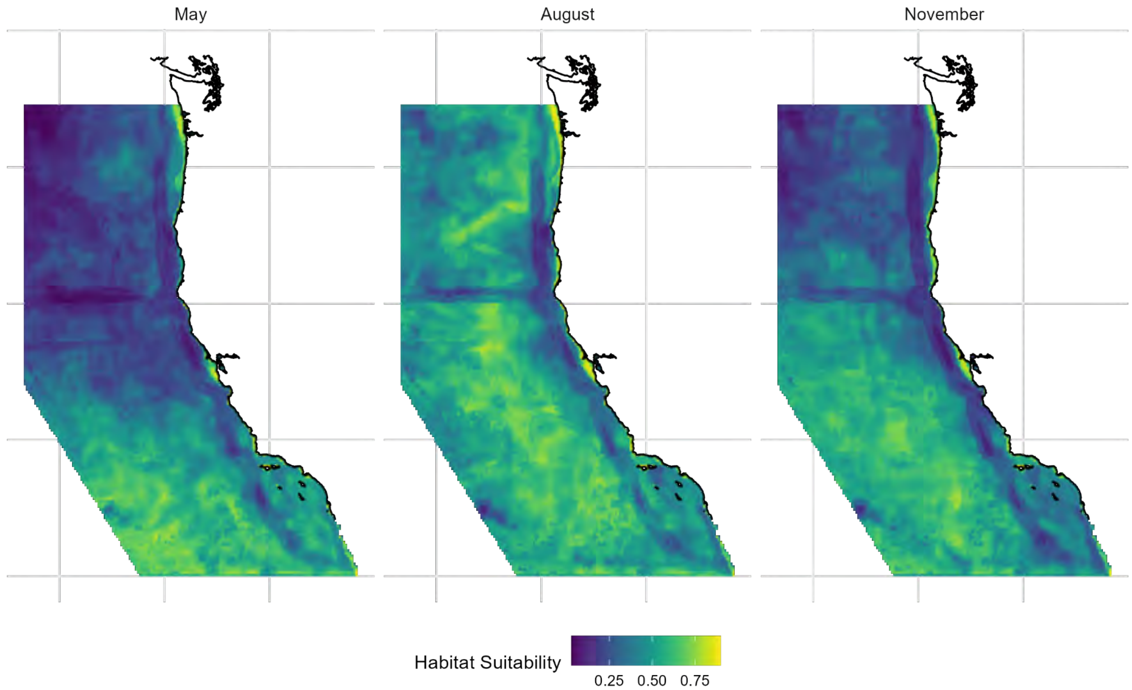
Leatherback Sea Turtle Habitat Suitability for May, August, and November - Year 2014



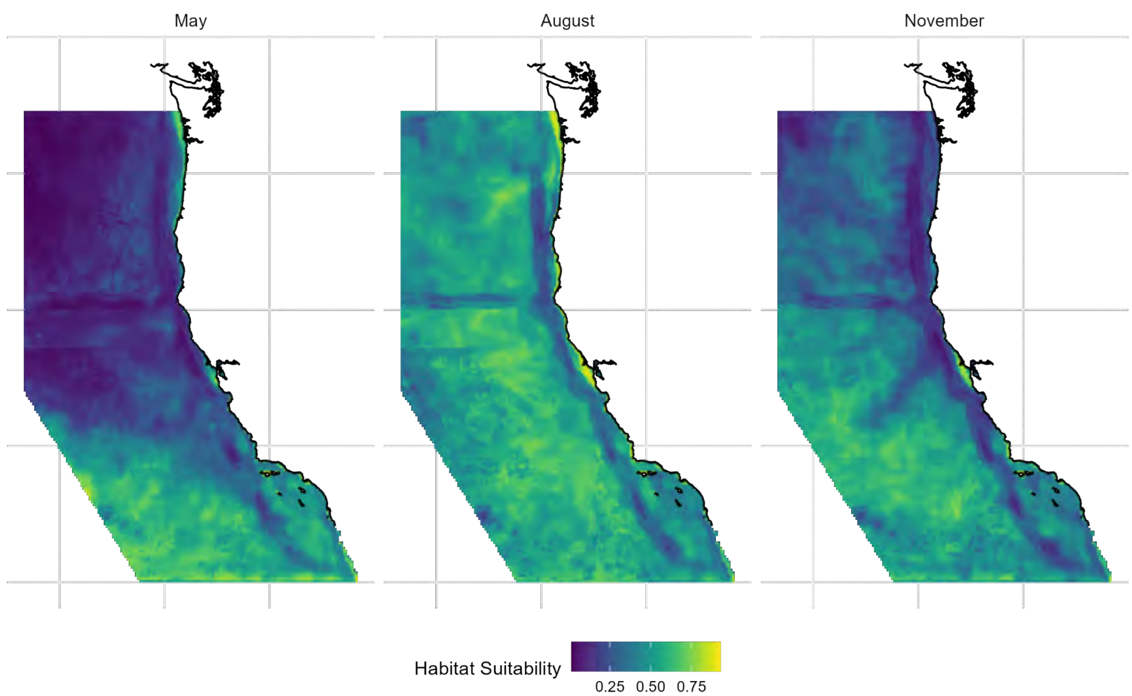
Leatherback Sea Turtle Habitat Suitability for May, August, and November - Year 2015

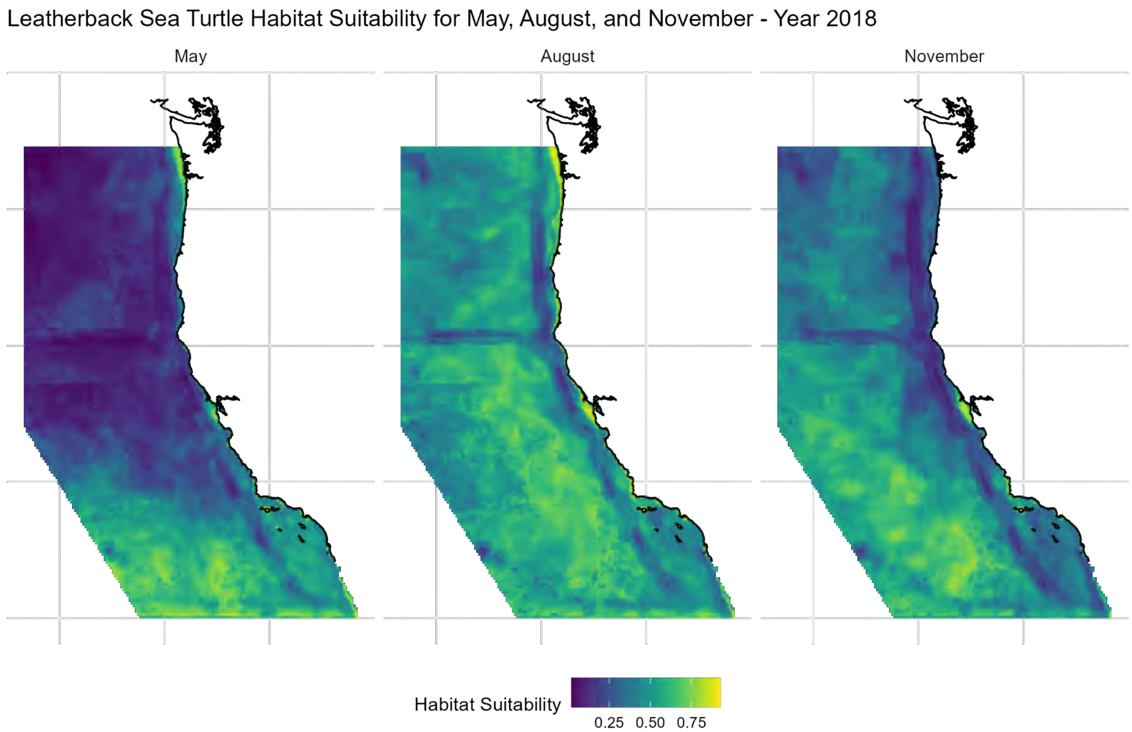


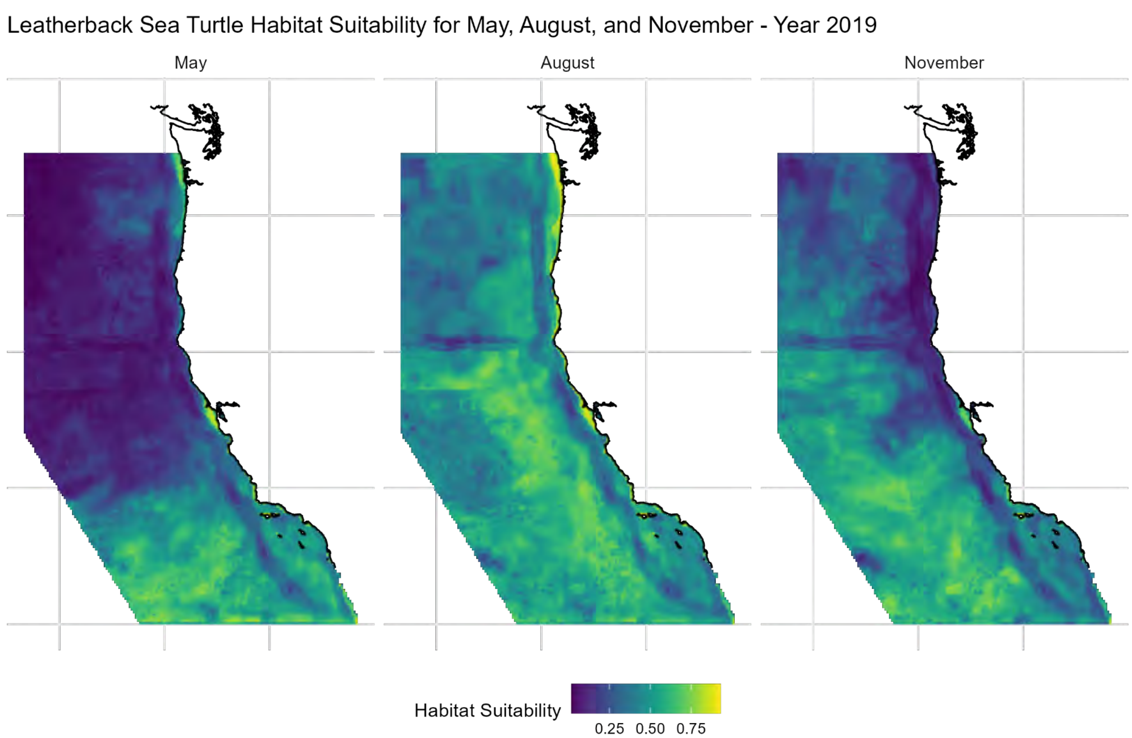
Leatherback Sea Turtle Habitat Suitability for May, August, and November - Year 2016



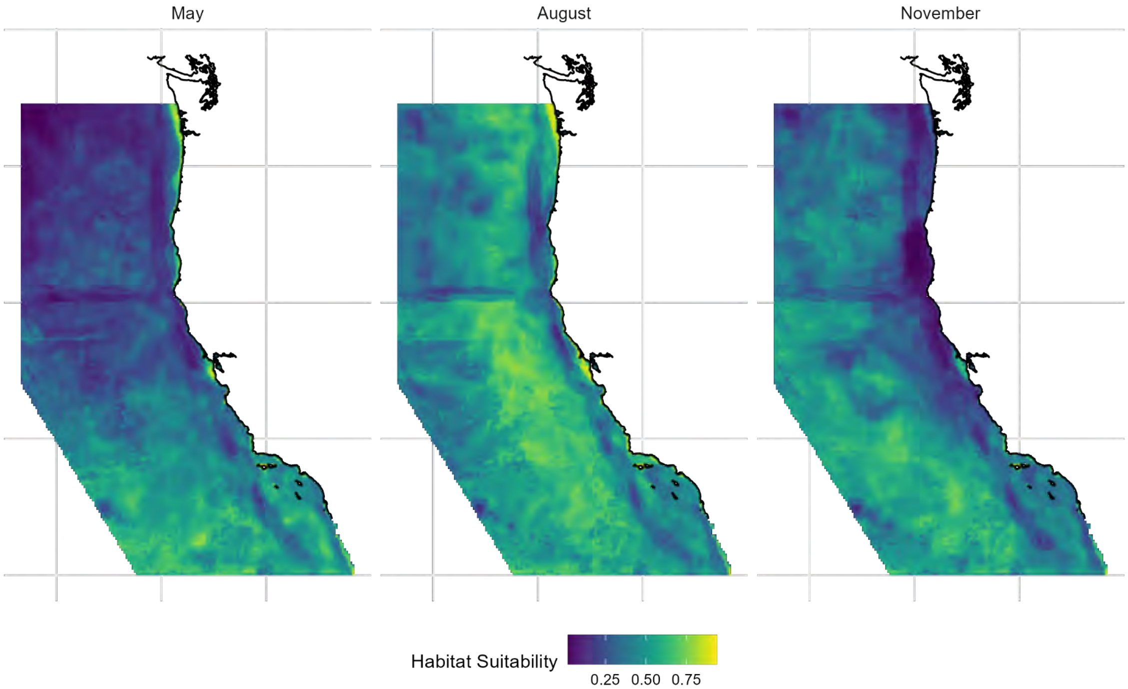
Leatherback Sea Turtle Habitat Suitability for May, August, and November - Year 2017



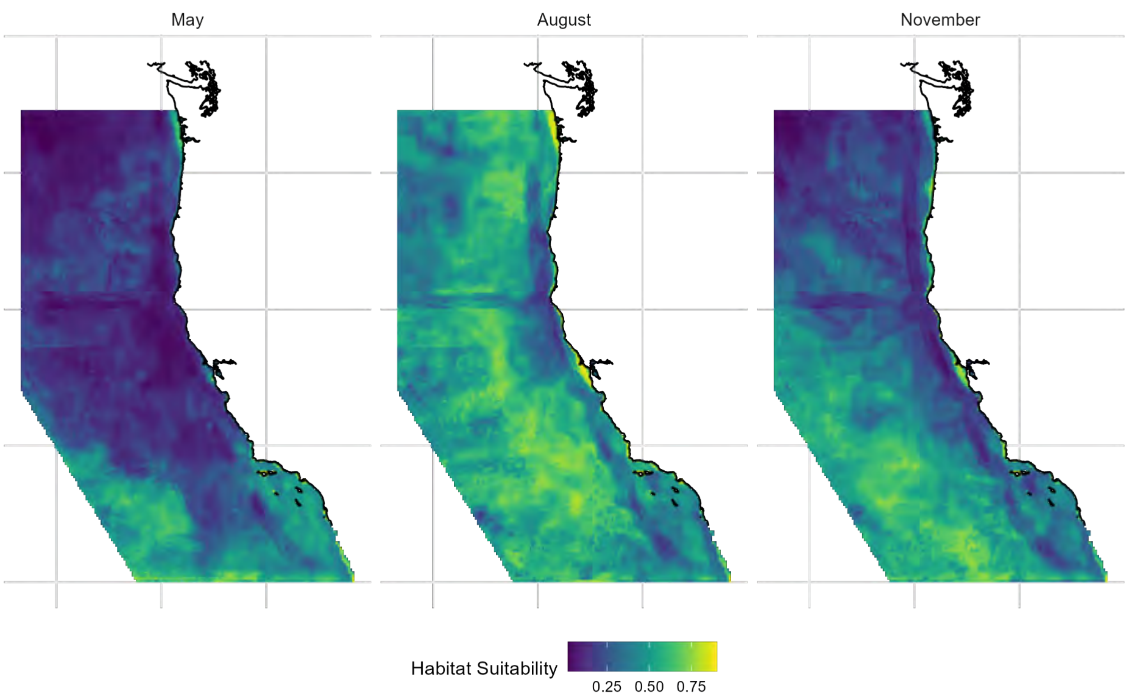

Leatherback Sea Turtle Habitat Suitability for May, August, and November - Year 2018
May
August
November
Habitat Suitability
0.25
0.50
0.75


Leatherback Sea Turtle Habitat Suitability for May, August, and November - Year 2019
May
August
November
Habitat Suitability
0.25
0.50
0.75

Leatherback Sea Turtle Habitat Suitability for May, August, and November - Year 2020



Leatherback Sea Turtle Habitat Suitability for May, August, and November - Year 2021



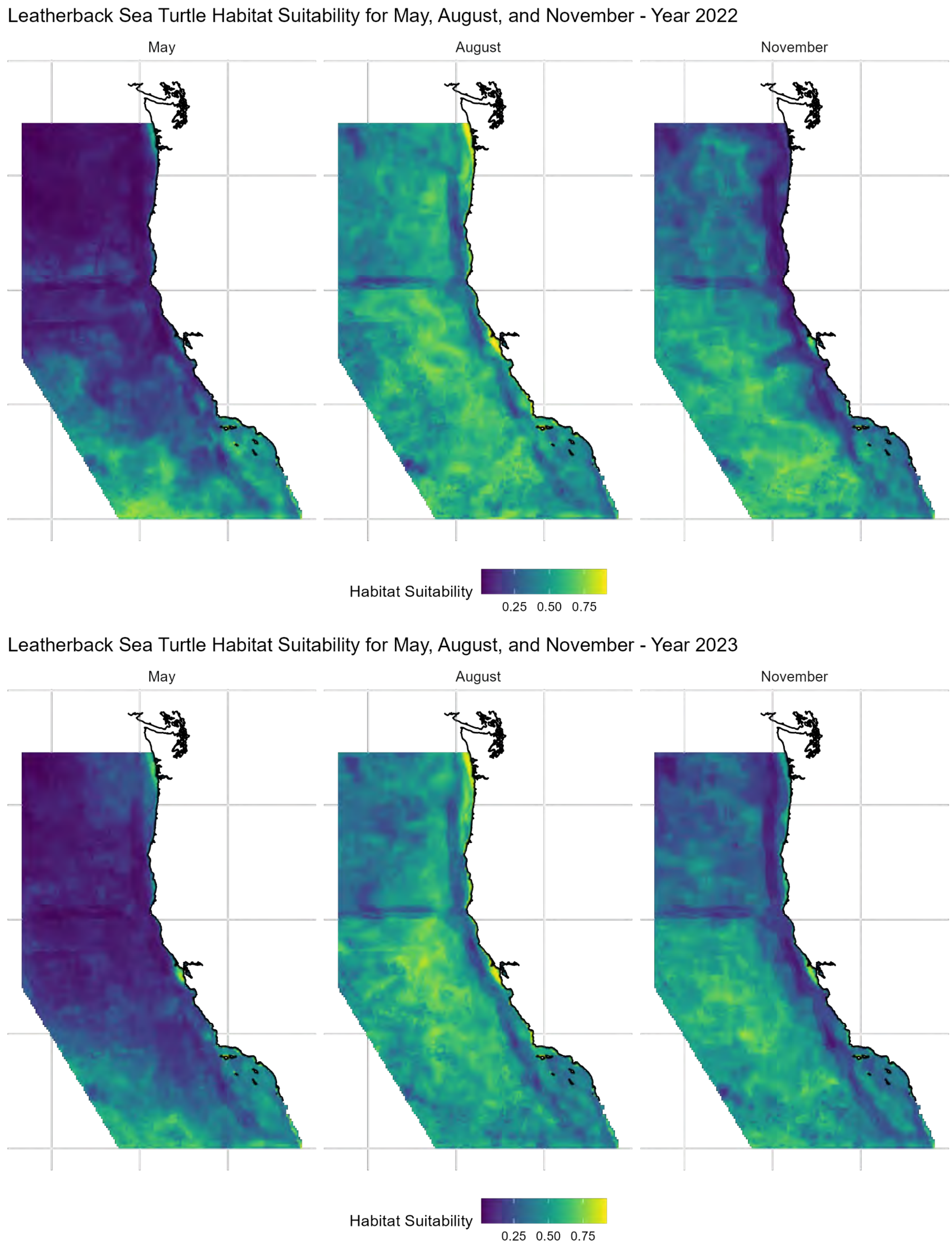


Figure A-19: Average leatherback habitat suitability (0-1) in the months of May, August, and November for each individual year (2014-2023).

Predictions for highly suitable leatherback sea turtle habitat (suitable habitat ≥ 0.75) are mostly absent from the CCE from January-April, with peak suitability occurring from June-October and still remaining elevated in November and December (Figure A-20). Large areas near coastal central California and slightly offshore of the Oregon and Washington coasts contain the highest habitat suitability for leatherbacks along the U.S. West Coast (Figure A-20). Given we know leatherbacks are common to occur off of Oregon and central California, this model captures that well, showing peak predicted habitat suitability in these areas from June-October (Figure A-20).

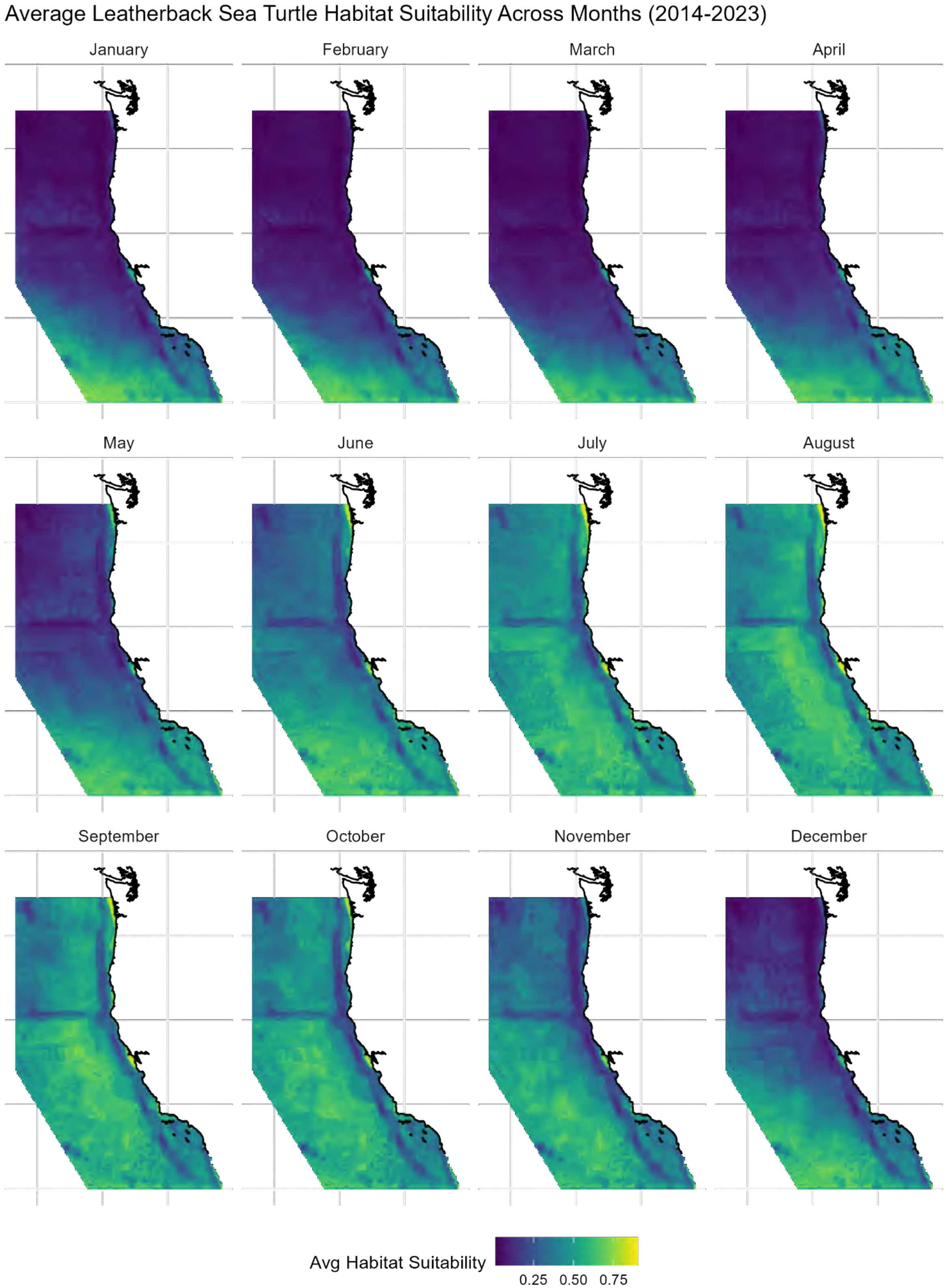


Figure A-20: Average predicted leatherback sea turtle habitat suitability, as an average of suitability values for each month across all years (2014-2023).

Humpback Whale Co-Occurrence

Pot Fisheries

We wanted to understand the spatial distribution of co-occurrence between humpback whales and the PCGF over the last decade, and how it has changed throughout the year, amongst years, and between sectors, to help identify where the dynamics of entanglement risk may be heading in the future. A vast majority of sablefish pot fishing occurs in the months from August-November (Figure A-4), and humpbacks are still present in large aggregations, specifically near the coast, during these months (Figure A-18). Figure A-21 displays the overlap calculated from 2014-2023, including all PCGF sablefish pot fisheries, with overlap categorized by the magnitude of value. Areas of dense overlap include the San Francisco Bay, Monterey Bay and Big Sur, south of Cape Mendocino, along the Oregon coast, and around the Columbia River mouth (Figure A-21). Despite these hotspots, recent overlap occurs primarily along the entirety of Oregon and Washington coastlines, with smaller aggregations closer to shore along the California coast (Figure A-21).

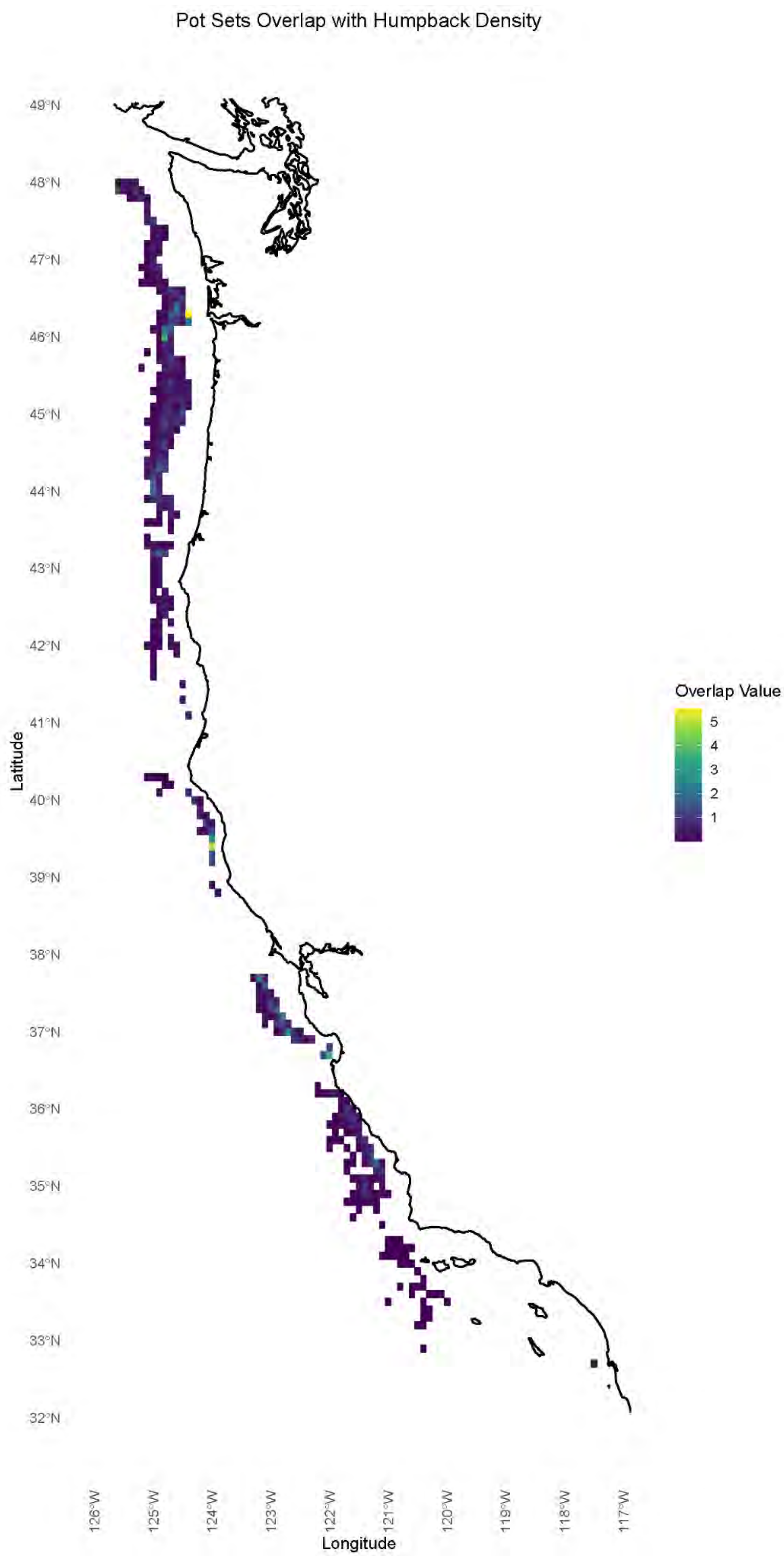

Pot Sets Overlap with Humpback Density
49°N
48°N
47°N
46°N
45°N
44°N
43°N
42°N
41°N
40°N
39°N
38°N
37°N
36°N
35°N
34°N
33°N
32°N
Latitude
126°W
125°W
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
Longitude
Overlap Value
5
4
3
2
1

Figure A-21: The product of the estimated number of pot sets overlapped with humpback whale density. Overlap is colored by magnitude of overlap and is a unitless metric.*

The months with the highest overlap across sectors are October and September (Table A-9) which correspond with the same months of peak pot fishing effort (Table A-2). The two months with the lowest summed overlap are January and March (Table A-9). These are months when most humpbacks are absent from West Coast waters, and have migrated to their winter breeding grounds (Figure A-18), and with very minimal pot fishing effort (Table A-2). Seasonally, 86.9% of all overlap occurs during the whale season (April-November).

Sectors also show variable overlap throughout the year (Table A-9, Figure A-22). The CS sector had the highest overlap in October, LE in October, and OA in June, which is several months before the CS and LE sectors peak and prior to peak humpback whale density in the CCE (Table A-9, Figure A-22). This suggests earlier OA effort may drive entanglement risks in that sector. Overlap was the most prevalent during the latter half of the year, July-December especially along the Oregon coast*. Some hotspots for overlap earlier in the year appear to have occurred off of Cape Mendocino in April and May and Cape Elizabeth and central and southern California from January-March*. LE overlap was concentrated in the Cape Elizabeth and Cape Mendocino areas and CS overlap was concentrated in central and southern California areas*. Generally, Washington overlap appeared to have occurred in the second half of the year, with the most having occurred in August-October*.

Table A-9: Overlap separated by month and sector for all sablefish pot overlap with the humpback whale density model. These are the sums of overlap within each unique month and sector for all years, 2014-2023.

Month	LE	OA	CS	Total
January	NA	0.38	0.59	0.97
February	NA	1.96	1.1	3.06
March	NA	0.75	1.43	2.18
April	1.3	1.88	2.47	5.65
May	7.85	2.55	6.26	16.66
June	3.42	13.73	8.58	25.73
July	5.02	1.85	7.61	14.48
August	2.75	9.68	6.09	18.52
September	14.15	5.23	8.28	27.66

October	15.79	4.54	12.53	32.86
November	0.76	4.73	7.95	13.44
December	0.04	0.52	1.6	2.12

The CS sector contains minimal overlap throughout the months, with a distinct increase in the fall specifically from June through November (Figure A-22). OA overlap oscillates throughout the season (Figure A-22). Peak overlap across all sectors occurs from June-October, coinciding with our general expectations with the highest levels of humpback whale presence on the West Coast (Figure A-22).

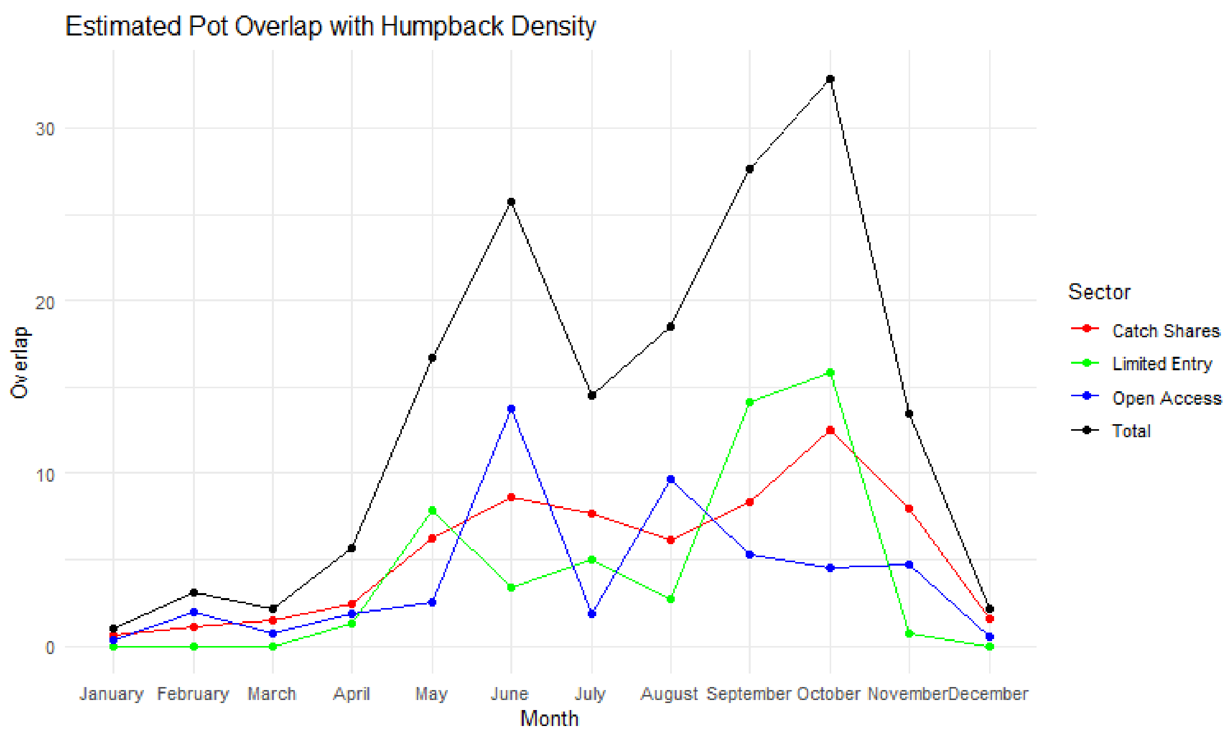


Figure A-22: Estimates of pot set overlap with the humpback whale density distribution model. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each month for all years 2014-2023.

Both PCGF effort and the predicted density of humpbacks elevate during the same times of the year in the CCE, making it difficult to discern which of the two factors is more influential on driving co-occurrence. Predicted whale density from August to November coincide with elevated fishing effort in the areas surrounding Cape Mendocino, California and Cape Blanco, Oregon, suggesting these areas have been hot spots for potential entanglement risk. Generally speaking, the elevated entanglement risk to humpbacks resulting from predicted co-occurrence predominantly in summer and fall coincides with the previous entanglement history where humpbacks tend to be entangled in larger frequencies in the summer and fall compared to the winter and spring. During the non-peak sablefish pot fishing season (December-April), the remaining pot effort is concentrated in Oregon and Washington waters and the presence of humpback whales off the U.S. West Coast during this time is fairly minimal. (Figure A-3 and A-18).

We also looked at the interannual variability of overlap over the last decade, to help understand how risk may change in the future. Over time, we see overlap risk has shifted northwards, with minimal overlap occurring in southern California waters in recent years, compared to the waters off of Oregon and Washington*. This is likely due to impacts of oceanographic dynamics that are altering species habitats and pushing them northwards due to increases in temperatures, decreased oxygen, lower productivity, etc., and fishing effort is following these species trends.

2017[18], had the highest overlap across sectors (Table A-10). It is likely fishing effort is driving overlap in 2017 as it corresponds with the second highest estimated number of pot sets over the time series (Table A-1). Overlap across sectors was stable or even decreasing until it began to increase in 2022 and 2023 back to nearly record high levels displayed in 2016 and 2017 (Figure A-23). Overlap also varies by sector throughout the years. For example, the CS sector has the largest summed overlap in 2017, LE in 2020, and OA in 2015 (Table A-10). Pot overlap remained relatively stable over the last decade with peaks during the marine heat wave, and recently increasing almost back to the marine heat wave overlap values (Figure A-23).

Table A-10: Overlap separated by year and sector for all sablefish pot overlap with the humpback whale density model. These include overlap within all months of the year.

Year	**LE**	**OA**	**CS**	**Total**
2014	3.11	1.75	4.69	9.55
2015	2.24	10.91	5.43	18.58
2016	6.66	4.47	9.33	20.46
2017	4.3	5.77	10.53	20.64
2018	5.08	4.45	6.93	16.46
2019	4.00	2.60	8.21	14.81
2020	7.70	1.40	6.85	15.95

[18] EM data was not available for 2023. The CS sector is the only sector with landings observed by EM, and in 2023 EM accounted for around 40% of the landings that were not detailed in this analysis. The LE and OA sectors do not have any observer coverage consisting of EM.

2021	6.31	1.63	4.79	12.73
2022	4.25	7.11	4.99	16.35
2023	7.1	7.71	2.74	17.54

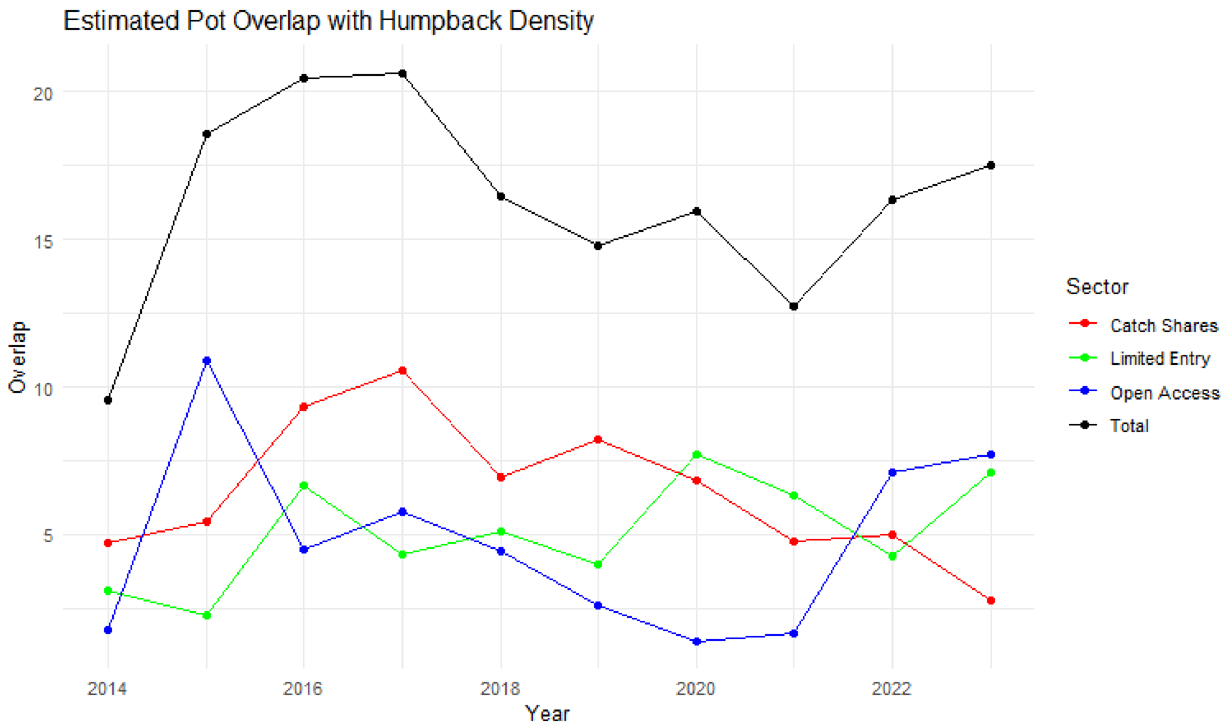


Figure A-23: Estimates of the pot set overlap with the humpback whale density distribution model. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each year for all years 2014-2023.

As another measure of co-occurrence, we considered what proportion of pot sets had at least some overlap with predicted humpback whale distribution (i.e., whale density prediction greater than zero). Given what we know about humpback whale DPSs and their relative distributions along the U.S. West Coast, we wanted to view how these fisheries interact in California and Oregon, versus Washington and how these overlap proportions measure up to the proportion and location of landings (Table A-11, A-12, and A-13). Our findings indicate 42% of total estimated pot sets in the LE sector overlapped with an area with humpback whale density, with 27% of these estimated overlap sets occurring in WA and 73% in CA/OR (Table A-11). LE landings are distributed so that 77% were made in CA/OR and 23% were made in Washington (Table A-12), thus displaying a similar overlap and landings ratio between the states. For the OA sector, 38% of estimated sets overlapped, with 11% of the estimated overlap sets occurring in WA, and 87% in CA/OR (Table A-11). OA landings also were similar proportions with 95% landed in CA/OR and 5% landed in WA (Table A-12). In the CS sector, 42% of estimated sets overlapped, with

25% of the estimated overlap sets occurring in WA, and 75% in CA/OR (Table A-11). CS landings slightly differ in that around 50% are landed in CA/OR and 50% in Washington, therefore their fishing effort in CA/OR is more likely to overlap with humpback than that of their WA effort (Table A-12). In total, 40% of total estimated sablefish pot fishing sets were predicted to have overlapped with humpback whale distribution, with 75% of those overlapping sets occurring in CA/OR and 25% in WA which is also very similar to their landing proportions (Table A-11 & A-12).

Table A-11: Total overlap relative to the percentage of pots sets with overlap with predicted humpback whale distribution (above zero) for each sablefish pot sector, broken down by area of fishing (California/Oregon versus Washington). Fishing effort sets are estimated/scaled up to account for 100% of fishing effort.

Sector	Overlapping Sets/Total Sets	Proportion Overlap in CA/OR	Proportion Overlap in WA
LE	42%	73%	27%
OA	38%	89%	11%
CS	42%	75%	25%
Total	40%	75%	25%

Table A-12: Proportion of estimated pot landings that occur in California and Oregon versus Washington, separated by sector.

Sector	Proportion Landings in CA/OR	Proportion Landings in WA
LE	77%	23%
OA	95%	5%
CS	50%	50%
Total	68%	32%

Table A-13: Proportion of estimated pot sets that occur in California and Oregon versus Washington, separated by sector.

Sector	Proportion Sets in CA/OR	Proportion Sets in WA
LE	70%	30%
OA	87%	13%
CS	46%	54%

Total	69%	31%

In Washington, all three sectors contain a fair amount of the total proportional overlap, especially given that California and Oregon make up more than 75% of the West Coast coastline. The comparable overlap proportions between the CS and LE sectors indicates these sectors are similar in their spatial overlap. The CS sector differs from LE and OA in that around half of its effort was concentrated in southern California, which occurred earlier in the time series*. Given the low observer coverage in the OA sector, it is difficult to directly compare it to CS and LE sectors. OA sector overlap was concentrated in northern California south of Cape Mendocino, in the Monterey Bay area, and offshore of the Columbia River mouth area*. The LE sector was concentrated around Cape Mendocino and extended north to La Push, Washington, sharing a similar spatial overlap with CS and similar hotspots of overlap with OA*.

Hook-and-Line Fisheries

We also evaluated the co-occurrence dynamics between humpbacks and commercial PCGF hook-and-line effort, given concern about the potential for interactions in these fisheries. There have been six entanglements of humpbacks that have documented monofilament line as part of the entanglement (five entanglements) or the PCGF hook-and-line fishery specifically (one entanglement). These records warrant the evaluation of humpback whale entanglement risk within PCGF hook-and-line sectors. Hook-and-line overlap hot spots include around the Columbia River mouth, Point Reyes, CA, Monterey Bay, CA, La Push, WA, Cape Mendocino, CA, and Cape Blanco, CA (Figure A-24). Overlap is widely distributed along the entire coast, similar to the broad distribution of fishing effort, but mostly occurs north of Monterey Bay, CA (Figure A-24).

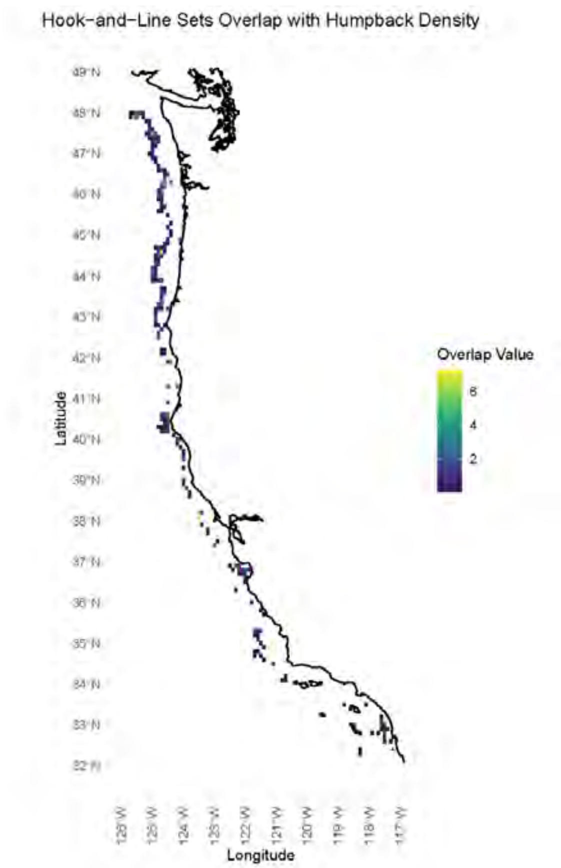


Figure A-24: Estimated overlap between hook-and-line sets and predicted humpback whale density. Overlap is colored by magnitude of overlap which is a unitless metric*.

The hook-and-line fisheries follow a similar temporal distribution to sablefish pot fishing, with the majority of fishing occurring during peak humpback whale season from April-November (Figure A-7). The months across sectors with the highest overlap are October and August (Table A-14, Figure A-25). The two months with the lowest overlap are December and March (Table A-14, Figure A-25). These months containing lower overlap coincide with the months, December-March, where most humpbacks are absent from the U.S. West Coast waters. The highest amounts of overlap occurred in June for the OA, September for LE, October for LE TL, and October for CS (Table A-14, Figure A-25). The LE sector had the most overlap, and the CS sector had the least overlap (Table A-14, Figures A-25).

The highest rate of overlap in the hook-and-line sector within California and Oregon appears to have occurred in the latter half of the year, from July-December, with overlap that occurred earlier in the year almost solely located in central and southern California, and further offshore*. In Washington, overlap was heavily dominated from August-December, with a main focus from September-November*. The few overlaps occurring in Washington later in the year in December were concentrated offshore of the Columbia River mouth*. Overlap that occurred earlier in the year in Washington appears to be concentrated in the northern half of the state, and further offshore, compared to later overlap*.

Table A-14: Overlap for all PCGF hook-and-line sectors by month. These are the summed overlap for the months within all years, 2014-2023.

Month	LE	LE TL	OA	CS	Total
January	NA	0.23	0.83	0.08	4.79
February	NA	0.38	0.82	0.29	8.73
March	0.04	0.19	2.24	0.21	4.39
April	6.34	0.28	4.90	0	17.48
May	7.76	0.31	8.36	0	20.56
June	15.67	0.21	16.85	0	37.13
July	15.82	0.11	10.36	0.28	29.73
August	17.08	0.18	16.63	0.72	42.12
September	21.43	0.05	11.15	1.60	34.94
October	17.70	0.39	14.46	2.37	42.80
November	0.40	0.20	7.16	0.75	10.36
December	0.05	0.13	2.03	0.15	4.11

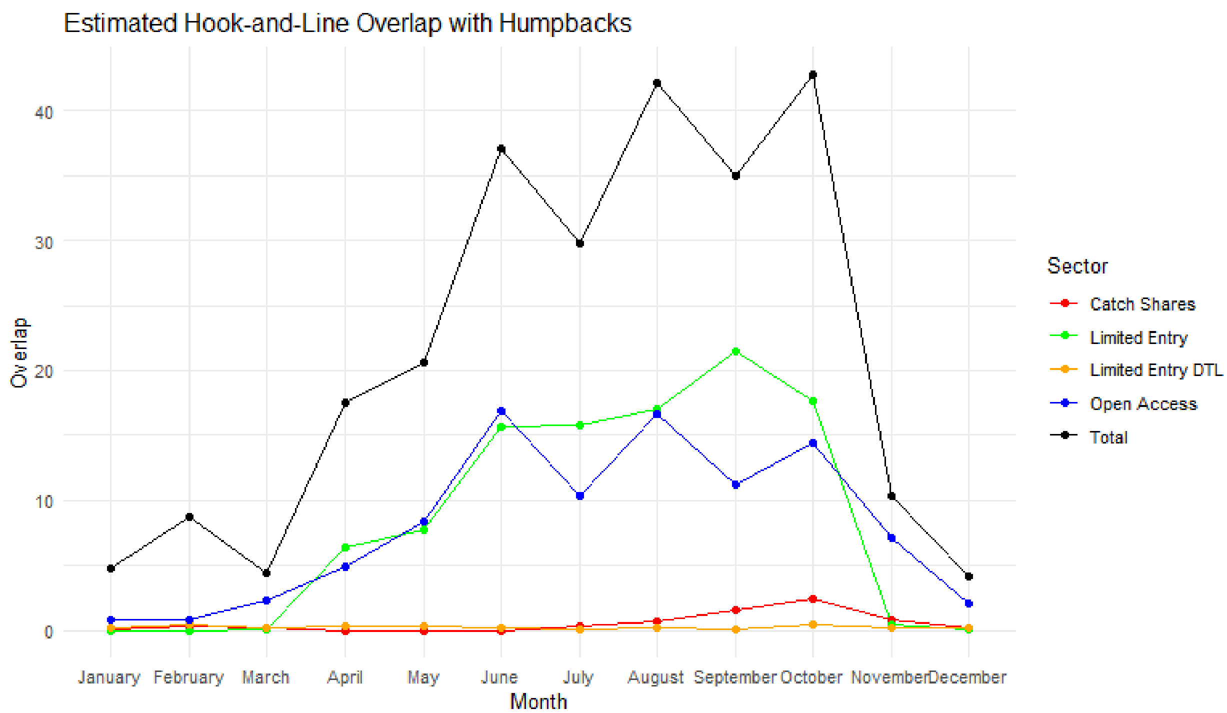


Figure A-25: Estimated hook-and-line set overlap with humpback whale density. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each month for all years 2014-2023.

We examined the interannual variability to help understand how risk may evolve in the future. More recent hook-and-line overlap is concentrated further north in northern California, Oregon, and Washington*. Some notable areas of recent overlap include offshore of Monterey Bay, CA, Cape Mendocino, CA, in between Cape Blanco and the Columbia River in Oregon, and around Cape Elizabeth, WA*. There is very little overlap in areas south of Monterey Bay in recent years*.

Overlap was the highest in 2016, followed by 2018, with 2020 having the lowest overlap (Table A-15, Figure A-26). LE TL also peaked in 2016, CS in 2016, LE in 2016, and OA in 2022 (Table A-15, Figures A-26). Total risk throughout the years has oscillated back and forth, presenting significant year to year variability in overlap (Figure A-16). Although overlap has oscillated throughout the time series, overall overlap has been smaller in recent years (2019-2023) compared to earlier years (2014-2019) (Figures A-26).

Table A-15: Summed overlap for all PCGF hook-and-line sectors by year. These are the monthly summed overlap for all months within the year that possess any overlap between the two data layers (i.e., excludes "zeros").

Year	LE	LE TL	OA	CS	Total
2014	8.32	6.62	5.65	0.75	20.91

2015	8.23	3.35	5.16	0.57	17.32
2016	15.84	14.07	14.37	2.21	46.49
2017	10.65	4.21	13.21	0.73	28.81
2018	15.57	8.05	10.08	1.66	35.36
2019	7.12	3.71	6.01	0.55	17.39
2020	7.56	3.21	5.37	0	16.14
2021	8.66	6.94	6.63	0	22.23
2022	8.54	0.87	19.56	0	28.97
2023	11.80	2.23	9.46	0	23.50

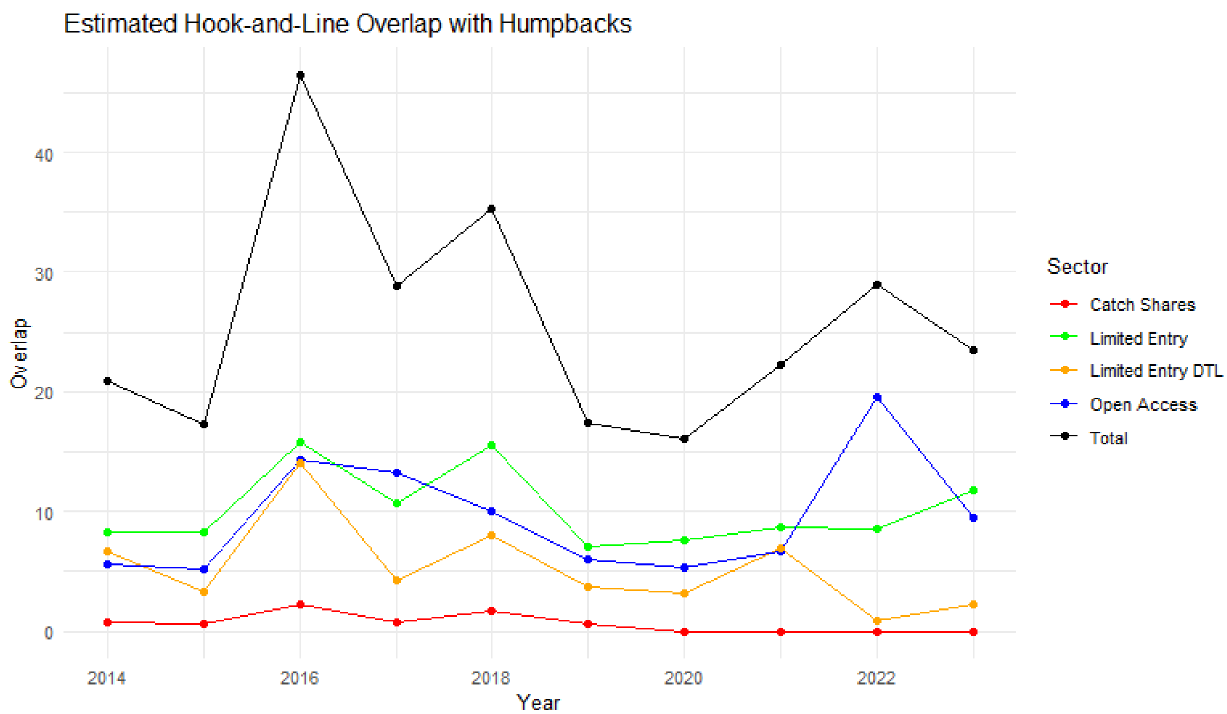


Figure A-26: Estimated hook-and-line set overlap with the humpback whale density. Lines and points are colored by the sector in which the overlap belongs or the total overlap.

38% of estimated hook-and-line sets had at least some overlap with predicted humpback whale density greater than zero (Table A-16). If we break this down by sector, 37 % of estimated LE sets overlap, 41% of estimated LE TL sets overlap, 40% of estimated CS sets overlap, and 42% of estimated OA sets overlap (Table A-16). These are all relatively the same proportion of fishing effort that overlap with predicted humpback whale density. Considering the distribution of humpback whale DPSs along the West Coast, we looked at the proportion of overlap and of hook-and-line landings that occurred in California and Oregon, versus Washington (Table A-16, Table A-18). In total 65% of estimated hook-and-line overlapping sets occurred in California and Oregon, and 35% occurred in Washington (Table A-16) which also corresponds to the proportion of landings between the states (Table A-18). By sector: LE overlap occurred 62% in CA/OR and 38% in WA; LE TL overlap occurred 97% in CA/OR and 3% in WA; OA overlap occurred 81% in CA/OR and 19% in WA; and CS overlap occurred 46% in CA/OR and 54% in WA (Table A-16). LE TL, OA, and CS all roughly coordinate with the proportion of hook-and-line landings and sets that are made within the respective areas by sector (Table A-16, A-17, and A-18). However, there is a discrepancy in the proportion distribution of LE sets and landings with more landings occurring in CA/OR than the amount of LE sets that occur there (Table A-17 and Table A-18). Therefore, the distribution of LE overlap more closely matches the proportion distribution of LE landings than LE sets (Table A-16, A-17, and A-18). Ultimately, all NCS sectors have had more overlap occurring in CA/OR and CS sector has more in WA (Table A-16). Overlap in California and Oregon was dominated by the LE sector, distributed primarily throughout Oregon and northern California, down to the Monterey Bay area (with a majority of OA occurring in this same geographic area)*. Overlap in the LE TL and CS sectors was predominantly in central and southern California*. Washington overlap is dominated by LE throughout the state, except for some OA sector overlap near the Columbia River, and CS sector overlap south of Cape Elizabeth*.

Table A-16: Percentage of hook-and-line sets with at least some overlap for each sector, and what proportion of overlap occurs in California and Oregon versus Washington. Fishing effort sets are estimated to account for 100% of fishing effort.

Sector	Percentage of Overlapping Sets	Proportion with Overlap in CA/OR	Proportion with Overlap in WA
LE	42%	62%	38%
LE TL	37%	97%	3%
OA	41%	81%	19%
CS	41%	46%	54%
Total	38%	65%	35%

Table A-17: Proportion of estimated hook-and-line sets that occur in California and Oregon versus Washington, separated by sector.

Sector	Proportion Sets in CA/OR	Proportion Sets in WA
LE	51%	49%

LE TL	98%	2%
OA	83%	17%
CS	42%	58%
Total	77%	23%

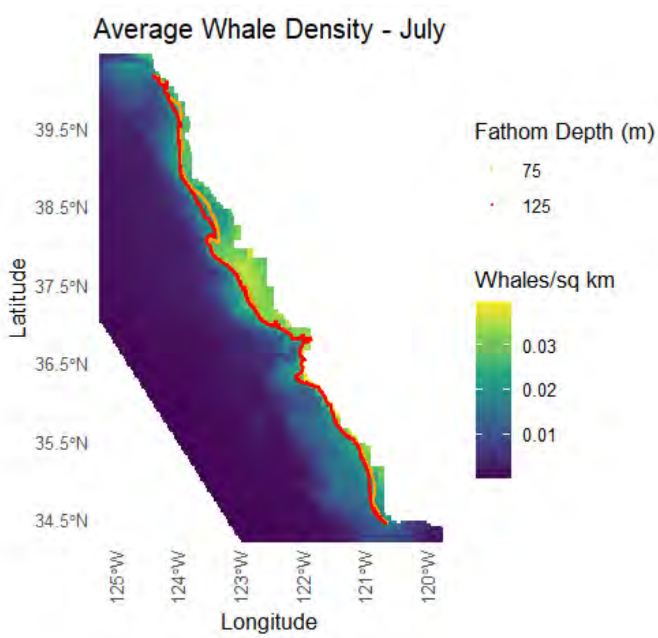
Table A-18: Proportion of estimated hook-and-line landings that occur in California and Oregon versus Washington, separated by sector.

Sector	Proportion Landings in CA/OR	Proportion Landings in WA
LE	60%	40%
LE TL	97%	3%
OA	86%	14%
CS	38%	62%
Total	65%	35%

Amendment 32

Amendment 32 to the groundfish FMP recently opened up a portion of an RCA area that was previously closed to non-trawl fishing off the coasts of Oregon and California. This opened up fishing in Oregon and northern California waters from 75-100 fathoms, and in central California from 75-125 fathoms, to be possibly exploited by fixed gear which has been previously closed for decades to most fishing. The risk of humpback whale entanglement with sablefish pot gear has been documented through multiple previous entanglements reported by observers or opportunistic sources. Although PCGF hook-and-line gear has not been associated with any confirmed entanglements, there has been one unconfirmed entanglement documented with vertical jig gear, and other entanglements with hooks or monofilament line that are similar to gear that might be used in the PCGF hook-and-line fisheries. Therefore, there is a risk of future entanglements occurring with various fixed-gear types. Humpback whale abundance and distribution along the U.S. West Coast tends to peak in late summer (Figure A-18), coinciding with the peak in groundfish pot (Figure A-4) and hook-and-line (Figure A-8) fishing effort from August-October. Figures A-27, A-28, and A-29 display average humpback whale density predictions for July, August, and September 2014-2023 which are the peak months for humpback whale distribution on the West Coast. Fathom contour lines bound the areas in which Amendment 32 opened up to non-trawl fixed gear. Figures A-27, A-28, and A-29 are separated by the different boundaries opened in central California versus northern California and Oregon waters.

Looking at predicted whale density in peak months relative to the newly reopened areas reveals that most of the area reopened by Amendment 32 to PCGF fixed-gear effort lies on the outer perimeters of peak predicted whale density (Figures A-28, A-28, and A-29). Although in some cases, specifically more so in central California, there are some areas of overlap with relatively high predicted whale density values (Figures A-28, A-28, and A-29). Previous groundfish fixed gear fishing has had effort occur in the areas immediately adjacent to these newly opened areas, and we expect that PCGF fixed gear fishermen will pursue these newly opened areas. For all three peak whale density months, the overlap with the newly opened areas will be highest in July around the San Francisco Bay, in August north of San Francisco Bay and slightly in offshore Oregon waters, and September resembles August but with a slight increase in overlap in Oregon waters (Figures A-28, A-28, and A-29). In summary, some areas being reopened by Amendment 32 are more of an increased entanglement risk in late summer in central California than Oregon/northern California, as the newly reopened fishing areas are closer to higher humpback whale densities further south. There is overall more PCGF effort further north around Oregon, which could limit the extent of any changes in co-occurrence dynamics over time, given the smaller potential impact of changes off Oregon indicated by our analysis.



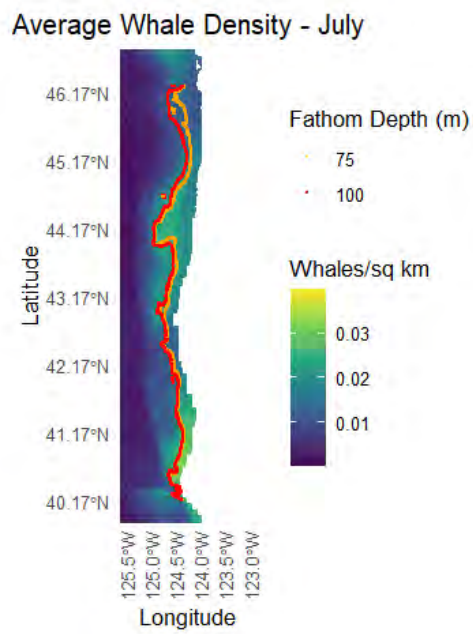
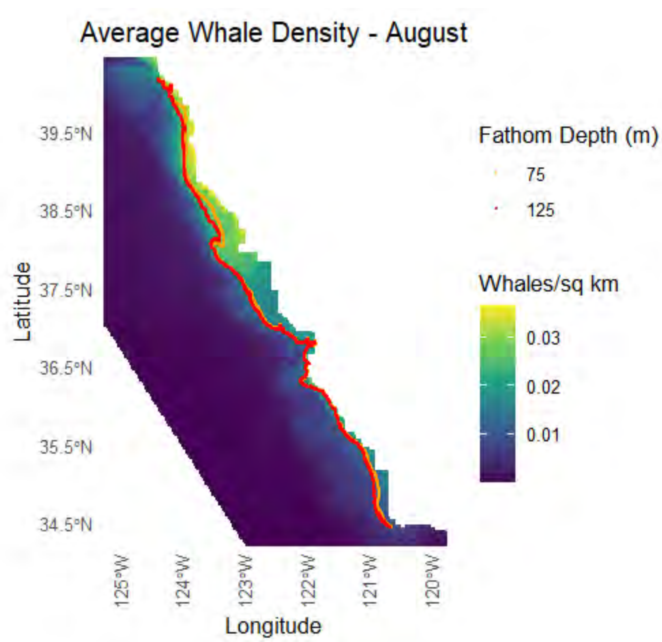


Figure A-27: Average predicted humpback whale density from 2014-2023 for the month of July in central California (top) and northern California and Oregon waters (bottom). The colored contour lines represent fathom depth reopened by Amendment 32 to the groundfish FMP to non-trawl fixed-gear fishing.



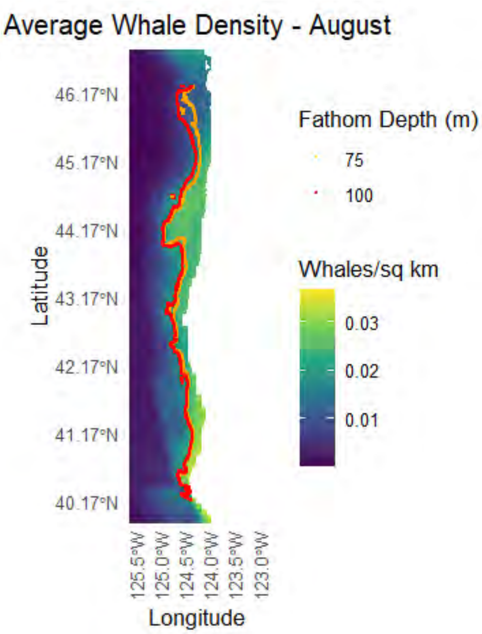
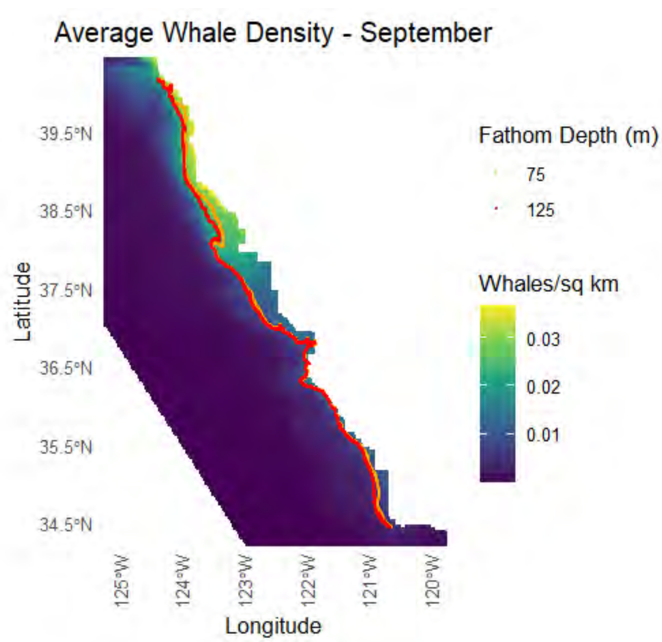


Figure A-28: Average predicted humpback whale density from 2014-2023 for the month of August in central California (top) and northern California and Oregon waters (bottom). The colored contour lines represent fathom depth reopened by Amendment 32 to the groundfish FMP to non-trawl fixed-gear fishing.



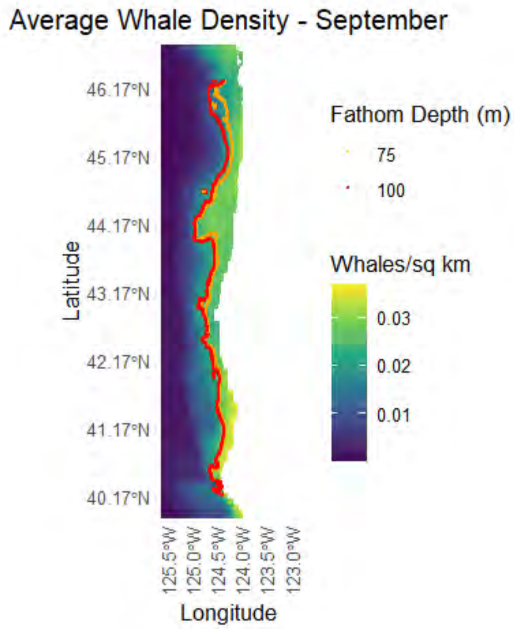


Figure A-29: Average predicted humpback whale density from 2014-2023 for the month of September in central California (top) and northern California and Oregon waters (bottom). The colored contour lines represent fathom depth reopened by Amendment 32 to the groundfish FMP to non-trawl fixed-gear fishing.

Midwater Trawl Fisheries

Humpbacks have also been reported entangled in midwater trawl nets in recent years, so we analyzed the overlap between PCGF midwater trawl effort and predicted humpback whale density to better understand how these dynamics may have been changing recently. SS midwater trawling effort and overlap occurs exclusively north of 40°N (Figure A-30). SS overlap in California and Oregon appears to be concentrated earlier in the year, from May-June*. From August-November overlap begins to occur further north in Oregon, likely corroborating with humpback migration as fishing effort distribution does not change drastically throughout the year*. The Midwater Hake EM sector spans a wide range, from California to Washington, with significant overlap throughout its range*. In contrast, other sectors like Midwater Rockfish (non-EM) and Midwater Hake (non-EM) tend to fish in more concentrated areas, such as near the Columbia River mouth, where overlap is also high, but confined to a smaller area*. There seems to be two major SS overlaps in Washington in recent years, near the Columbia River mouth and between 47°N and 48°N latitude (Figure A-30).

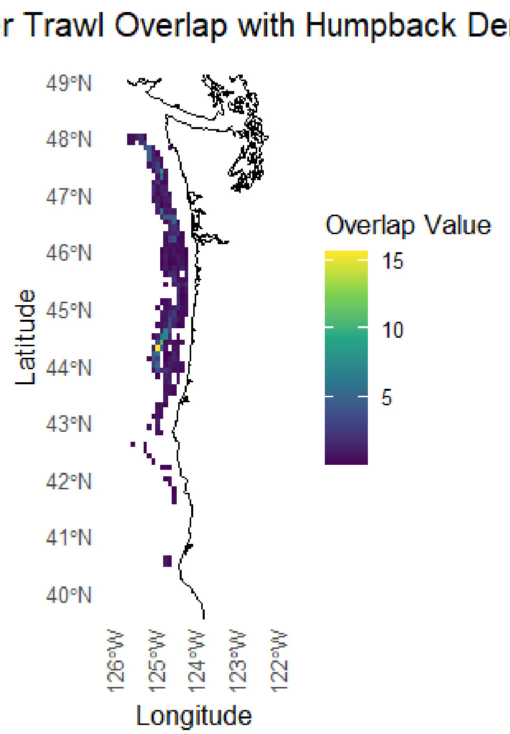


Figure A-30: The overlap of shoreside trawl hours and predicted humpback whale density. Overlap is colored by the magnitude of overlap which is unitless.*

AS midwater trawling effort and overlap occurs exclusively north of 41°N, which is slightly further north than SS trawling (Figure A-31). Hot spots for AS overlap occur all around Cape Blanco, OR, between 44°N and 45°N latitude, and off of La Push, WA (Figure A-31). Overlap is fairly extensive and widely distributed between both of the subsectors, CP and MS*. AS overlap does appear to peak in magnitude in more nearshore areas, with the offshore overlap values remaining relatively small in comparison to the nearshore overlap values likely because humpback whales are more coastally associated (Figure A-31).

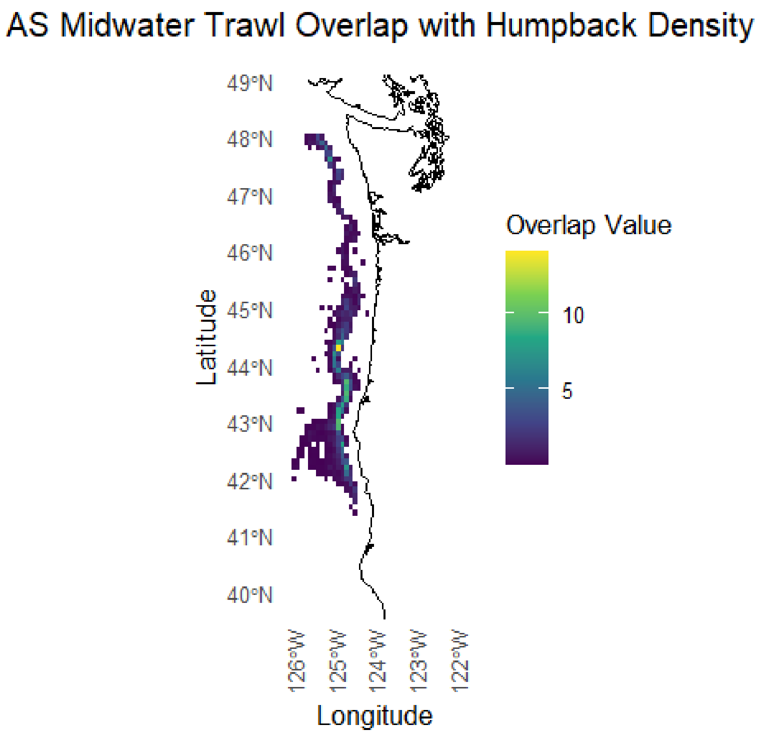


Figure A-31: The overlap of at-sea trawl hours and predicted humpback whale density. Overlap is colored by the magnitude of overlap which is unitless.*

SS overlap peaks in the earlier part of the fishing season from May-June, but overlap still occurs in large quantities from August-October (Figure A-32). Most entanglements tend to occur in late summer time due to higher whale densities during this time period, and SS overlap is peaking slightly before then. The months with the highest SS overlap are July and June (Table A-19). In these months there is both high SS fishing effort (Figure A-9) and overlap, deeming fishing effort as the main driver for SS overlap, especially considering humpback abundance doesn't peak until August (Figure A-18). The two months with the lowest amount of overlap are January and February which coincides with both minimal SS fishing effort and humpback density (Table A-19). Overlap by SS sector was also variable with Midwater Hake peaking in July and Midwater Rockfish peaking in October (Table A-18, Figure A-32). Both sectors contain overlap with humpbacks throughout the year(Table A-19).

Table A-19: Overlap by month and sector of shoreside midwater trawl with humpback whale density. These are the summed monthly overlap for all years, 2014-2023. There is no EM data for 2014 and the 2023 EM was unavailable upon time of publication.

Month	Hake	Rockfish	Total
January	NA	0.06	0.06
February	NA	0.08	0.08

March	NA	0.10	0.10
April	NA	0.47	0.47
May	15.70	3.24	18.94
June	67.06	3.43	70.49
July	70.53	2.61	73.14
August	56.05	2.09	58.14
September	51.03	3.16	54.19
October	41.78	6.21	47.99
November	6.22	4.38	10.60
December	NA	0.64	0.64

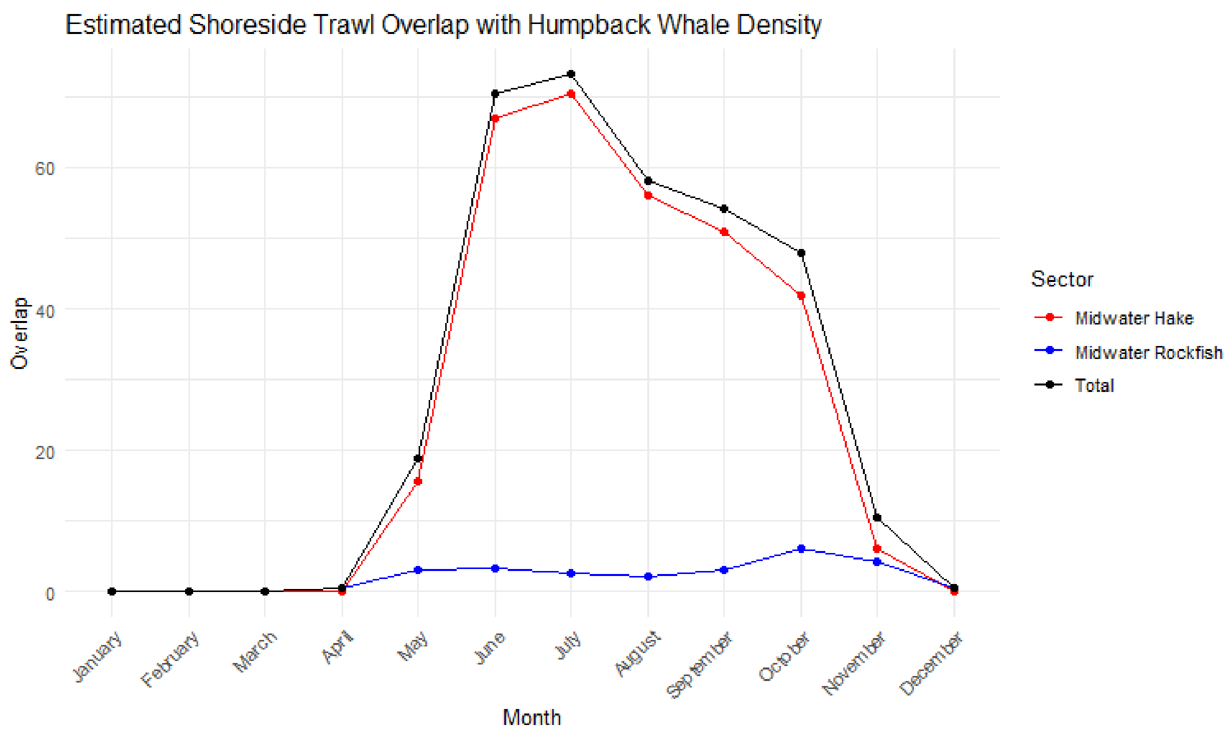


Figure A-32: Estimated shoreside midwater trawl overlap with humpback whale density. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each month for all years 2014-2023.

The months with the highest AS overlap across sectors are October and June (Table A-20 and Figure A-33). This is also the same trend displayed by both CP and MS peaking in October and June (Table A-20, Figures A-33). These two peaks in AS overlap are highly representative and correlate strongly with the peak in AS fishing effort (Figure A-16), with the ultimate peak in overlap also likely influenced by the peak in humpback whale density in those late summer and early fall months (A-18). CP also contains more overlap over the months compared to MS, which again is highly correlated with the same fishing effort trends (Figure A-33 and A-16). There is no overlap occurring between December and April as no fishing effort takes place during those months (Table A-20). There is also minimal overlap for both sectors in July and August, again because fishing effort is very minimal during these months (Figure A-33).

Table A-20: Overlap by month and sector of at-sea midwater trawl with humpback whale density. These are the summed monthly overlap for all years, 2014-2023. There is no EM data for 2014 and the 2023 EM was unavailable upon time of publication.

Month	Catcher-Processor	Mothership	Total
January	NA	NA	NA
February	NA	NA	NA
March	NA	NA	NA
April	NA	NA	NA
May	49.72	29.14	78.86
June	50.53	47.65	98.18
July	0.15	1.66	1.82
August	3.30	4.45	7.76
September	45.74	24.45	70.19
October	75.30	61.61	136.92
November	30.28	9.32	39.60
December	NA	NA	NA

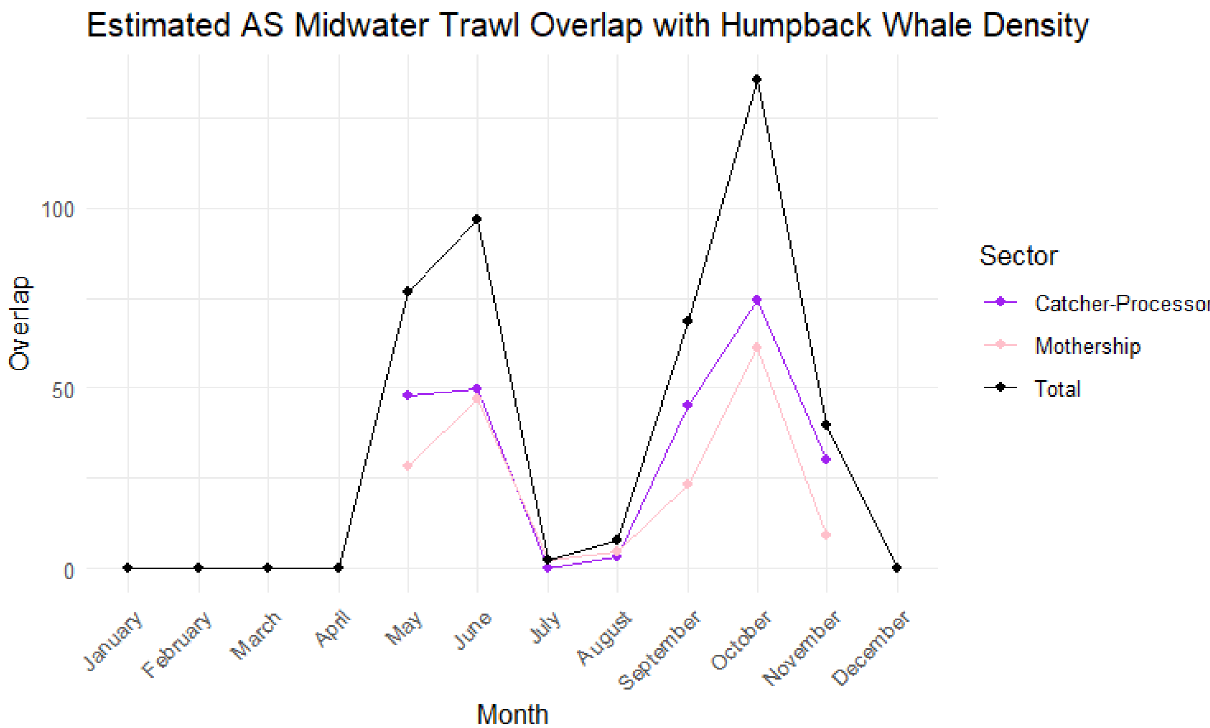


Figure A-33: Estimated at-sea midwater trawl overlap with humpback whale density. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each month for all years 2014-2023.

Previously, there had not been reports of humpback whale bycatch in PCGF trawl nets, which indicates there may have been recent changes in either whale distribution or fishing effort that could be increasing risk. There has been an increase in SS overlap in recent years, which also coincides with the increasing trend in SS trawl hours overall across the sectors (Table A-5 and Table A-21). The spatial distribution of SS trawling effort has remained stable and has not varied significantly on an intra-annual basis (Figure A-9). With regards to interannual variability, recent SS overlap within California and Oregon appears to happen over both states with no real year-to-year trend evident.*

The highest SS overlap occurred in 2020, followed by 2022 (Table A-21, Figure A-34). The recent increases in SS overlap could help to explain the recent entanglements we have noted in these fisheries. SS overlap also varies by sector with Midwater Hake containing the highest overlap for all available years due to its higher amount of fishing effort (Figure A-34). Midwater Hake's highest overlap occurred in 2020 and Midwater Rockfish in 2018 (Table A-21).

Table A-21: Overlap by year and sector for all shoreside midwater trawl and humpback whale density. These are the summed overlap for all months within the year. There is no EM data for 2014 and the 2023 EM was unavailable upon time of publication.

Year	Hake	Rockfish	Total

2014	20.4	0.8	21.17
2015	24.0	1.3	25.31
2016	28.5	1.2	29.71
2017	37.7	2.8	40.43
2018	35.5	5.4	40.98
2019	21.9	2.3	24.24
2020	57.0	2.6	59.54
2021	34.0	3.5	37.45
2022	47.5	5.2	52.68

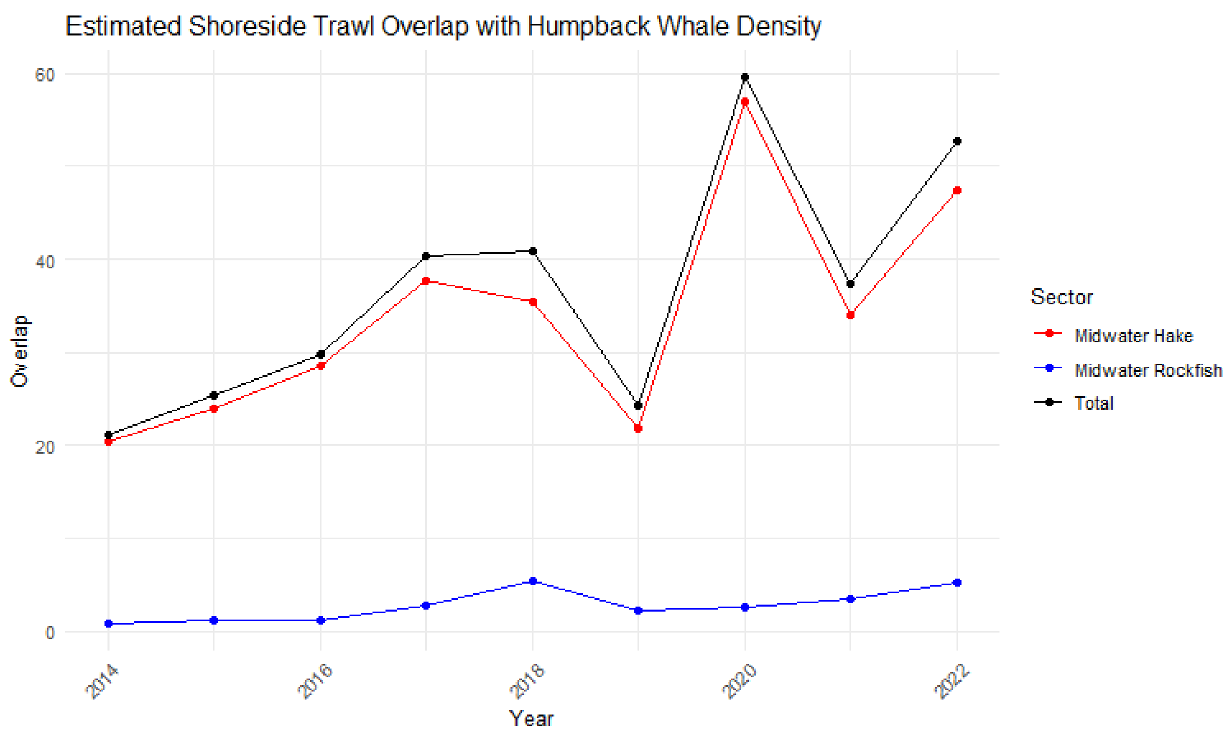


Figure A-34: Estimated shoreside midwater trawl overlap with humpback whale density. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each year for all years 2014-2022.

Overlap in the AS midwater trawl fishery has fluctuated throughout the years with all sub sectors following the same trend in overlap (Table A-22). There were two peaks in overlap, first in 2018 and then again in 2022 (Figure A-35). These peaks in overlap also match fairly closely the trends in AS fishing effort with the same peaks in effort occurring in 2018 and 2022 (Figure A-12).

Table A-22: Overlap by year and sector for all at-sea midwater trawl and humpback whale density. These are the summed overlap for all months within the year. There is no EM data for 2014 and the 2023 EM was unavailable upon time of publication.

Year	Catcher-Processor	Mothership	Total
2014	12.4	10.5	22.9
2015	17.1	6.0	23.1
2016	28.8	21.1	49.9
2017	31.0	25.6	56.6
2018	37.2	29.4	66.5
2019	19.1	13.1	32.2
2020	20.1	8.2	28.3
2021	24.9	11.3	36.1
2022	37.0	37.2	74.2
2023	23.4	13.6	37.0

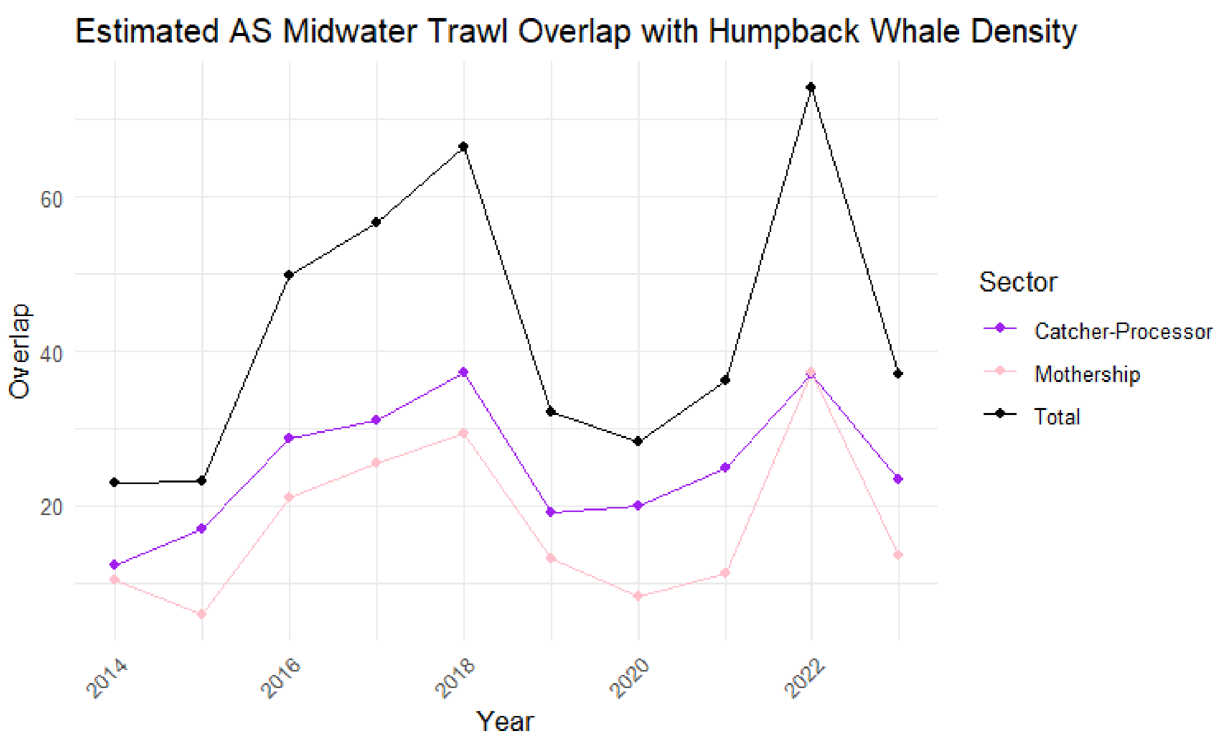


Figure A-35: Estimated at-sea midwater trawl overlap with humpback whale density. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each year for all years 2014-2023.

Given that humpbacks have only been reported entangled in the Hake fisheries, and that these sectors dominate both overlap and overall landings, we analyzed these sectors more closely. The Midwater Hake sector had 28% of their trawl hours overlap with humpback whale densities, and the Rockfish sector had 24% of its hours overlap (Table A-23).

Given what we know about the distribution of humpback whale DPSs along the West Coast, we wanted to view how these sectors interact in California and Oregon, versus Washington (Table A-23), and how this aligns with landings of SS midwater trawling along the coast (Table A-24). Of the proportion of SS trawl hours that overlapped and occurred in the Hake sector, 58% of them occurred off California and Oregon and 42% off Washington (Table A-23), similar to the landings spatial proportions (Table A-24). Of the overlapping trawl hours that occurred in the Rockfish sector, 46% occurred off California and Oregon and 54% off Washington (Table A-23), which was similar to the landings proportions (Table A-24).

Table A-23: Proportion of shoreside trawl hours with at least some overlap for each trawl sector, and what proportion of overlap occurs off California and Oregon versus Washington.

Sector	Overlapping Trawl Hours	Proportion Overlap in CA/OR	Proportion Overlap in WA
Midwater Hake	28%	58%	42%
Midwater Rockfish	24%	46%	54%
Total	27%	60%	40%

Table A-24: Proportion of shoreside midwater trawl landings that occur in California and Oregon versus Washington, separated by sector.

Sector	Proportion Landings in CA/OR	Proportion Landings in WA
Midwater Hake	46%	53%
Midwater Rockfish	49%	51%
Total	49%	51%

The AS midwater trawl fishery also primarily targets hake, and could present similar entanglement risk similar to the SS Hake sectors. The CP sector had 28% of its trawl hours overlapping with humpback whale densities, the MS sector had 27% of its trawl hours overlapping, and in total 27% of the AS trawl hours overlapping (Table A-25). Of the proportion of CP trawl hours that overlap, 85% of them occur in CA/OR and 15% in WA, of the MS trawl hours that overlap, 83% of them occur in CA/OR and 17% in WA, and of the total overlapping AS trawl hours, 84% occur in CA/OR and 16% in WA (Table A-25). These distributions of overlap proportions, roughly match the distribution of SS landings and their distributions between CA/OR and WA (Table A-26).

Table A-25: Proportion of at-sea trawl overlap for each sector, and what proportion of overlap occurs off California and Oregon versus Washington.

Sector	Overlapping Trawl Hours	Proportion Overlap in CA/OR	Proportion Overlap in WA
Catcher-Processor	28%	85%	15%
Mothership	27%	83%	17%
Total	27%	84%	16%

Table A-26: Proportion of estimated at-sea midwater trawl landings for each sector that occur in California and Oregon versus Washington.

Sector	Proportion Landings in CA/OR	Proportion Landings in WA
Catcher-Processor	87%	13%
Mothership	74%	26%
Total	83%	17

Leatherback Sea Turtle Co-Occurrence

We wanted to understand the spatial distribution of overlap and co-occurrence over the last decade, and how it has changed throughout the year, amongst years, and between sectors, to help identify where the dynamics of entanglement risk for leatherbacks may be heading in the future. This overlap risk metric through the multiplication of species and fishing data is not a measure of absolute risk of entanglement, but rather allows us to measure the relative change in risk across seasons, years, and fishing gear.

Pot Fisheries

We first examine how sablefish pot fishing overlap with leatherback habitat suitability is distributed (Figure A-36). A majority of recent overlap was concentrated in Oregon, specifically around the Columbia River mouth, but really spans the entirety of the Oregon coast (Figure A-36). The few places of overlap in California surround Big Sur and the San Francisco Bay (Figure

A-36).

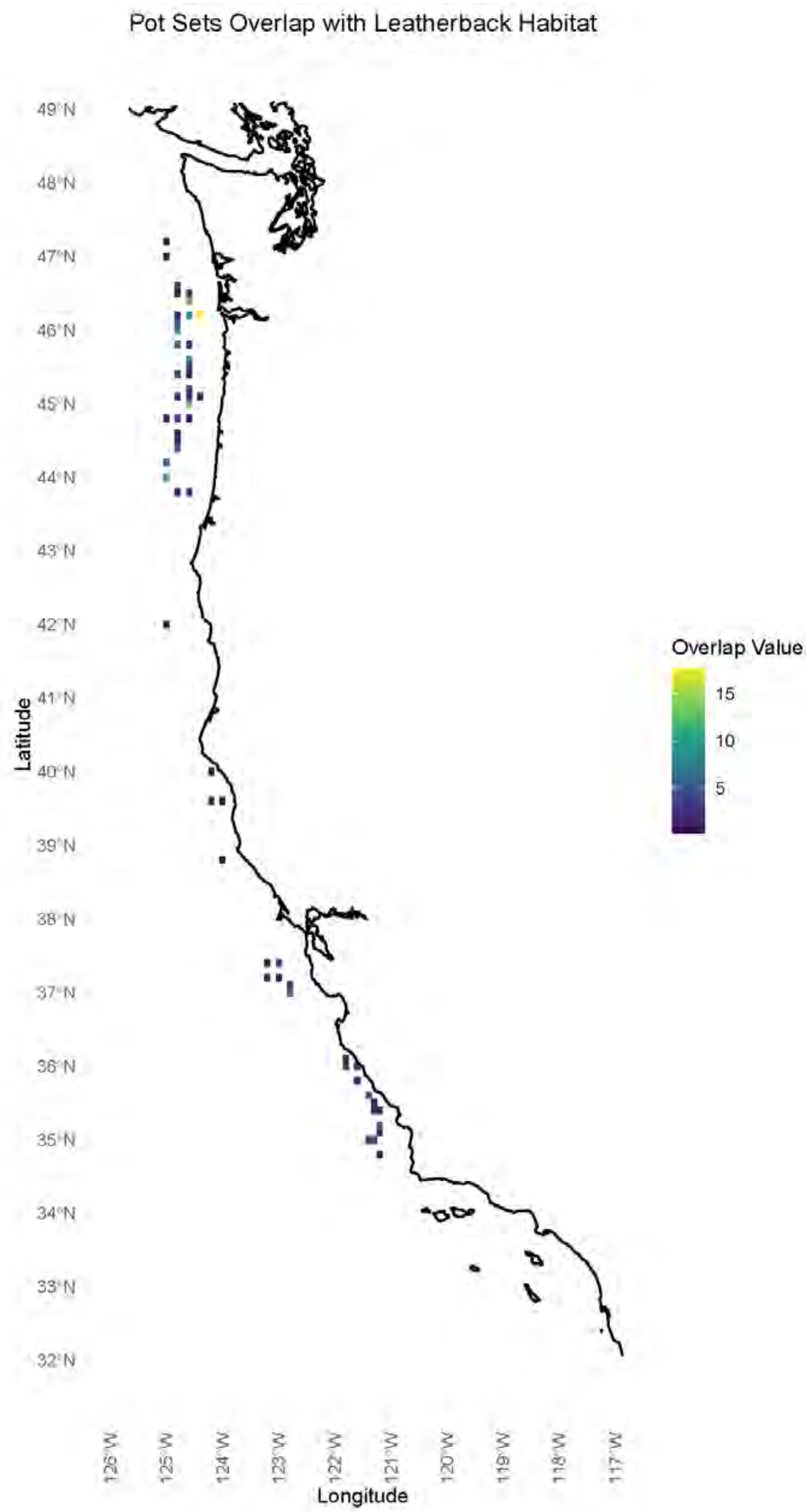

Pot Sets Overlap with Leatherback Habitat
49°N
48°N
47°N
46°N
45°N
44°N
43°N
42°N
41°N
40°N
39°N
38°N
37°N
36°N
35°N
34°N
33°N
32°N
Latitude
126°W
125°W
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
Longitude
Overlap Value
15
10
5

Figure A-36: Overlap of scaled number of pot sets (scaled to represent 100% fishing effort based on observer coverage annual rates), with leatherback habitat suitability. Overlap is colored by the magnitude of overlap and is unitless.*

The vast majority of sablefish pot fishing occurs in the months from August-November (Figure A-4). The months with the highest overlap were August and September (Table A-27, Figure A-37). The two months with the lowest amount of summed overlap were February and January (Table A-27, Figure A-37). The CS sector had the largest overlap in October, LE in September, and OA in August (Table A-27, Figure A-37), all coinciding with peak fishing effort and peak leatherback habitat suitability. CS and OA pot fishing sectors operate year-round, with the LE sector having a defined season. While the OA sector operates all year, the largest amount of effort occurred in the spring and summer months.* OA had a longer period of overlap with humpback whales than it did with leatherbacks, containing overlap for almost every month of the year compared to only overlapping from March-August for leatherbacks.

Table A-27: Overlap separated by month and sector for all sablefish pot overlap with leatherback habitat suitability. These are the monthly summed overlap for all years, 2014-2023.

Month	LE	OA	CS	Total
January	NA	0.00	1.15	1.15
February	NA	0.00	2.60	2.60
March	NA	0.84	3.82	4.66
April	1.39	0.00	2.08	3.47
May	4.14	1.25	8.44	13.83
June	1.61	0.00	12.33	13.94
July	9.97	0.00	18.55	28.52
August	15.15	25.87	24.7	65.72
September	26.57	0.00	25.78	52.35
October	17.9	0.00	31.82	49.72
November	1.53	0.00	6.22	7.75
December	NA	0.00	1.24	1.24

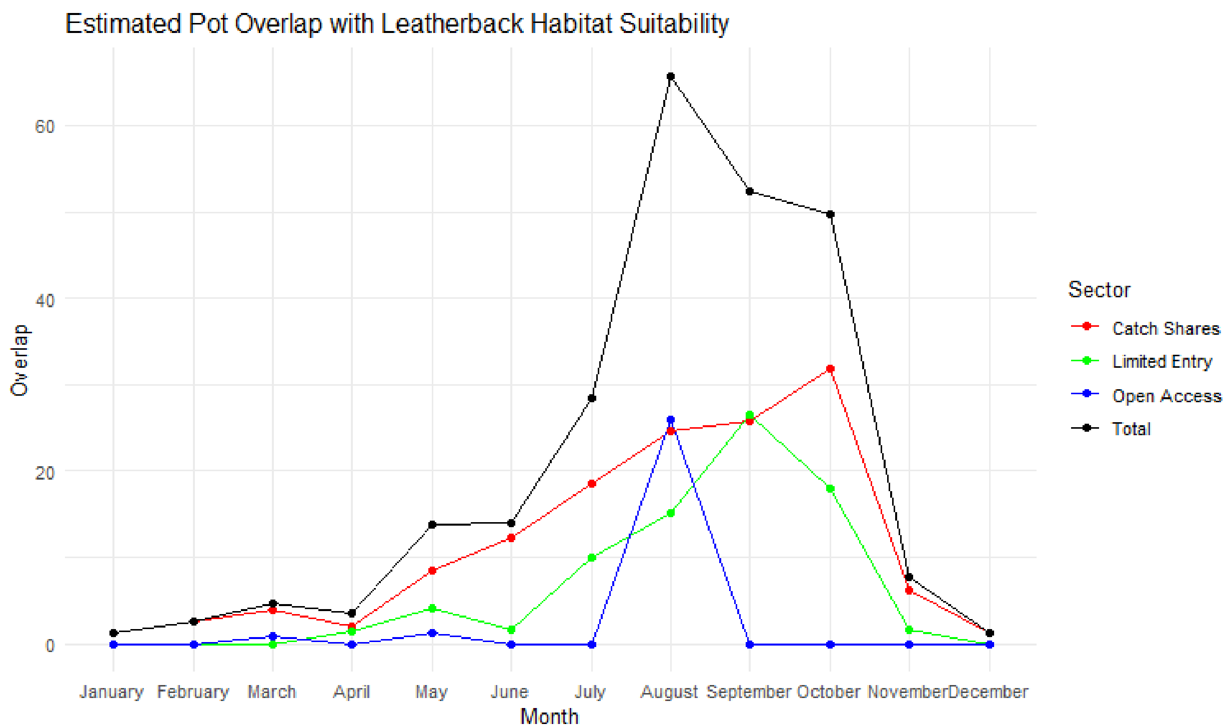


Figure A-37: Estimated pot sets overlap with leatherback sea turtle habitat suitability. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each month for all years 2014-2023.

Variation in overlap is driven by the dynamics of fishing effort, habitat suitability prediction, or both. This is illustrated well with our results, given that both PCGF sablefish pot fishing effort (Figure A-4) and predicted leatherback habitat suitability (Figure A-20) elevate during the same times of the year in the CCE, making it difficult to discern which of the two factors is most influential in driving co-occurrence. We estimate that 85% of sablefish pot fisheries landings are made between April-November, due in large part because LE permits only allow fishing during this time period. In recent years there has been fewer sightings of leatherbacks in their historic distributions along the Pacific Northwest coast (Benson, SWFSC, personal comm August 8th 2024). This decline is likely due to decreases of the Western Pacific population rather than distribution changes impacted by climate change, but functionally 'decreases' entanglement risk in this area, even if suitable habitat remains. Despite this, there are still high efforts of pot fishing in summer and fall months in Oregon.

Over time we see that overlap has shifted northwards, with minimal overlap occurring in southern California waters compared to those off of Oregon and Washington in recent years.* Most predicted overlap occurring in the most recent years, 2021-2023, occurred north of Cape Mendocino, CA,* likely indicative in the northward shift displayed by pot fishing effort (Figure A-1). This is especially evident in the CS sector, which decreased fishing effort in southern California and concentrated further north, likely contributing to the elevated northern overlap areas.* Given that leatherback habitat suitability has remained relatively stable (Figure A-19), it is likely the northward shift of pot fishing effort that is driving variability in overlap over the years.

The northward shift in fishing effort is especially pertinent to suitable leatherback habitat that occurs off of Cape Elizabeth, WA as this is a key area for leatherback critical habitat due to the dense aggregations of sea nettles that occur in this area (Benson SWFSC, Personal comm, August 8th, 2024). In recent years, we have seen an increase in pot fishing in this area, potentially elevating overall risk to leatherbacks that might occupy those northern areas. However, given there have not been many if any sightings of leatherbacks in this area in recent years, it is likely that this northern push in pot effort has not necessarily increased the entanglement risk of leatherbacks, even though suitable habitat is available in the northern area.

Table A-28 and Figure A-38 illustrate the sum of all overlap that occurred within each year for each sector. The most recent year, 2023, had the highest overlap across sectors (Table A-28, Figure A-38). Overlap was highest for the LE sector in 2023, OA in 2014, and CS in 2017 although we do not have the 2023 EM data for CS (Table A-28, Figure A-38). Overlap between pot fishing and leatherbacks was stable throughout the time series, potentially supporting why we have not witnessed any entanglements with leatherbacks in recent years (Figure A-38). This could also possibly be attributed to their shrinking population in the Pacific. Therefore, despite a plethora of suitable habitat, there are not large actual densities of leatherbacks within the CCE in recent years, especially in the Pacific Northwest. However, if fishing effort continues to increase this could increase overlap and entanglement risks with leatherbacks.

Table A-28: Overlap separated by year and sector for all sablefish pot overlap with leatherback habitat suitability. These are the monthly summed overlap for all months within the year.

Year	LE	OA	CS	Total
2014	1.41	15.48	12.94	29.83
2015	2.43	0.00	17.25	19.68
2016	7.18	0.00	15.75	22.93
2017	3.2	0.00	20.86	24.01
2018	8.41	6.93	16.51	31.85
2019	6.07	0.00	21.64	27.71
2020	16.18	0.00	12.48	28.66
2021	3.19	0.00	8.79	11.98

2022	6.16	0.00	8.74	14.90
2023	24.1	5.55	3.77	33.40

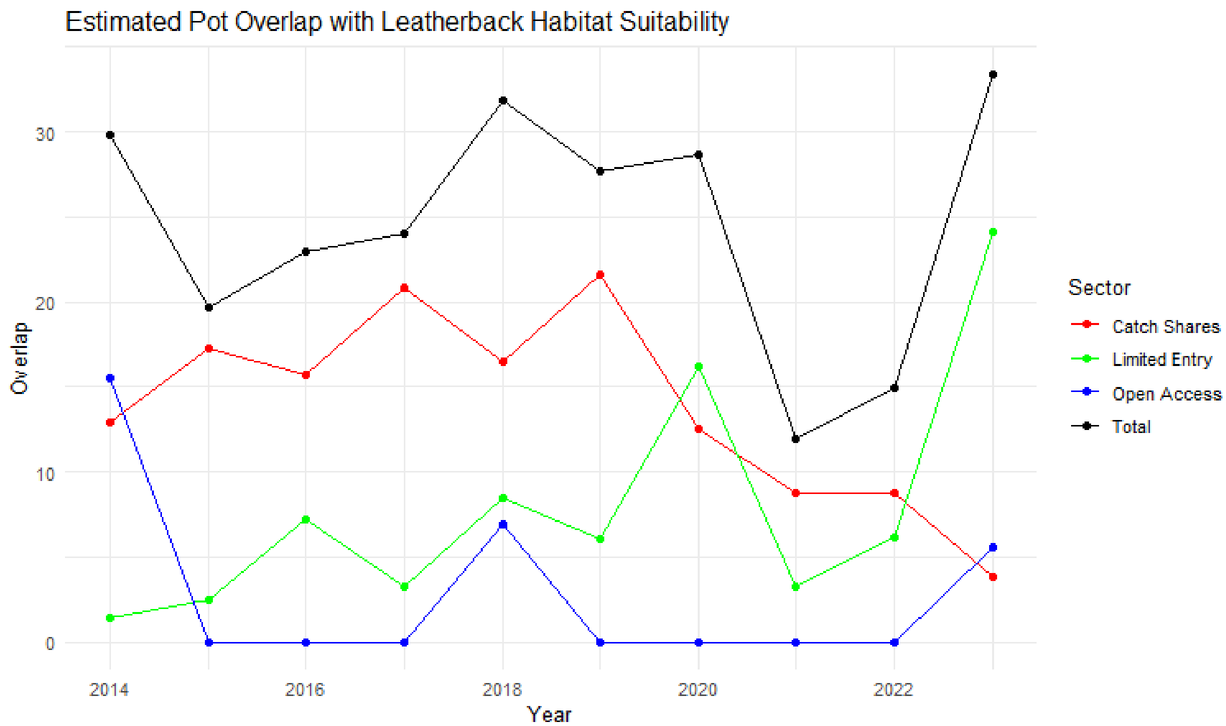


Figure A-38: Estimated pot sets overlap with leatherback sea turtle habitat suitability. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each year for all years 2014-2023.

OA sablefish pot fishing effort is similar in distribution and timing to LE effort, as they both have a seasonal peak in effort in the late summer and early fall months, unlike CS effort, which is relatively stable year-round (Figure A-4). Upon analyzing the spatial distribution of OA fishing effort from 2014-2023, a majority (94%) of the observed effort occurs within northern and central California between 35.5°N and 40°N. Leatherbacks are known to forage closer to shore in their central California habitat (in depth ≤ 200 m: Benson personal comm August 8th, 2024; Benson et al. 2011), thus likely having a relatively low co-occurrence with sablefish pot fishing averaging depths around 300 m with a median depth of 250 m (140-170 fathoms). Especially in comparison to their Oregon foraging habitat which occurs further offshore, around 2000 m (Benson et al. 2011), which would be expected to even less likely overlap with sablefish pot gear.

Although there is only a single observed leatherback entanglement in the groundfish fisheries, within the OA sector of the fishery that occurred offshore of northern California, we investigated the more recent overlap. Only 0.85% of observed OA sets overlap with a location that contains leatherback habitat suitability. This would indicate (still noting the relatively low observer coverage rate and therefore available data), that the OA sector has posed a limited risk to leatherback entanglement in the past. A majority of these overlaps (n=3) occurred in August and in 2018, at the end of the marine heat wave. The other two values occurred in 2014 and 2023 and in May and March. These overlaps occur between 122-124° longitude and 37-46° latitude.

Leatherbacks forage in their critical habitat due to the large aggregation of jellyfish, their main prey item, and it appears that during warmer water years, leatherback distribution shifts towards their prey and possibly into increased pot effort. We see recent increases in overlap in Oregon waters, with central California overlap dominated by earlier years (2014-2016). If this trend continues there would be elevated risk for leatherbacks in northern waters and decreased risk in California waters which is where we know leatherbacks to reside in recent years.

Hook-and-Line Fisheries

Although there are no observed entanglements of leatherback turtles in PCGF hook-and-line gear, we recognize that the risk of entanglement or hooking in vertical lines associated with hook-and-line gear could occur in the future, or may have occurred previously without confirmed documentation. In addition, given that Amendment 32 reopened areas to PCGF hook-and-line gear within areas associated with designated critical habitat for leatherbacks (recognizing that a large amount of leatherback critical habitat was already open to PCGF hook-and-line gear), we wanted to evaluate the co-occurrence dynamics between leatherbacks and PCGF hook-and-line fishing. We analyzed the distribution of hook-and-line fishing overlap with leatherbacks, spatially, seasonally, over time, and across sectors, to identify any specific trends that can inform our understanding of entanglement risks associated with PCGF hook-and-line gear, and how those risks may change in the future.

LE effort overlaps highest along the Oregon and Washington coasts, as well as northern California through Monterey Bay, and is the prominent sector with overlap.* OA effort overlaps the most off along the Oregon coast, and in the Monterey Bay area.* LE TL overlap mostly occurs within the Southern California Bight, and up into central California.* CS effort overlap is minimal, but is distributed fairly evenly along the U.S. West Coast.* Overall, the main hotspots for hook-and-line overlap with suitable leatherback habitat include north of the Columbia River mouth, south of Cape Blanco, Monterey Bay, and Orange County(Figure A-39). However, overlap is very sparse especially compared to the distribution of hook-and-line effort (Figure A-39 and A-5).

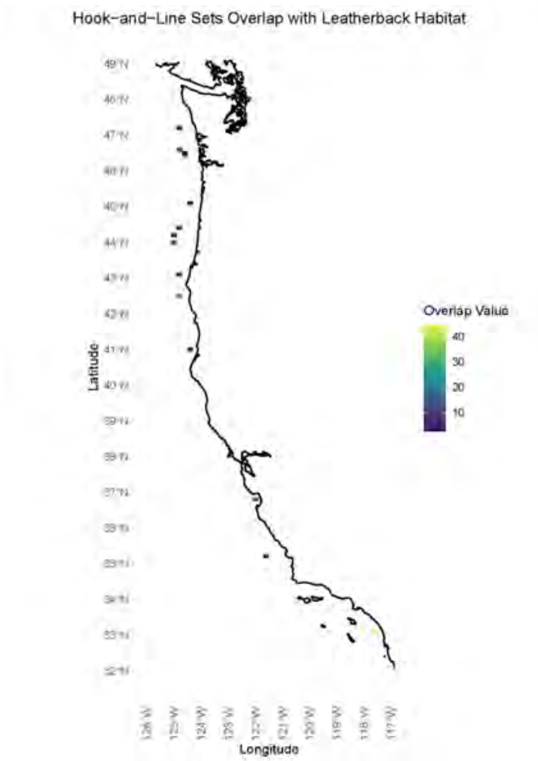


Figure A-39: Estimated total hook-and-line sets (scaled to represent 100% fishing effort based on annual observer coverage annual rates) overlapped with predicted leatherback habitat suitability. Overlap is colored by the magnitude of overlap which is unitless.*

Next, we analyzed how hook-and-line overlap varied seasonally throughout the year. Hook-and-line total overlap across sectors peaked in August and had the lowest overlap in April (Table A-29, Figure A-40). The CS sector had the highest overlap in September, LE in September, LE TL in August, and OA in July (Table A-29, Figure A-30).

Table A-29: Overlap separated by month and sector for all PCGF hook-and-line overlap with leatherback habitat suitability. These are the monthly summed overlap for all years, 2014-2023.

Month	LE	LE TL	OA	CS	Total
January	0	20.42	0	0.04	20.45
February	0	22.93	0	0.21	23.14
March	0	24.77	0.76	0.08	25.61
April	4.62	0	2.36	0	6.98
May	5.01	7.58	17.34	0	29.94
June	22.43	7.12	15.06	0	44.61

July	13.70	31.37	32.74	0	77.81
August	11.40	54.27	22.02	2.32	90.02
September	32.21	0	17.89	5.02	55.11
October	8.12	17.74	22.15	3.28	51.29
November	0	23.05	13.06	1.45	37.56
December	0	16.07	0	0.39	16.46

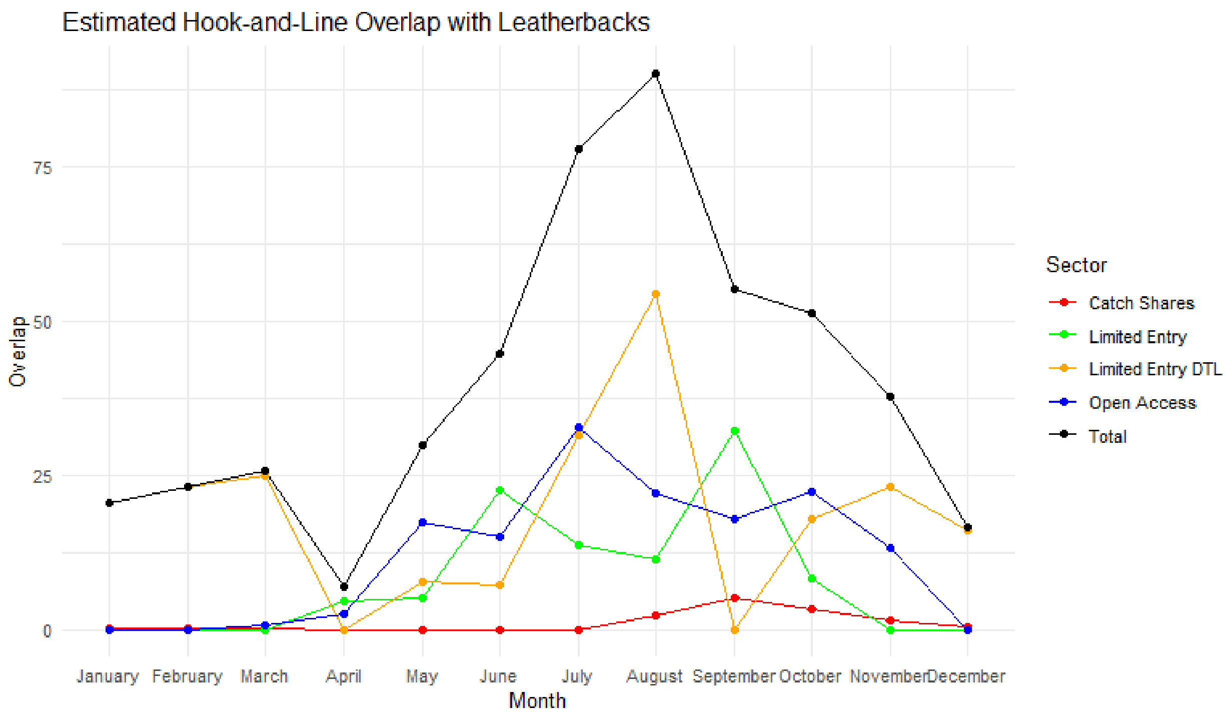


Figure A-40: Estimated hook-and-line overlap with leatherback sea turtle habitat suitability. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each month for all years 2014-2023.

We also assessed the interannual variability to help understand the dynamics of risk associated with PCGF hook-and-line fisheries. There was not much overlap in recent years, and there appears to have been more overlap in previous years, thus a decreasing trend in overlap throughout the time series (Figure A-41). Recent overlap mostly occurred along the Oregon coast, although there has been some in central and southern California*. The sum of annual hook-and-line overlap was highest in 2017 and the least amount of overlap occurred in 2020 (Table A-30). The CS sector had the highest overlap in 2014, LE in 2017, LE TL in 2017, and OA in 2023 (Table A-30, Figure A-41).

Table A-30: Overlap separated by year and sector for all PCGF hook-and-line overlap with leatherback habitat suitability. These are the summed overlap for all months within the year.

Year	LE	LE TL	OA	CS	Total
2014	14.14	31.51	0	5.47	51.12
2015	16.50	24.50	23.43	1.69	66.12
2016	13.20	8.60	19.24	3.70	44.75
2017	14.28	57.47	30.81	0.46	103.02
2018	12.57	34.98	29.98	1.32	78.85
2019	8.63	26.53	0	0.15	35.31
2020	3.09	16.95	0	0	20.05
2021	6.55	0	6.99	0	13.54
2022	8.52	24.77	0.76	0	34.05
2023	0	0	32.18	0	32.18

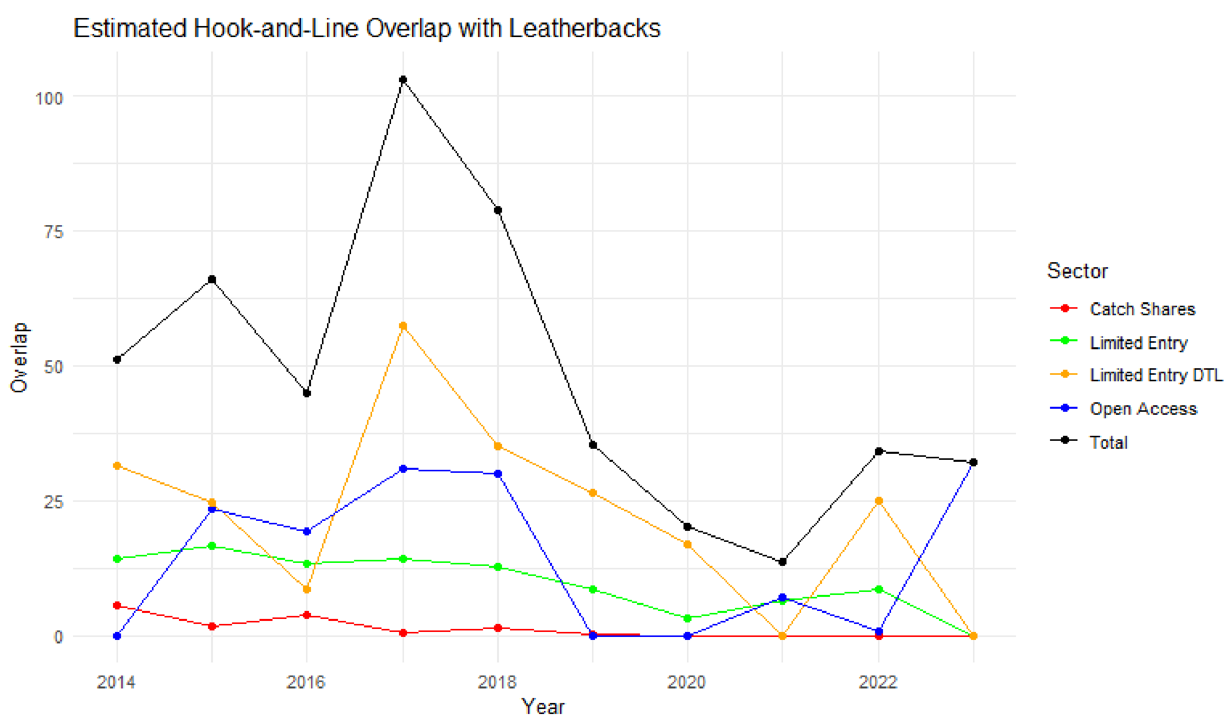


Figure A-41: Estimated hook-and-line overlap with leatherback sea turtle habitat suitability. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each year for all years 2014-2023.

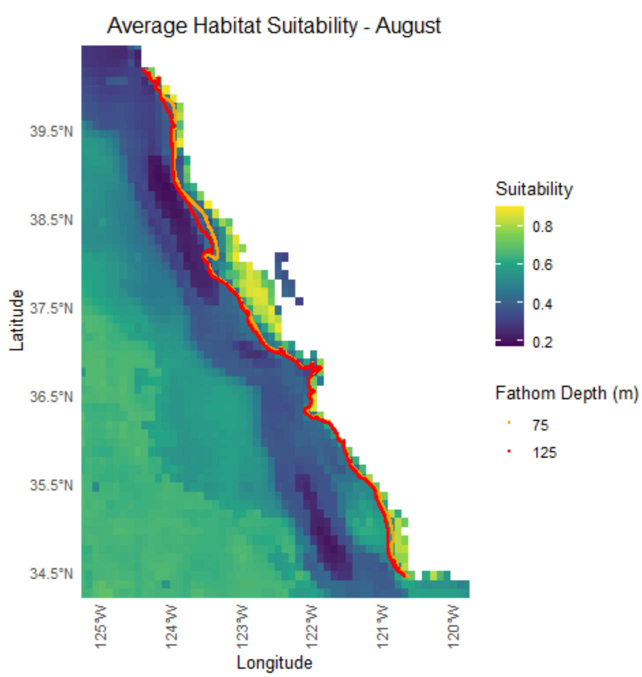
Amendment 32

Amendment 32 to the groundfish FMP recently reopened a portion of a RCA area that was previously closed off the coasts of Oregon and California to non-trawl fishing, including the fixed-gear (pot and hook-and-line gear) sectors and vessels that gear switch under the IFQ program. This opened up fishing opportunities in Oregon and northern California waters from 75-100 fathoms, and in central California from 75-125 fathoms, to be possibly exploited by sablefish pots and hook-and-line fishing which had been closed for decades. Since leatherbacks have been known to aggregate around and migrate through these areas, we wanted to assess the risk of future increased fishing may have in this area given the predictions for average monthly leatherback habitat suitability values from 2014-2023. Predictions for suitable leatherback habitat along the U.S. West Coast peak in late summer and fall, coinciding with the peak in groundfish fishing effort. Figures A-42, A-43, and A-44 display average leatherback habitat suitability predictions values for August, September, and October, from 2014-2023. Fathom contour lines bind the areas that Amendment 32 opened up to fixed-gear fishing. Figures are separated by the different boundaries opened in central California versus northern California and Oregon waters.

Looking at average habitat suitability predictions in peak months reveals that most of the area reopened by Amendment 32 is outside of highly suitable leatherback habitat. Assuming the probability of leatherback presence is related to the relative suitability of habitat, it appears that leatherbacks are more likely to be found inshore of the 75-125 fathom lines that distinguish the newly opened areas (Figure A-42, A-43, and A-44). However, we note that the distances between the new boundaries and the previous ones are spread further apart offshore in Oregon waters than they are in California waters, which highlights the challenge of interpreting the relatively small spatial margins associated both with the recent changes, along with distinctions from the model predictions, especially when the margins are packed closely together.

Previous fixed-gear fishing displayed effort in the areas immediately adjacent to these newly opened areas, therefore we believe it is likely that fixed-gear fishing will occur in these newly reopened areas, although the extent of effort shift is unknown. For all three peak months of suitable leatherback habitat, the newly opened fishing areas are relatively far from the peak habitat suitability in Oregon, but come closer to peak habitat suitability in central California. Areas of particular concern are the Monterey Bay, Cape Mendocino, and Point Conception. However, we note that the newly reopened areas seem to avoid the peak of San Francisco Bay Area prime habitat. This provides evidence that Amendment 32 may not pose a high risk to leatherback entanglement given that the areas opened up in Oregon are further away from peak leatherback habitat suitability in comparison to the central California opening.

In summary, the areas being reopened by Amendment 32 are more of an entanglement risk in late summer and early fall in California than Oregon, as the new fishing areas are closer to leatherback habitat further south. We consider overlap with a habitat suitability value higher than 0.75 to be a more substantial problem, and would represent the yellow areas on the model maps (Figure A-42, A-43, and A-44). This allows us to think there is a high likelihood of leatherbacks being found in those areas, especially given their small population sizes. This is especially true, as leatherbacks have only been recently seen in the central California foraging grounds and not their Oregon foraging grounds. Additionally, leatherbacks that forage in central California waters do so at shallower depths (< 200 m), compared to their foraging counterparts in Oregon which do so in deeper waters (200-2000m) (Benson et al. 2011). However, there is overall more fixed-gear effort further north in Oregon than around central California. There was not much overlap with hook-and-line fishing and leatherback habitat suitability in recent years, and there appears to have been more overlap in previous years (Figure A-41). This is a good sign that may indicate that Amendment 32 and the reopening of those areas to fixed gear fishing may not pose a high entanglement risk to leatherbacks. Considering the spatiotemporal differences in fishing effort by sector, the sectors most likely to overlap with these newly opened areas are likely OA and LE, and are likely to overlap more along Oregon than central California, given the current trends in spatial and sector overlap currently associated with the PCGF hook-and-line and pot fisheries.*



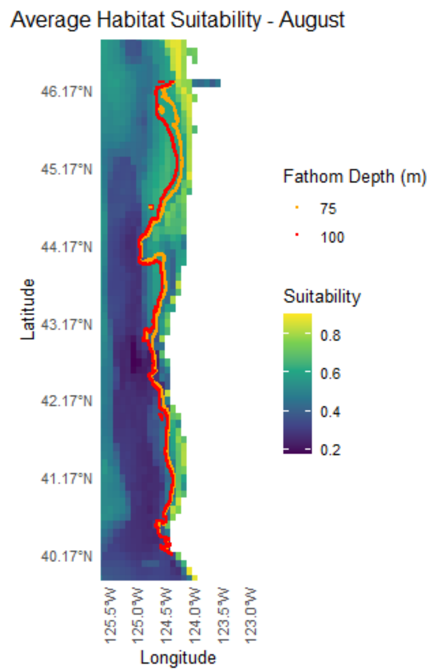
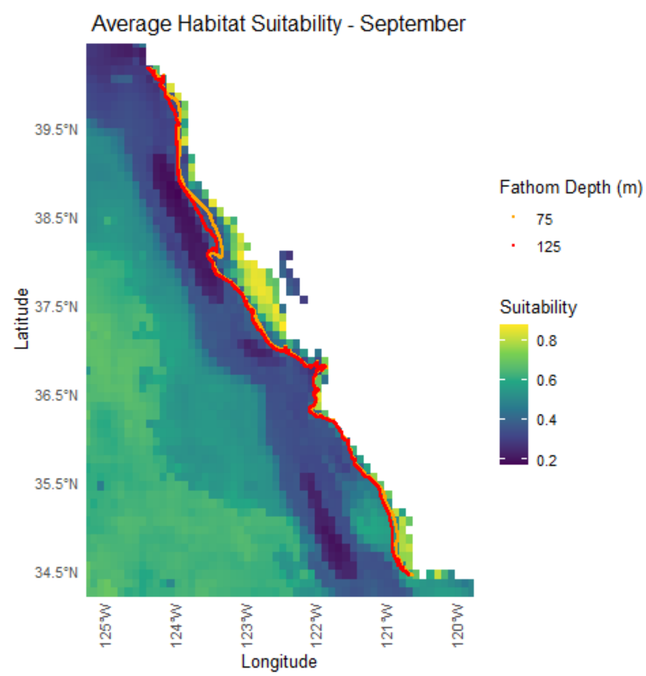


Figure A-42: Average leatherback habitat suitability from 2014-2023 for August in relevant central California waters (top) and northern California and Oregon waters (bottom). The colored contour lines represent fathom depths reopened by Amendment 32 to the groundfish FMP to non-trawl fixed-gear fishing.



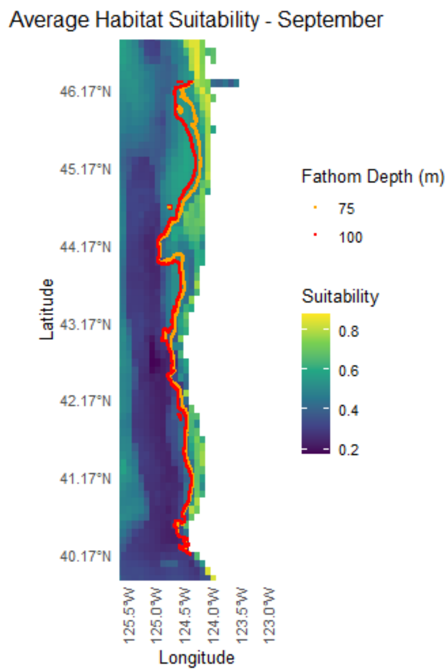
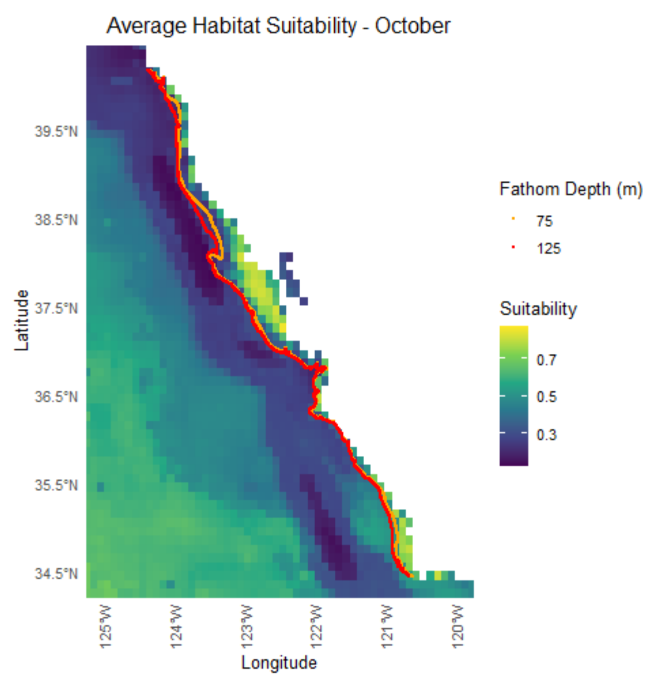


Figure A-43: Average leatherback habitat suitability from 2014-2023 for September in relevant central California waters (top) and northern California and Oregon waters (bottom). The colored contour lines represent fathom depths reopened by Amendment 32 to the groundfish FMP to non-trawl fixed-gear fishing.



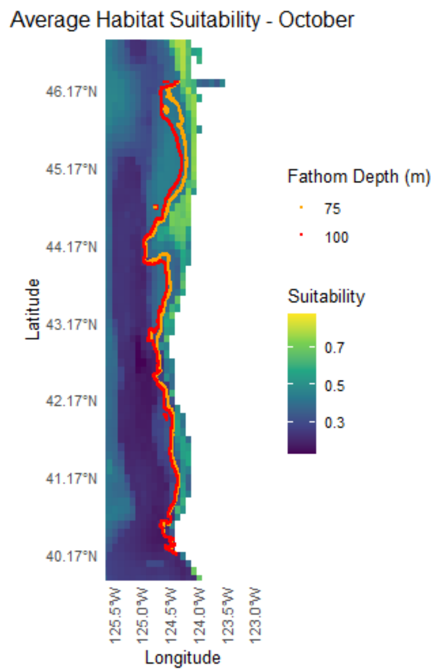


Figure A-44: Average leatherback habitat suitability from 2014-2023 for October in relevant central California waters (top) and northern California and Oregon waters (bottom). The colored contour lines represent fathom depths opened by Amendment 32 to the groundfish FMP to non-trawl fixed-gear fishing.

Midwater Trawl Fisheries

Although there have not been any observed entanglements of leatherback sea turtles in PCGF trawl gear, there have been some observed instances of incidental entanglement of leatherbacks and other sea turtle species in other trawl fisheries (Wallace et al. 2013). Therefore, we analyzed the co-occurrence of PCGF midwater trawl fisheries with predicted leatherback sea turtle habitat suitability. We chose not to analyze PCGF bottom trawl effort, as bottom trawling does not pose much of a threat to leatherbacks, as they are primarily a pelagic and epipelagic species, and we conclude it is unlikely that trawl nets associated with the seafloor would come into contact with leatherbacks during active fishing, with the exception of the limited time of set/retrieval of the net. Similar to the other PCGF gear types, we chose to analyze the distribution of co-occurrence of predicted leatherback habitat suitability with PCGF midwater trawling, seasonally, by year over time, by midwater trawl sector.

SS trawling overlap with suitable leatherback habitat occurs mainly offshore of the Oregon coast (Figure A-45). Overlap is highest offshore between 44°N-45°N and directly north of the Columbia river mouth (Figure A-45).

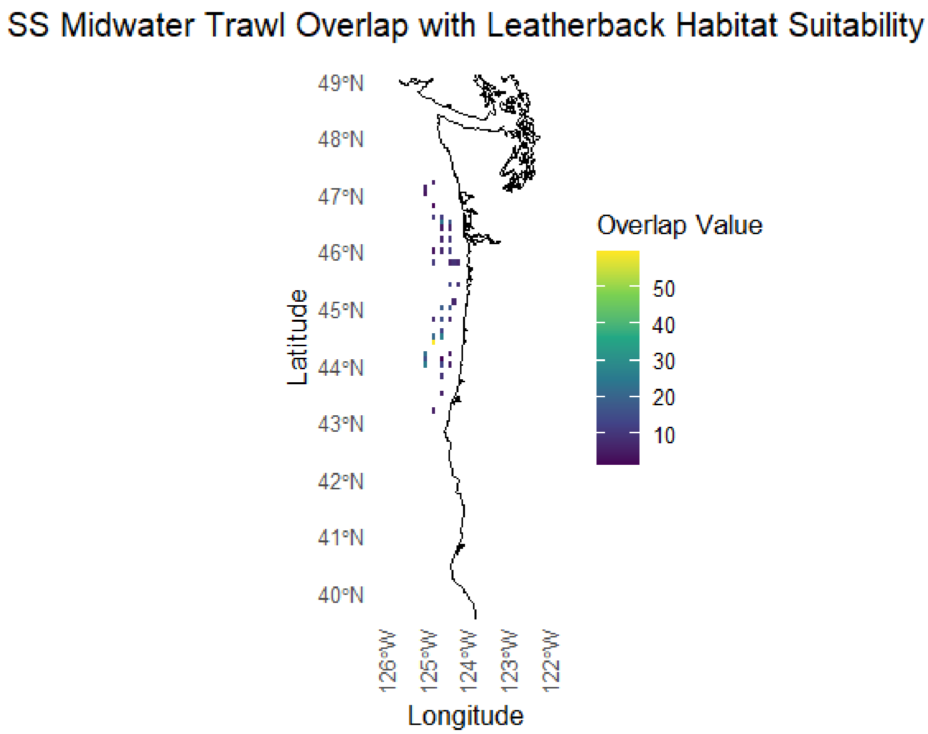


Figure A-45: Shoreside midwater trawl hours overlapped with leatherback habitat suitability. Overlap is colored by the magnitude of overlap and is unitless.*

AS midwater trawling effort occurs even further north than SS, with effort and thus overlap only occurring north of 41°N (Figure A-46). Hotspots for overlap with AS trawl include north of Cape Blanco, OR to south of the Columbia River Mouth and south of Cape Blanco, OR (Figure A-46).

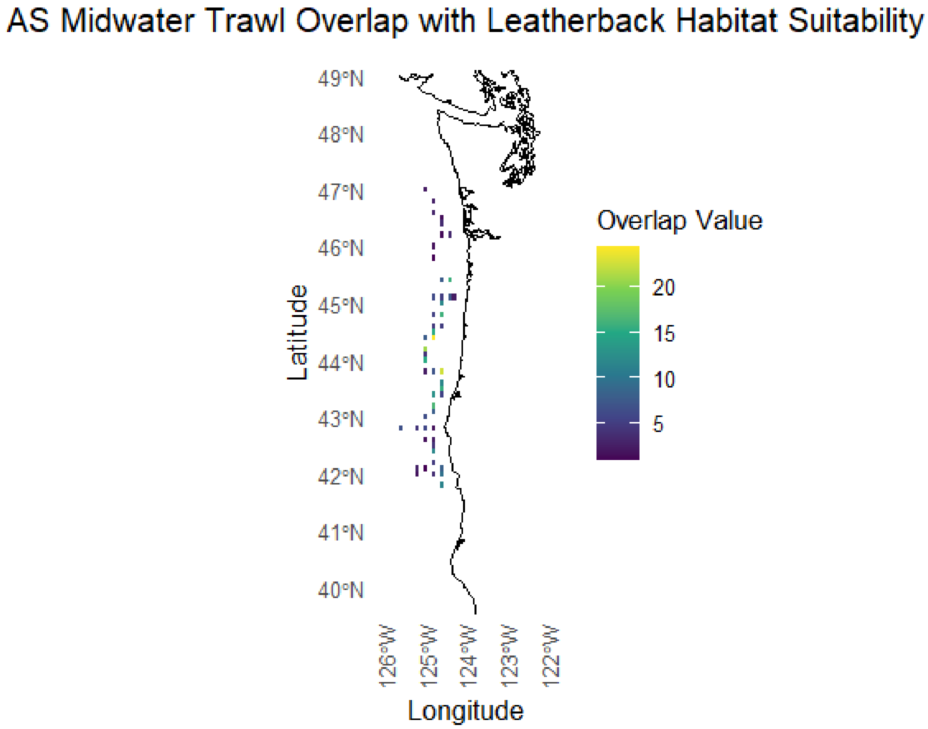


Figure A-46: At-sea midwater trawl hours overlapped with leatherback habitat suitability. Overlap is colored by the magnitude of overlap and is unitless.*

We also analyzed how SS midwater trawl overlap with predicted leatherback habitat suitability varies seasonally. Figure A-47 and Table A-31 illustrate peak overlap occurred from May-August, which is slightly ahead of peak leatherback distribution which tends to occur in late summer/early fall. This would suggest that midwater trawl effort may not pose as large of an entanglement risk to leatherbacks due to the offset in peak trawl effort (July) with peak leatherback sea turtle habitat (September/October). This makes sense as there have not been observations of leatherbacks entangled in SS trawl gear. However, given the high degree of habitat suitability in September and October, this was still driving relatively high risk during those months. It is important to note, since this model only represents suitable habitat and not actual leatherback density, this may be elevating actualized risk. Overlap was highest in the Hake sector in August, in October for the Rockfish sector (Table A-47 Figure A-31).

Table A-31: Overlap separated by month and sector for all shoreside midwater trawl overlap with leatherback habitat suitability. These are the monthly summed overlap for all years, 2014-2023. There is no EM data for 2014 and the 2023 EM was unavailable upon time of publication.

Month	Hake	Rockfish	Total
January	NA	0.4	0.4
February	NA	0.1	0.1

March	NA	0.2	0.2
April	NA	0.7	0.7
May	16.6	3.0	19.6
June	76.8	0.0	76.8
July	142.2	4.5	146.7
August	157.8	3.7	161.5
September	99.6	5.5	105.1
October	55.9	17.4	73.3
November	8.4	4.9	13.3
December	NA	0.2	0.2

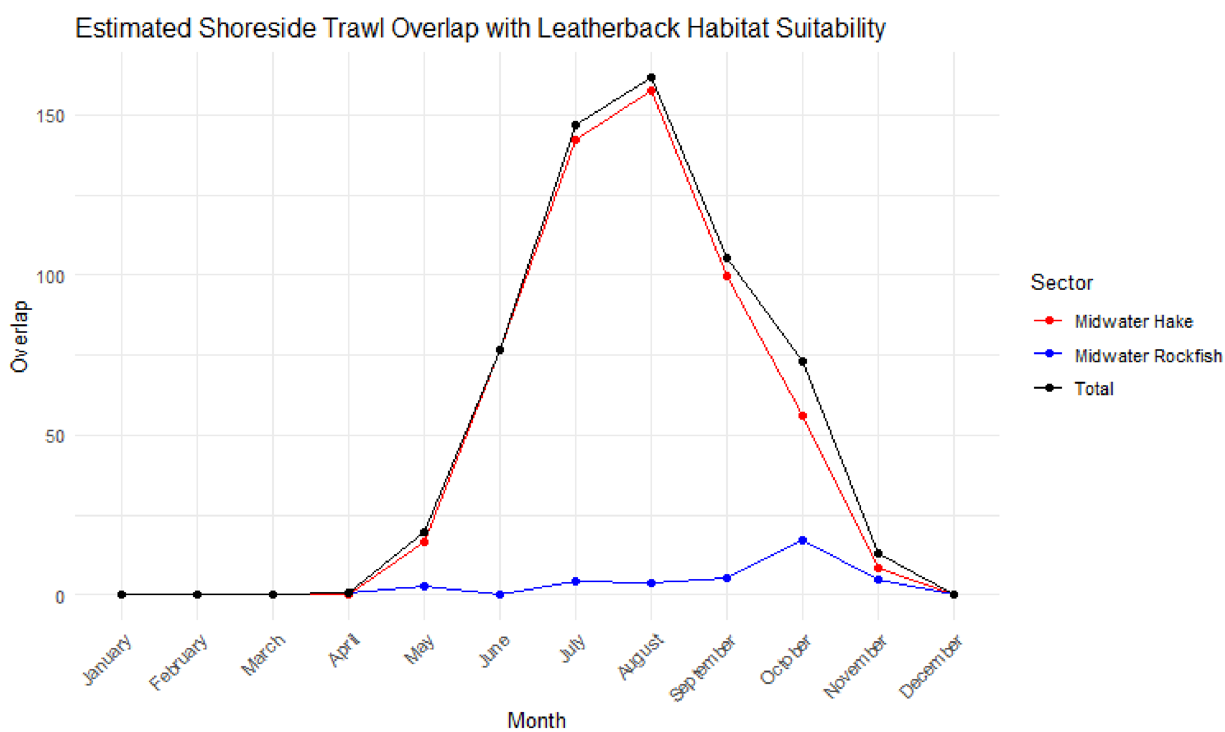


Figure A-47: Estimated shoreside midwater trawl overlap with leatherback sea turtle habitat suitability. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each month for all years 2014-2023.

Figure A-48 and Table A-32 illustrate the two peaks of overlap that occur, first a minor peak in

June, and then a major peak in October. This bimodal peak in overlap occurs for both the CP and MS sectors (Table A-32 and Figure A-48). This bimodal trend is also indicative of how AS fishing effort varies throughout the year (Figure A-16), likely being the main driver in overlap with leatherbacks. Leatherback distributions peak in October as well, which is likely what's also driving that largest peak that we see in October as compared to June (Figure A-20). There is no overlap between December and April as there is no AS fishing effort that occurs during those months (Figure A-48). Both the CP and MS subsectors of the AS fishery contribute to overlap fairly equally, with CP having larger trawl hours therefore slightly higher overlap.

Table A-32: Overlap separated by month and sector for all at-sea midwater trawl overlap with leatherback habitat suitability. These are the monthly summed overlap for all years, 2014-2023. There is no EM data for 2014 and the 2023 EM was unavailable upon time of publication.

Month	Catcher-Processor	Mothership	Total
January	NA	NA	0.0
February	NA	NA	0.0
March	NA	NA	0.0
April	NA	NA	0.0
May	26.7	21.6	48.3
June	38.0	46.7	84.7
July	NA	7.1	7.1
August	2.8	10.3	13.1
September	81.4	44.8	126.2
October	94.4	70.8	165.2
November	17.2	13.1	30.3
December	NA	NA	0.0

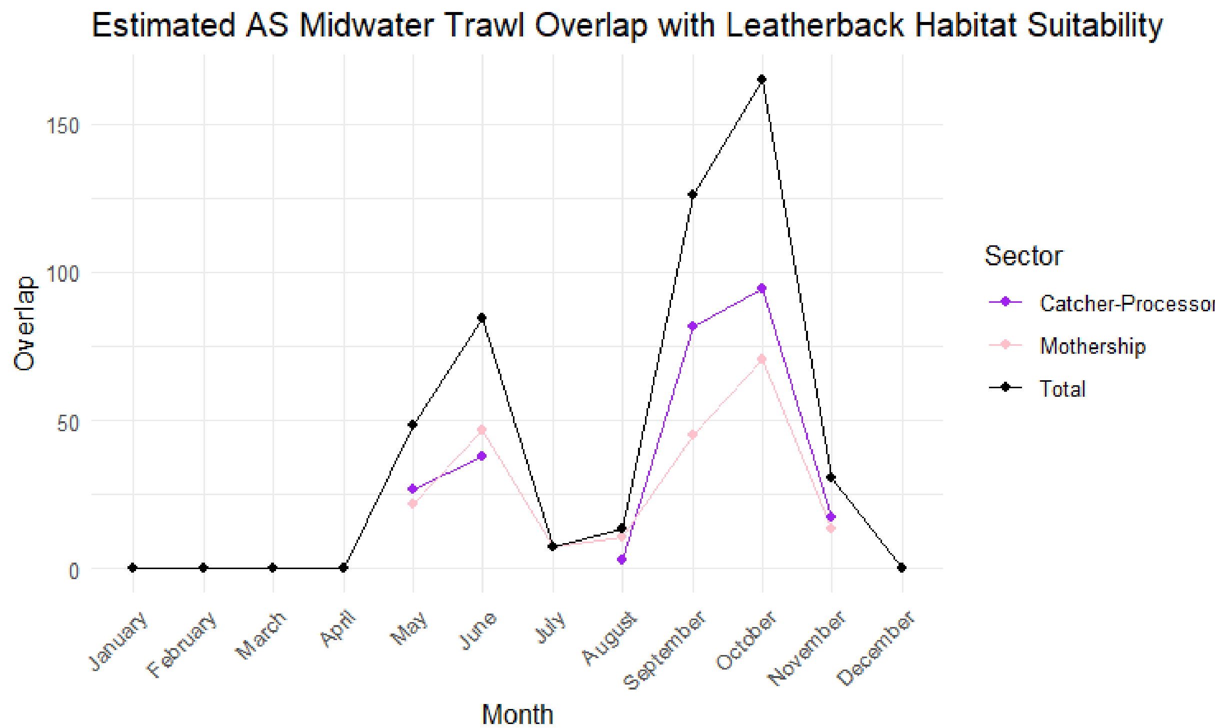


Figure A-48: Estimated at-sea midwater trawl overlap with leatherback sea turtle habitat suitability. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each month for all years 2014-2023.

We also evaluated how overlap of the SS midwater trawl fisheries with predicted leatherback habitat suitability varied throughout the time series, 2014-2022 (Table A-33 and Figure A-49). Overlap is highest in most recent years 2019-2022, and fairly small during the years prior, with the exception of 2015 (Figure A-49). Overlap has increased throughout the year (Figure A-49), similar to trawling fishing effort which has also increased throughout the years (Figure A-11). There does not appear to be any clear spatial trends in recent overlap, as overlap has generally spanned the entire distribution of midwater trawl fisheries over the entire time series.* Trawling effort is densely aggregated along the coasts of Oregon and Washington, where leatherback presence has become increasingly rare as the population continues to decline. Given the high level of observer coverage in the midwater trawl sectors, and the lack of observation of sea turtle bycatch in those fisheries, we generally conclude that leatherback entanglement risk in the SS midwater trawl sector is likely minimal, although we recognize that the potential may be increasing over time with respect to overlap with predicted suitable leatherback habitat.

Table A-33: Overlap separated by year and sector for all shoreside midwater trawl overlap with leatherback habitat suitability. The summed overlap represents overlap for all months within the year. There is no EM data for 2014 and the 2023 EM was unavailable upon time of publication.

Year	Hake	Rockfish	Total
2014	64.9	4.0	68.9
2015	93.5	7.6	101.0
2016	37.4	1.7	39.1
2017	29.9	1.6	31.5
2018	55.6	2.9	58.5
2019	68.2	3.4	71.6
2020	80.5	2.4	82.9
2021	54.6	11.5	66.1
2022	65.5	4.8	70.3

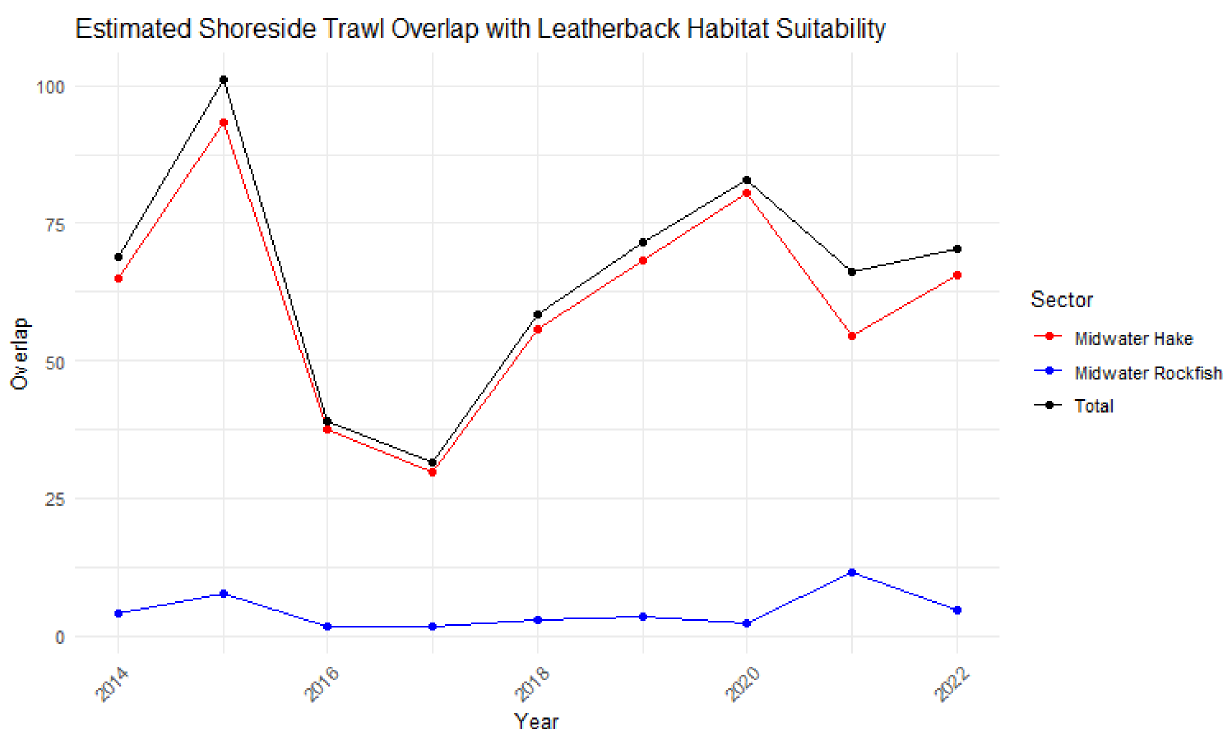


Figure A-49: Estimated shoreside midwater trawl overlap with leatherback sea turtle habitat suitability. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each year for all years 2014-2022.

Finally, we evaluated how overlap of the AS midwater trawl fisheries with predicted leatherback habitat suitability varied throughout the time series, 2014-2023 (Table A-34 and Figure A-50). Overlap is the highest across sectors in 2022, with CP and MS also peaking in overlap in 2022 (Table A-34). Before 2022, it appears as though overlap was oscillating, but remained fairly static across sectors and within the AS fishery as a whole (Figure A-50). Therefore, in the most recent years, 2020-2022, overlap was increasing and reaching its time series high in 2022, but it is hard to definitively say if this will continue into the future, especially without complete 2023 data. This is likely being driven by fishing effort as leatherback habitat suitability across years is fairly similar and does not deviate significantly in magnitude or distribution (Figure A-19).

Table A-34: Overlap separated by year and sector for all at-sea midwater trawl overlap with leatherback habitat suitability. The summed overlap represents overlap for all months within the year. There is no EM data for 2014 and the 2023 EM was unavailable upon time of publication.

Year	Catcher-Processor	Mothership	Total
2014	21.4	22.6	44.0
2015	29.4	13.5	42.9
2016	30.3	25.3	55.7
2017	23.8	23.5	47.3
2018	24.3	35.3	59.6
2019	14.8	12.8	27.6
2020	27.7	4.6	32.3
2021	33.6	21.3	54.9
2022	36.7	41.2	77.9
2023	18.4	14.3	32.7

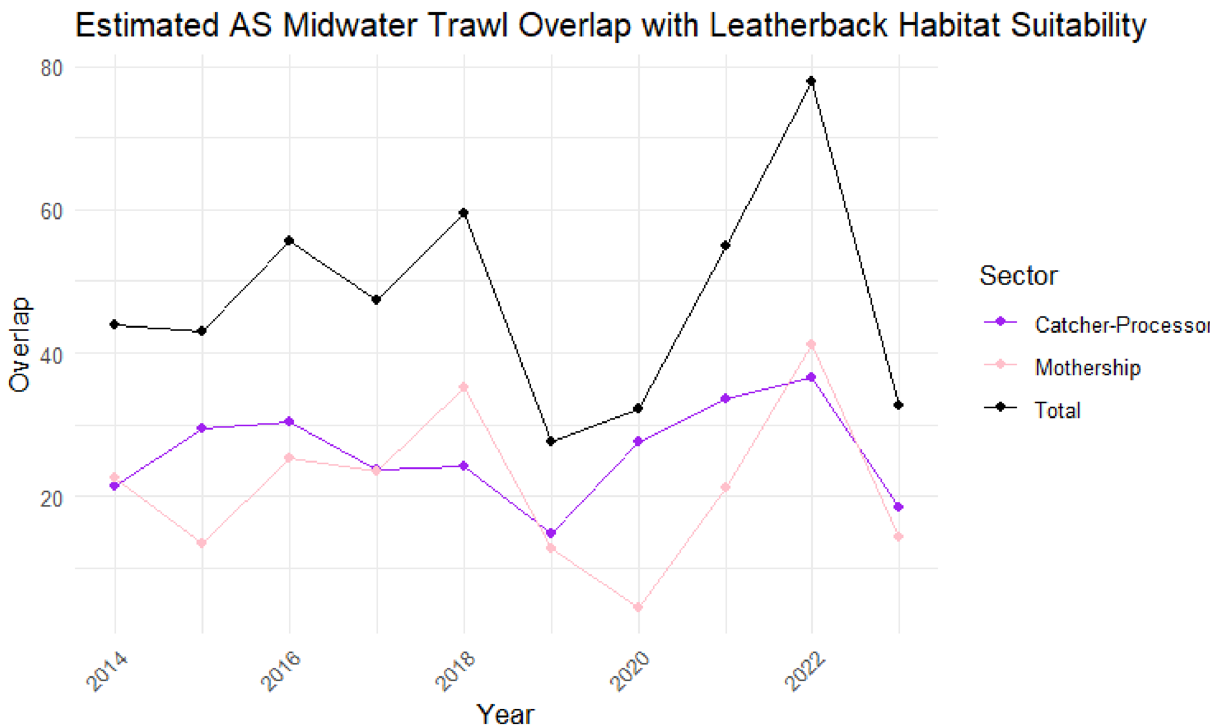


Figure A-50: Estimated at-sea midwater trawl overlap with leatherback sea turtle habitat suitability. Lines and points are colored by the sector in which the overlap belongs or the total overlap. Values are the summed overlap that occurs within each year for all years 2014-2023.

Key Findings and Overall Conclusions

Fishing Effort

- Pot:
  - Qualitative review of mapped effort shows a northward shift over the time series in pot set effort, particularly for the CS sector
    - Effort no longer occurs in southern California
  - Qualitative review of mapped effort shows OA sector effort concentrated around central and northern California but this could be biased as there is very minimal observer coverage
  - Estimated pot sets have fluctuated throughout the years, but were the largest of the time series in 2016. Overall estimated number of sets has oscillated but remained stable throughout the time series
  - Effort was highest in September and October
- Hook-and-Line:
  - Numbers of sets have been fairly consistent across years and sectors, and show no clear linear increasing or decreasing trend, except for the CS sector (which has ceased completely as of 2020)

- Qualitative review of mapped effort shows broad distribution along the entire coast which is consistent across years
- Low observation rates within hook-and-line gear makes it difficult to draw conclusions about trends
- There is no distinction within WCGOP data of the type of hook-and-line gear used, and therefore it is difficult to partition out specific gear types and their associated risk
- Hook-and-line effort was highest in August

- Midwater Trawl:
  - Hake is the predominant trawl sector, with the effort spread across SS fishing effort and CP and MS both contributing highly to observed AS fishing effort
  - Effort only occurs north of 40°N for both AS and SS
  - Estimated SS trawl hours have increased throughout the time series, with 2022 (the last year with full available data) having the largest number of estimated hours of the time series, despite landings remaining relatively constant
  - Estimated AS trawl hours have oscillated throughout the times series, but also peaked in 2022
  - Trawl hours peak in July and August for all SS sectors, and in May and October for AS sectors

Species Distribution:

- Humpback Density Distribution Prediction
  - This model is likely underestimating the abundance of whales on the U.S. West Coast, especially in the winter, and considered to estimate the average risk and not necessarily the peak entanglement risk when used in conjunction with co-occurrence analyses
  - Hot spots of predicted humpback whale aggregation throughout the years include: Cape Mendocino, Monterey Bay, Cape Elizabeth, and along the Oregon coast, these fluctuated on a yearly basis
  - During the recent marine heat wave (2014-2018), humpback whales returned to the U.S. West Coast earlier than in more recent years, and in higher densities earlier in the year in those heat wave years
  - Densities, distributions, and migration timing vary from year to year and month to month, but peak density appears to occur consistently in the late summer/early fall months around September
- Leatherback Habitat Suitability Prediction
  - Peak in predicted habitat suitability occurs in the late summer and early fall months (September and October)

- ○ There are not substantial differences in the timing or distribution of predicted suitability across years; peak suitability typically occurs in the same months and is distributed in the same areas
- ○ Consistent hot spots include around the Columbia River mouth and just offshore from the San Francisco Bay area
- ○ If there is variability across years, it was earlier months having higher/broader suitability in some years (marine heat wave years) and others having lower/narrower suitability in earlier months (non-heat wave years)
- ○ Despite relatively high habitat suitability, sighting and survey data show minimal recent observations of leatherbacks in waters off the coast of Oregon and Washington
- ○ This model represents a conservative estimate of entanglement risk because it evaluates the potential for risk in areas of suitable habitat regardless of whether leatherbacks have been recently observed, as the abundance of Western Pacific population of leatherbacks has diminished

Humpback Whales Co-Occurrence:

- Pot:
  - Overlap was largest in late September and October which coincides with peak pot effort and the peak of humpback whales in the EEZ
    - Overlap is highest for the OA sector in June, LE in October, and CS in October.
  - Overlap has shifted northward over time, reflecting the same trend displayed by pot fishing effort, although the predicted distributions of humpbacks instead fluctuates on a year to year basis
  - For each sector, and in total, ~40% of sets overlapped with predicted humpback whale distribution, with the majority of this overlap occurred in CA/OR
- Hook-and-Line:
  - Overlap was largest in October coinciding with peak fishing effort
    - June is peak for the OA sector, September for LE, and October for LE TL and CS
    - Hook-and-line effort matches peak months for LE and CS, and effort is likely driving overlap in the LE and CS sectors, while humpback whale density is driving overlap in the OA and LE TL sectors
  - Recent overlap has occurred further north than historical trends, however we have not seen a drastic northward shift in effort. With a broad distribution in hook-and-line effort and decreasing overall effort, recent overlap is likely driven by humpback whale distribution

    - Over all sectors, ~40% of estimated hook-and-line sets overlapped with predicted humpback whale distributions, with a majority of this overlap occurring in CA/OR versus WA with the exception of the CS sector which has 54% of its overlap in WA.
- Reopened areas will lie outside of the outer perimeters of peak whale density, but in some areas, specifically central California, these newly reopened areas do tend to overlap with whale density
    - The newly reopened areas avoid the peak areas for humpback whales but still presents some but small risk to entanglement
    - Previously fixed gear fishing has occurred right next to the previously closed borders; therefore, it is likely to assume that fishing will push into these areas and may interact with humpback whales
    - Overlap in this new area is highest in July around San Francisco, in August from San Francisco to offshore OR, and in September further into OR waters
- Midwater Trawl:
    - June and July are the highest overlap months for the SS fishery, and June and October for AS likely driven by the earlier distribution of fishing effort rather than predicted humpback distribution as these months are before peak seasonal humpback distribution predictions
    - The increase in SS and AS overlap in recent years corresponds directly to the increase in trawl hours over the same time series
    - However only around 1-5% of trawls tows overlap with predicted humpback whale distribution making the overall risk of the fishery to humpbacks minimal, but increasing effort especially that of which overlaps with humpback whale densities could change this in the future
        - There is around a 50% split between overlap in CA/OR versus WA

Leatherbacks Sea Turtles Co-Occurrence:

- Pot:
    - Overlap was highest in August which coincided with peak fishing season and right in the middle of peak leatherback habitat suitability
        - OA sector overlap is highest in August, LE in September, and CS in October.
    - Overlap has shifted northward over time, driven more by the respective change of fishing effort in northern waters as leatherback suitability has not changed much. But given there are no recent sightings of leatherbacks in more northern waters of the CCE, risk may not have been tracking this northern shift

        - Overlap in California in recent years has decreased, and given this is where leatherbacks have recently been sighted, this likely does reflect decreasing entanglement risk with the sablefish pot fisheries
        - Overlap was oscillating but remaining relatively stable throughout the time series, peaked in overlap in 2023
- Hook-and-Line:
    - The LE sector had the largest and most broadly distributed overlap
    - The OA sector overlaps along the Oregon coast and offshore Monterey Bay
    - The LE TL sector overlaps in the Southern California Bight and further north into central CA.
    - Overlap peaks in July and August, which is driven by peak fishing effort during these same times, but also coincides with the beginning of peak leatherback suitability as well
    - Overlap peaked at the beginning of the time series (2014-2023), and in recent years overlap has been decreasing, with very minimal overlap in recent years.
    - Peak predicted leatherback suitability does not coincide with the re-opened boundaries
    - Re-opened areas are closer to peak suitability in northern and central California waters, but further away in Oregon waters
    - Fixed gear sectors most likely to interact with the reopened areas are the OA and LE sectors, and are more likely to overlap along Oregon than in California. Given leatherbacks have not recently been seen in these areas this will likely have minimal risk to leatherbacks
- Midwater Trawl:
    - Given fishing effort is concentrated in northern waters, and that leatherbacks have not been recently sighted in these areas, there is likely minimal entanglement risk between PCGF midwater trawling effort and leatherbacks
    - Predicted overlap has increased throughout the years due to the increase in fishing effort. While it is possible that this trend could continue, leatherbacks are not found in these more northern areas in recent years, and the risk still remains minimal.