UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

January 16, 2025

Refer to NMFS No: WCRO-2024-01765

Ryan J. Wulff
Assistant Regional Administrator for Sustainable Fisheries
650 Capitol Mall
Suite 5-100
Sacramento, CA 98514

Re: Endangered Species Act Section 7(a)(2) Biological Opinion for the Continued Operation of the Groundfish Fishery Under the Pacific Coast Groundfish Fishery Management Plan and the Effects of the Fishery on Sunflower Sea Stars

Dear Mr. Wulff:

Thank you for your letter of June 10, 2024, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for Continued Operation of the Groundfish Fishery Under the Pacific Coast Groundfish Fishery Management Plan and the Effects of the Fishery on Sunflower Sea Stars.

Having conducted a comprehensive review of the potential impacts of continued operation of the groundfish fishery on the sunflower sea star, we concur with your determination that operation of the fishery is likely to adversely affect the species, but not likely to jeopardize the species. This serves as a conference opinion at this time, given that the sunflower sea star is only proposed for listing (88 FR 16212), but may be adopted as our formal biological opinion per 50 CFR § 402.10(d) should: 1) no significant new information be developed during the final rulemaking process to list the species; and 2) no significant changes to the proposed action occur that would alter the content of this opinion. When this rulemaking is complete, we will document evaluation of these criteria in writing and state whether reassessment is needed, or whether this conference opinion now represents our biological opinion.

Please contact Dayv Lowry, Protected Resources Division, Seattle Branch (Lacey Field Office) at dayv.lowry@noaa.gov or 253-317-1764 if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Assistant Regional Administrator
for Protected Resources

Enclosure

cc: Administrative file 2024WCR151422PR00229
Maggie Sommer, SFD
Keeley Kent, SFD
Grace Ferrara, PRD
Lynne Barre, PRD
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Endangered Species Act Section 7(a)(2) Conference/Biological Opinion

Continued Operation of the Groundfish Fishery Under the Pacific Coast Groundfish Fishery Management Plan and the Effects of the Fishery on Sunflower Sea Stars

NMFS Consultation Number: *WCRO-2024-01765*
DOI: 10.25923/v7s8-vs43

Action Agency: National Marine Fisheries Service, West Coast Region, Sustainable Fisheries Division

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	If likely to adversely affect, Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	If likely to adversely affect, is Action Likely to Destroy or Adversely Modify Critical Habitat?
Sunflower Sea Star (*Pycnopodia helianthoides*)	Proposed Threatened	Yes	No	NA	NA

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

Issued By: Chris E Yates

Chris Yates
Assistant Regional Administrator
for Protected Resources

Date: January 16, 2025

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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

The National Marine Fisheries Service (NMFS) prepared the conference 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 U.S.C. 1531 et seq.), as amended, and implementing regulations at 50 CFR part 402.

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/welcome). A complete record of this consultation is on file at the Lacey Field Office in Lacey, WA.

1.2. Consultation History

NMFS has considered impacts to ESA-listed species resulting from continued operation of the groundfish fishery under the Pacific Coast Groundfish Fishery Management Plan (FMP) in several previous biological opinions. The sequence of previous consultation activities related to the FMP is summarized in Table ***1.*** ESA section 7 consultation activities related to the Pacific Coast Groundfish Fishery Management Plan.. In each determination, NMFS concluded that the proposed actions were not likely to jeopardize the continued existence of any of the listed species. NMFS also concluded that the actions were not likely to destroy or adversely modify designated critical habitat for any of the listed species. The most recent consultation on effects on ESA-listed salmonids was completed in 2017 (NMFS 2017a), a consultation for Southern Resident killer whales was completed in 2022 (NMFS 2022a), and a consultation for impacts to humpback whales and leatherback sea turtles was completed in 2024 (NMFS 2024a).

On March 16, 2023, NMFS proposed to list the sunflower sea star (*Pycnopodia helianthoides*) as threatened under the ESA throughout its range (88 FR 16212). Given that the sunflower sea star is only proposed for listing, this document represents a conference opinion at this time but may be adopted as our formal biological opinion per 50 CFR § 402.10(d) should: 1) no significant new information be developed during the final rulemaking process to list the species; and 2) no significant changes to the proposed action occur that would alter the content of this opinion. When this rulemaking is complete, we will document evaluation of these criteria in writing and state whether reassessment is needed, or whether this conference opinion now represents our biological opinion.

In the proposed listing (88FR 16212), we concluded that critical habitat was indeterminable. As

the result of a lack of specific knowledge regarding habitat attributes and features critical to the survival of the sunflower sea star, critical habitat for the sunflower sea star has not been proposed or designated.

Table 1. *ESA section 7 consultation activities related to the Pacific Coast Groundfish Fishery Management Plan.*

Date	Citation	ESU considered or circumstances
10-Aug-90	(NMFS 1990)	Sacramento River winter-run Chinook salmon, marine mammals, and turtles
26-Nov-91	(NMFS 1991)	Sacramento River winter-run Chinook salmon and Snake River sockeye salmon
28-Aug-92	(NMFS 1992)	Sacramento River winter-run Chinook salmon, Snake River sockeye salmon, Snake River spring/summer Chinook salmon, and Snake River fall Chinook salmon
27-Sep-93	(NMFS 1993)	High bycatch of pink salmon, ITS revised
14-May-96	(NMFS 1996)	Bycatch exceedance of take limit of Chinook in the 1995 whiting fishery (14,557)
15-Dec-99	(NMFS 1999)	Consultation on the effects of the FMP on 22 newly listed ESUs and Snake River fall Chinook
25-Apr-02	(Robinson 2002)	Bycatch exceedance of take limit of Chinook in the 2000 whiting fishery (11,513)
11-Mar-06	(NMFS 2006a)	Bycatch exceedance of take limit of Chinook in the 2000 and 2004 trawl fishery and the 2005 whiting fishery; reconsideration of Puget Sound, LCR, Snake River fall, UWR Chinook; addition of Sacramento River winter-run, CC, and Central Valley spring-run Chinook
7-Dec-12	(NMFS 2012)	Green sturgeon, eulachon, humpback whales, Stellar sea lions, and leatherback sea turtles
11-Dec-17	(NMFS 2017a)	Puget Sound, Lower Columbia River, Upper Willamette River, Upper Columbia River spring, Snake River spring/summer, and California coastal Chinook salmon; Lower Columbia River, Oregon coast, southern Oregon/northern California, and central California coast coho
12-Oct-18	(NMFS 2018)	Eulachon
26-Oct-20	(NMFS 2020)	Humpback whales
7-Dec-22	(NMFS 2022a)	Southern Resident killer whales
22-Nov-24	(NMFS 2024a)	Humpback whales and leatherback sea turtles

Anticipating completion of the listing proposal for the sunflower sea star, NMFS staff with the West Coast Region Protected Resources Division (Dayv Lowry) and Sustainable Fisheries Division (Keeley Kent and Maggie Sommer) began sharing data and informally consulting in October of 2022. Over the next 20 months, staff identified gear types within the groundfish fishery likely to interact with sunflower sea stars and developed a strategy to estimate impacts from such interaction, drawing on fishery bycatch and systematic survey data where possible.

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 (84 FR 44976; 89 FR 24268). 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 Pacific Coast Groundfish Fishery (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 Pacific Fishery Management Council (Council) 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 groundfish harvest specifications and considers new information, then makes recommendations to NMFS, which implements specifications for the next two-year period. Harvest specifications for the current biennium are 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

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

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 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.

Based on fishery, gear, and target strategy, the PCGF can be further broken down into the following components (Table 2).

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. Beginning in 2025, 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 2. *Summary of gear and components by fishery managed through the Groundfish FMP.*

Fishery	Gear	Components
Limited Entry (LE) vessels registered to Federal LE groundfish permits (non- tribal)	Trawl—At-sea Pacific whiting cooperatives	Catcher-processor cooperative, Mothership sector cooperative
	Trawl—Shorebased Individual Fishing Quota (IFQ) program - Catch Shares	Pacific whiting midwater trawl
	Fixed gear (longline & pots/traps) - Non-Catch Shares	Non-Pacific whiting midwater trawl; Bottom trawl; IFQ Fixed gear (gear switching)
		Sablefish permit stacking (a.k.a. primary or tier) 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 closing 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 2011-18 as the fishery has evolved over this time, although groundfish retention decreased slightly in 2019 and 2020, before returning to 2018 levels in 2021-23 (Figure 1; Somers et al. 2023a). 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 2011-18, landings of midwater non-whiting occurred from central Washington to central Oregon, and expanded in 2019-21 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 (Somers et al. 2023a), 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 1) despite a gradual increase in hours fished over the last several years (Figure 2).

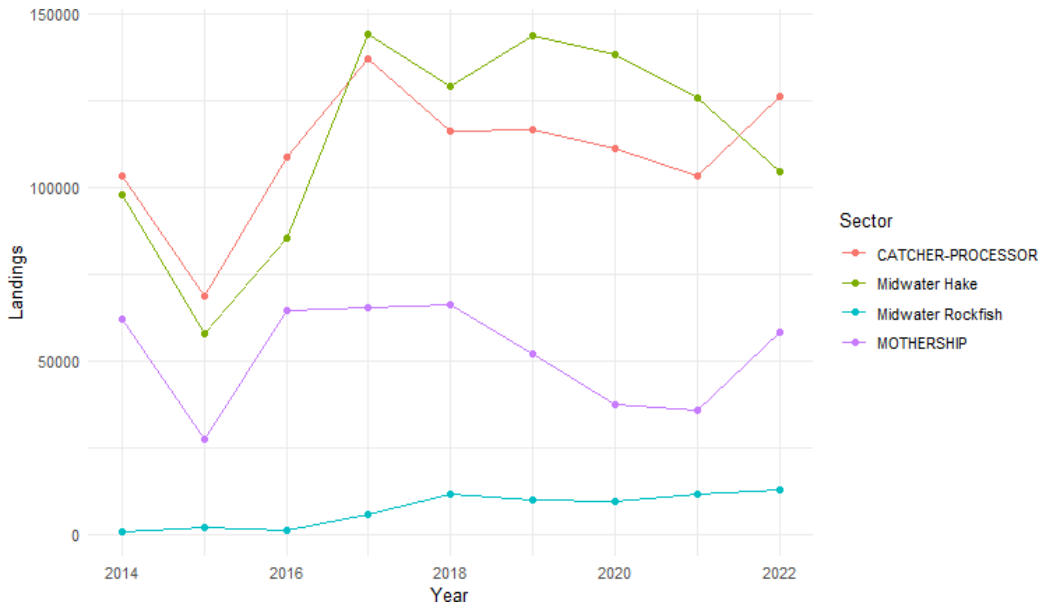

Figure 1. *Observed PCGF midwater trawl landings from 2014-22. Lines and points are colored by the sector in which fishing occurs and landings are represented in metric tons.*

Bottom Trawling

The bottom trawl fishery uses various types of trawl gear to target benthic groundfish species (e.g., Dover sole, petrale sole, sablefish). Management measures may vary depending on the type of trawl gear (i.e., large footrope, small footrope, selective flatfish trawl) used and/or on board a vessel during a fishing trip, cumulative limit period, and the area fished[2]. Landings and effort (tow hours) in the catch shares (CS) bottom trawl fleet have decreased from a high during the catch shares period in 2013.

Fleetwide bottom trawl effort continued to decrease from the high of the catch shares period in 2013, and was almost a third of that level in 2020 and 2021. Median haul duration has generally decreased since 2011 to around two hours and forty minutes in 2020 and 2021. The spatial distributions of landings were similar from 2019 to 2021. The greatest proportions of landings were made near Astoria, Oregon. Landings near the ports of Newport, Oregon and Fort Bragg, California each comprised approximately 20% of coastwide landings. The proportions of landings north of 46°N and south of 39°N for the most recent three years remained low and similar to past landings in those areas. Effort in the 0–50 fm depth bin decreased compared to earlier years, while activity in the 50–100 fm depth bin increased slightly (Somers et al. 2023a).

Hake Trawling

Pacific hake or whiting is managed under several authorities. The Joint Management Committee of the Pacific Whiting Agreement between the United States and Canada (2003) recommends the whiting total annual catch (TAC), and the U.S. implements catch limits for the U.S. portion of the fishery. The Council may adopt management measures for the hake fishery, such as measures to minimize salmon bycatch, which NMFS then implements. The U.S. TAC is variable, but 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 (Somers et al. 2023a). However, there is evidence to suggest that hake trawl hours are increasing over time (Somers et al. 2023a). Trawling effort only occurs north of 40°N, and has operated over relatively the same amount of space in the most recent decade (Somers et al. 2023a). Landings of hake made by PCGF midwater trawl gear include catch from SS, MS, and CP sectors (Figure 1). Although trawl hours have increased over the most recent decade (Figure 2), landings have remained relatively stable (Figure 1; Somers et al. 2023a).

The hake sectors may operate in the same area, but due to average vessel size and other operational constraints, may have slightly different depth ranges. Vessels delivering catch to shore-based first receivers tend to fish in waters closer to the ports where first receivers are located. Shoreside hauls have generally occurred within 120 fm or shallower. Since 2006, more than 80% of CP and MS landings have come from hauls in 100–250 fm; from 2019 to 2021, this pattern increased to 90% or more in each year (Somers et al. 2023a).

[2] https://www.ecfr.gov/current/title-50/part-660/section-660.130#p-660.130(c)

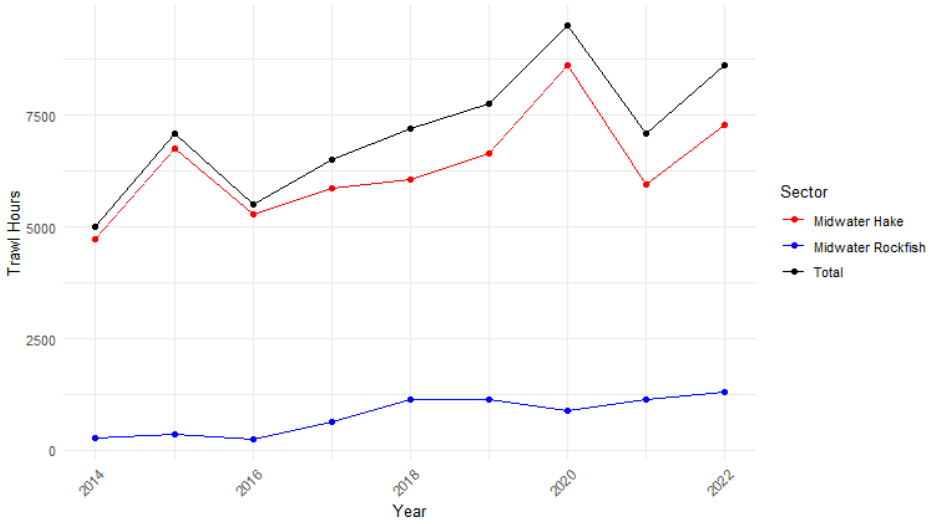

Figure 2. *Line plot representing shoreside (SS) trawl hours by sector, which includes the estimated midwater trawl hours for the years 2014-22. Lines are colored by sector and the black line represents the total sets summed for all sectors.*

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. 2023a). Fishing effort in both at-sea fleets have varied since 2014 but reached historic highs in 2022 (Figure 3).

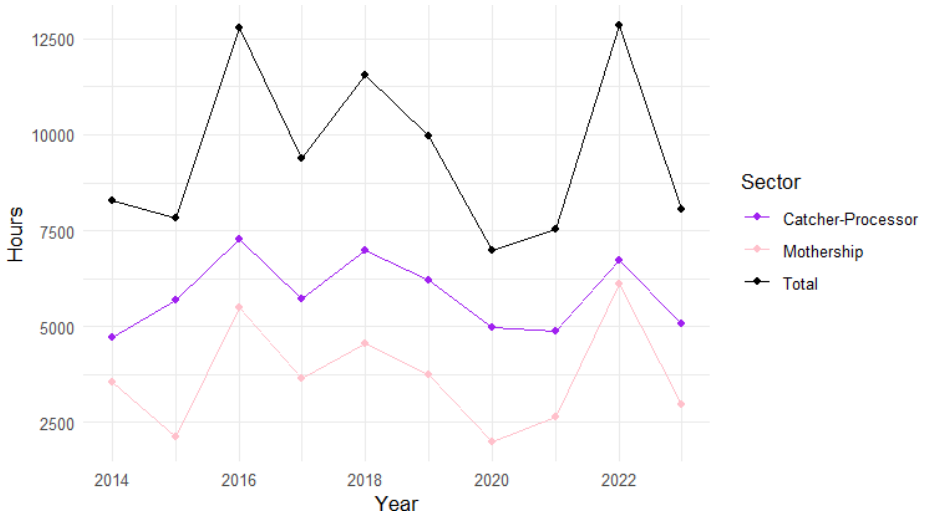

Figure 3. *Line plot representing at-sea (AS) trawl hours by sector, which includes the estimated midwater trawl hours for the years 2014-23. Lines are colored by sector and the black line represents the total sets summed for all sectors.*

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. Under the framework, the fishery opens on May 1 north of 42°30’ N and on April 15 south of 40°30' N. 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 nautical miles (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 2011-18, 39 different LE trawl vessels landed sablefish north of 36° N with fixed gear. From 2016 to 2018, 16 vessels landed sablefish north of 36° N 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 2020). 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 2013-19, but 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. 2023a). 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. 2023a). 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. 2023a).

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 sablefish 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 sablefish 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 limit." Regulations allow for up to three sablefish-endorsed permits, and associated tier limits, to be stacked[3] 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 sablefish 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 in addition to bottom longline gear, 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

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

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[4].

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 (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 Council 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 or concerned about the potential for 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 provided vessels with access to continental slope and nearshore species, but less access to continental shelf species. For waters south of 40°10′ N, 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.

[4] NMFS West Coast Region Pacific Coast Fisheries Permit System, queried January 1st, 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 2014-21, 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 2014-23. 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. (2023a) 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. (2023a) presents higher landings numbers due to the incorporation of fish ticket data. Somers et al. (2023a) is likely a more exact estimate of landings, but both datasets show the same overall linear trends.

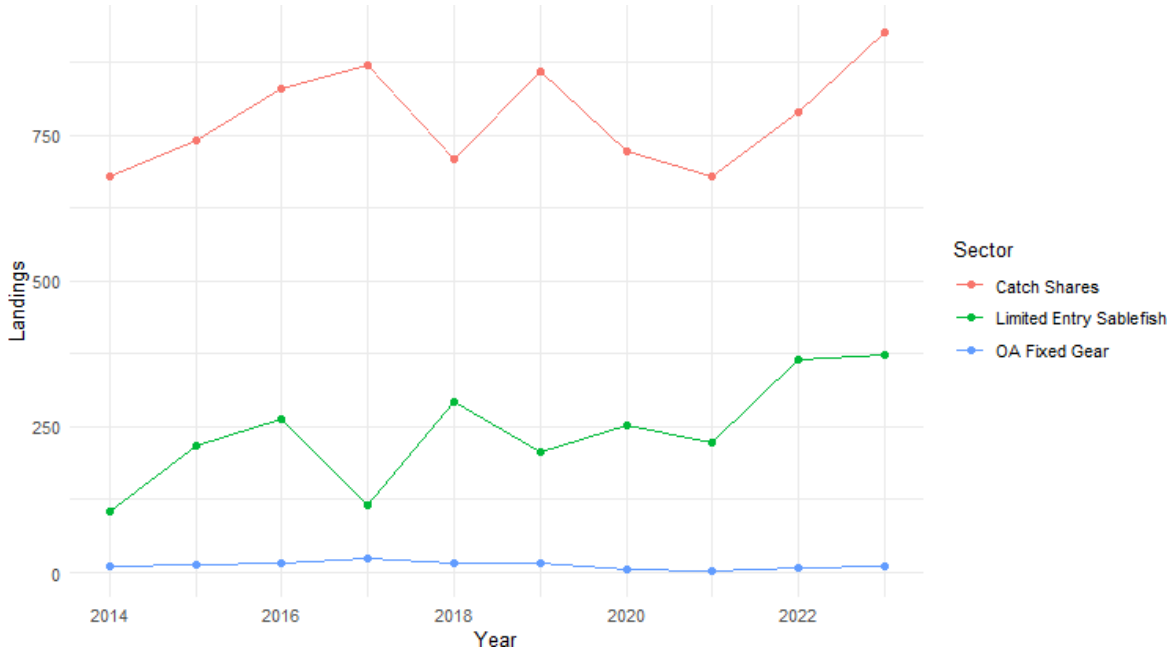

Figure 4. *Observed PCGF pot landings in metric tons from 2014-23. Each line is colored by the sector within the pot fishery. Landings were estimated by dividing the observed landings by the observation coverage rate provided for the unique year, sector, and gear type (WCGOP).*

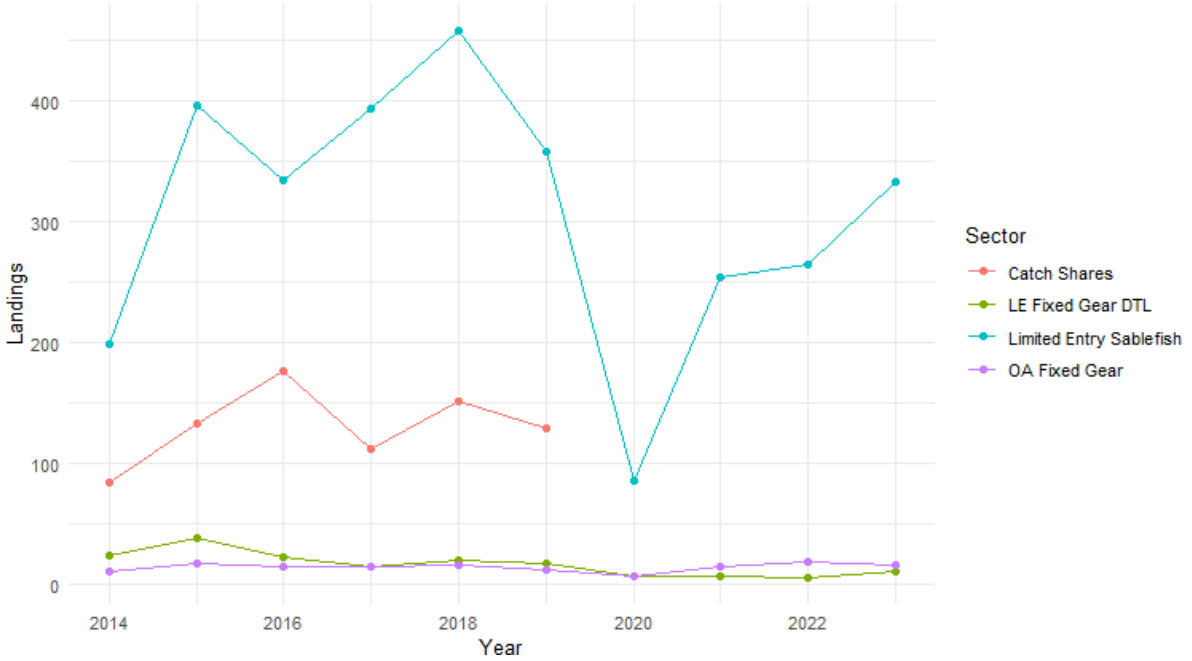

Figure 5. *Observed PCGF hook-and-line landings in metric tons from 2014-23. Each line is colored by the sector within the hook-and-line fishery. Landings were estimated by dividing the observed landings by the observation coverage rate provided for the unique year, sector, and gear type (WCGOP).*

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, which are recommended by the Council and implemented by NMFS. 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 at-sea 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. The SS fishery is also subject to shoreside catch monitoring. 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.

Prior to January 1, 2023, sea star bycatch in the groundfish fisheries was recorded by observers as an aggregate (e.g., 'sea star unidentified'). As of January 1, 2023, sunflower sea star bycatch is identified to species separately from other sea stars. No sunflower sea star bycatch was recorded in commercial groundfish fisheries by observers in 2023.

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.

Monitoring indicates fleetwide bottom trawl effort has decreased from a high during the CS period in 2013 to approximately a third that level in 2020 and 2021 (Somers et al. 2023b). Median haul duration has generally decreased since 2011 to around two hours and forty minutes in 2020 and 2021. A concentration of bottom trawl effort in the northern part of the coast and in deeper, farther-offshore waters has occurred. Effort in the southern parts of the coast is relatively low and patchy in the few places that bottom trawl fishing occurs, and almost no effort has occurred south of 36° N after 2018. The proportion of hauls in waters shallower than 50 fathoms, where the majority of sunflower sea stars have been documented (Gravem et al. 2021; Lowry et al. 2022; 2024), has continued to decrease in recent years. Activity in waters 50–100 fathoms deep has increased slightly.

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 3 provides observer coverage rates by sector and gear (Somers et al., 2023b).

Table 3. *Median observer coverage rates, defined as the percentage of total groundfish landings monitored by human observers in the sector of the fishery 2015-23. 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 3.

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. Closed Areas That Apply to All Groundfish Fisheries

1.3.8.1. 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.

1.3.8.2. 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. 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.

1.3.8.3. 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.

1.3.8.4. 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 adjusting the boundaries of, or re-opening, areas off Washington, Oregon, and California. Areas that re-opened may 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, and Garibaldi Reef South).

1.3.9. Closed Areas That Apply Only to Trawl Fisheries

Closed areas that apply to the trawl fisheries differ for bottom trawl and midwater trawl, with the latter generally less geographically restricted than bottom trawl. Bottom trawling is prohibited in EFHCAs, Cowcod Conservation Areas, the trawl RCA off Washington, and, along with all groundfish bottom contact gear, the Deep-sea Ecosystem Closed south of Mendocino Ridge and seaward (west) of approximately 1,900 fm (3,500 m). Bottom trawling, except with selective flatfish gear, and midwater trawling are prohibited in areas around the mouths of the Klamath River and Columbia River.

In addition to these year-round closures, Block Area Closures or Bycatch Reduction Areas may be closed to various groundfish trawl sectors via in-season action if necessary to reduce bycatch of certain non-target species.

1.3.9.1. 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. As of January 1, 2020, the trawl RCA is between management lines approximating the 100-fm and 150-fm depth contours off the coast of

Washington, between the US/Canada border and 46°16′ N. 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 NM. The individual block areas, or groups of blocks, could be closed as needed, by the Council or NMFS, to protect Council-managed or other protected species.

Bottom trawl gear restrictions are based on the current or historic trawl RCA boundaries: large footrope trawl gear (footrope diameter greater than 8" but may not be greater than 19") is allowed where trawling is allowed seaward of the trawl RCA off Washington or seaward of the 100-fm management line south of the Washington/Oregon border. Small footrope (footrope diameter 8" or less) is allowed wherever bottom trawling is allowed, subject to additional restrictions in certain areas for salmon bycatch mitigation.

1.3.9.2. 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, 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.

1.3.9.3. 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 subject to restrictions 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 (approximately 6 NM north of the Klamath River mouth), on the west by 124°23′ W (approximately 12 NM from shore), and on the south by 41°26.80′ N (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 to 124°13.30′ W, then southerly along a line of 167 True to 46°11.10′ N and

124°11′ W (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-fm 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.

1.3.9.4. At-sea Processing South of 42° N

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

1.3.10. 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.

1.3.10.1. 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 2023-24 Harvest Specifications, these restrictions do not apply to a subset of vessels using certain gear types in the *Directed Open Access* sector[5].

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.

[5] Directed open access means that a fishing vessel is target fishing for groundfish under the requirements of 50 CFR 50 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.

1.3.11. Closed Areas That Apply to Recreational Fisheries

Closed Areas (i.e., 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 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: Conference Biological 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 to 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 reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

No critical habitat has been designated or proposed for the sunflower sea star; therefore, potential impacts from the proposed action were not analyzed.

2.1. Analytical Approach

This conference biological opinion includes a jeopardy analysis that 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.

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; August 27, 2019), 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 the sunflower sea star:

- Evaluate the range-wide status of the species expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species.
- Evaluate the effects of the proposed action on the species using an exposure–response approach.
- 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, analyze whether the proposed action is likely to 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.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2. Range-wide Status of the Species

This section summarizes the status of the sunflower sea star. The status is determined by the level of extinction risk that the proposed listed species faces, based on parameters considered in the status review (Lowry et al. 2022; 2024) and proposed listing decision (88 FR 16212). This informs the description of the species' likelihood of both survival and recovery. The species status section provides the species' current "reproduction, numbers, or distribution" for the jeopardy analysis. There is no proposed or designated critical habitat for sunflower sea stars.

On August 18, 2021, we received a petition to list the sunflower sea star (*Pycnopodia helianthoides*) as a threatened or endangered species under the ESA (Sakashita 2021). On December 27, 2021, we published a positive 90-day finding (86 FR 73230) announcing that the petition presented substantial scientific or commercial information indicating that the petitioned action may be warranted, and initiated a status review of the species. A Status Review Team was formed, an initial species status report was completed (Lowry et al. 2022), and an initial listing determination was made. On March 16, 2023, we proposed that the sunflower sea star be listed as a threatened species throughout its range, and solicited concurrent peer and public comment on this determination (88 FR 16212). The comment period closed on May 15, 2023, and comments were systematically responded to. A final status review report was published in 2024 (Lowry et al. 2024), and NMFS is working toward the final listing determination.

2.2.1 Description, Range, Distribution, Habitat Use, and Diet

The sunflower sea star is among the largest sea stars in the world, reaching over 1 meter (m) in total diameter from ray tip to ray tip across the central disk. The species is distinguished from other co-occurring sea stars by having 16–20 rays, a greatly reduced abactinal (dorsal) skeleton with no actinal plates, and prominently crossed pedicellariae (Fisher 1928).

The previously described maximum geographic range of the sunflower sea star spans the Northeastern Pacific Ocean from the Aleutian Islands to Baja California (Sakashita 2021; Gravem et al. 2021). This range includes 33 degrees of latitude (3,663 km) across western coasts of the continental United States, Canada, and northern Mexico. Prior to 2024, the farthest reported reaches of sunflower sea star observations included: northernmost - Bettles Bay, in Prince William Sound, Alaska (Gravem et al., 2021); westernmost – central and eastern Aleutian Islands (Kuluk Bay, Adak Island east to Unalaska Island, Samalga Pass, and Nikolski) (Feder 1980; O'Clair and O'Clair 1998; Jewett et al. 2015; Gravem et al. 2021); and southernmost - Bahia Asunción, Baja California Sur, Mexico (Gravem et al. 2021), though unconfirmed reports extend the range southward to San Ignacio Lagoon. Lowry et al. (2024) extended the known range westward along the Aleutian Archipelago and northward onto Petrel Bank, in the Bering Sea, based on benthic trawl survey data from NOAA's Alaska Fisheries Science Center (Figure 5). This same dataset also repeatedly documented the species north of Unimak Island and the westernmost tip of the Alaska Peninsula, also in the Bering Sea. Prior to 2013 (see below for details), the sunflower sea star was generally more common from the Alaska Peninsula to Monterey, California, though inadequate sampling in sparsely populated regions at both tails of the range result in detection bias.

This sunflower sea star has no clear associations with specific habitats and is considered a habitat generalist (Gravem et al. 2021, and citations therein; Lowry et al. 222; 2024). The large geographic and depth range of *P. helianthoides* indicates this species is well adapted for a wide variety of environmental conditions and habitat types. They are found along the outer coasts and inside waters, which have complex geophysical features including glacial fjords, sounds, embayments, and tidewater glaciers. Preferring temperate waters, they inhabit kelp forests and rocky intertidal shoals (Hodin et al. 2021), but are regularly found in eelgrass meadows as well (Dean and Jewett 2001; Gravem et al. 2021). The species occupies a wide range of benthic substrates including mud, sand, shell, gravel, and rocky bottoms while roaming in search of prey (Konar et al. 2019; Lambert 2000). Individuals dwell in the low intertidal and subtidal zones to a depth of at least 435 m (1,427 ft) throughout the known range, but are most common at depths less than 25 m (82 ft) and rare in waters deeper than 120 m (394 ft) (Fisher 1928; Lambert 2000; Hemery et al. 2016; Gravem et al. 2021). In one survey program, sunflower sea stars have been observed at depths beyond 435 m deep offshore of Oregon and central California, with a gradual decline through ~600 m and sporadic occurrence to a maximum depth of 1,158 m (3,799 ft) (e.g., Keller et al. 2008; https://www.webapps.nwfsc.noaa.gov/data). While this survey focuses on groundfish, staff are trained to identify a wide range of invertebrate species, and to differentiate this species from other multi-rayed sea stars. Since 2003, a small fraction (0.8%, or 29 of 2,945 individuals) of all sunflower sea stars encountered in the survey have come from hauls >600 m deep (Figure 5, inset map), which constitutes 1.0% of all "positive hauls" in which the species was encountered and are likely wash-down from prior tows in shallower waters (A. Keller, NWFSC, pers. comm.). The last observation of a specimen in this survey deeper than 600 m was in 2011, at 951 m.

Current understanding of the species' prevalence across depth ranges is biased by: (1) differential sampling methods and effort, with SCUBA-based observations dominating records; and (2) the propensity to record all sea stars as "sea star unidentified" when they occur as incidental bycatch in various survey and fishery records. Additional data are actively being collected to offset this bias, including by those engaged in activities described in section 1.3.9, Monitoring, above.

Larval and pre-metamorphic sunflower sea stars are planktonic feeders and no data exist to suggest a prey preference at this stage. The diet of adult sunflower sea stars generally consists of benthic and mobile epibenthic invertebrates, including sea urchins, snails, crab, sea cucumbers, and other sea stars (Mauzey et al. 1968; Shivji et al. 1983), and appears to be driven largely by prey availability. Sunflower sea stars locate their prey by chemosensing and may show preference for dead or damaged prey (Brewer and Konar 2005), likely due to reduced energy expenditure relative to catching and subduing active prey; thus, they occasionally scavenge fish, seabirds, and octopus (Shivji et al. 1983). This behavior also predisposes them to consumption of bait used with an array of fishing gears, from longlines, to pots, to hook-and-line.

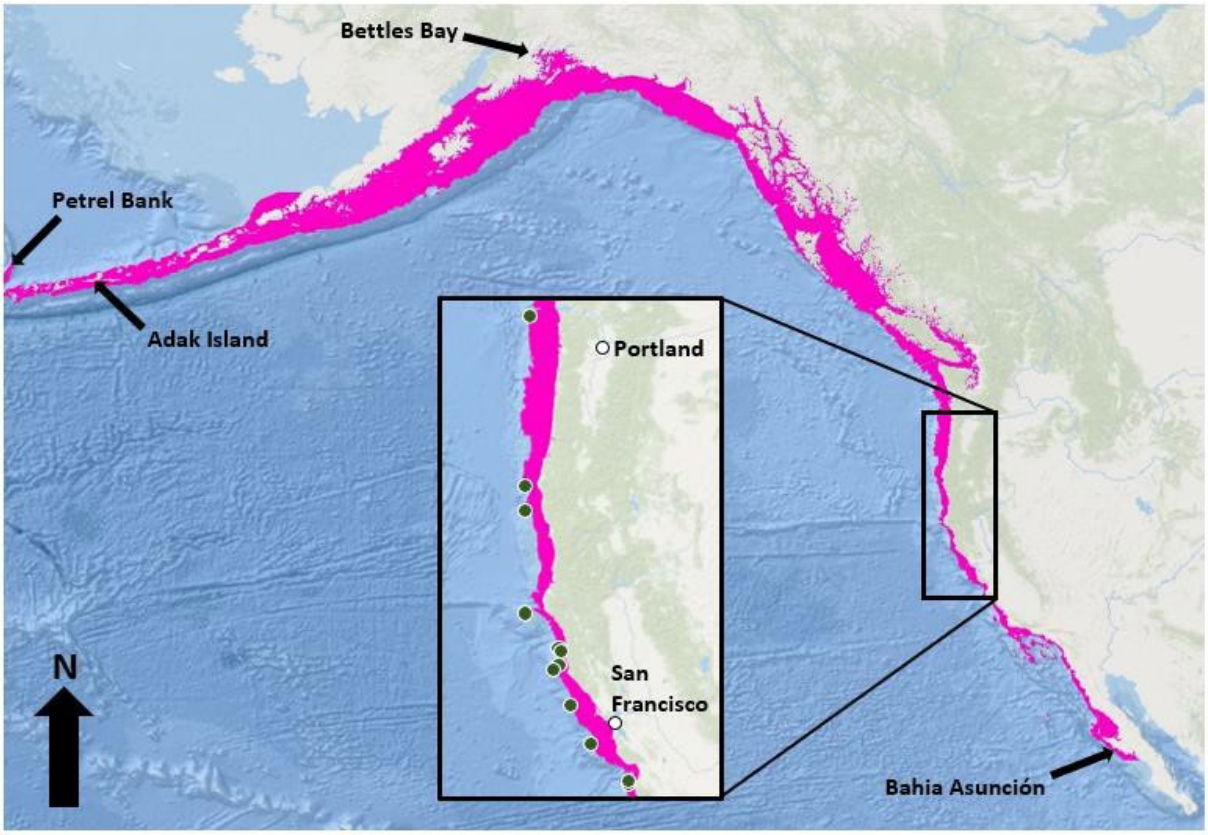

Figure 6. *Known distribution of the sunflower sea star (*Pycnopodia helianthoides*) from the Aleutian Islands to Baja California Sur, Mexico. All habitats shallower than 435 m (1,427 ft) are highlighted in pink. Documentation of presence in the Bering Sea, and westward along the Aleutian Archipelago to Petrel Bank, is newly reported here based on benthic trawl survey data from NOAA's Alaska Fisheries Science Center (see text for details). The inset map shows twelve locations (green dots with white edges) ranging from the Columbia River to Monterey Bay, CA, where NOAA trawls have documented the species in waters deeper than 600 m (1,969 ft).*

2.2.2. Population Demographics and Viability

Prior to onset of the coast-wide sea star wasting syndrome (SSWS) pandemic in 2013 (see below), directed population monitoring for the sunflower sea star was haphazard and typically the result of short-term research projects rather than long-term monitoring programs. Such efforts were rarely focused on the sea star itself, but it was often included as a component of the local invertebrate assemblage. Recent descriptions of sunflower sea star distribution and

population declines by Harvell et al. (2019), Gravem et al. (2021), Hamilton et al. (2021), and Lowry et al. (2022; 2024) relied on datasets gathered either exclusively or predominantly during the 21st century and, in some cases, as a direct response to losses due to SSWS. The most intense loss occurred over just a few years from 2013-17, generally commencing later in more northern portions of the range, and impacts varied by region (Gravem et al. 2021; Lowry et al. 2022; 2024). Hence, understanding of both the historical and contemporary abundance of the sunflower sea star is patchy in time and space, with substantial gaps.

Summary data presented in Gravem et al. (2021) and Lowry et al. (2022; 2024) indicate that, prior to the 2013-17 SSWS pandemic, the sunflower sea star was fairly common throughout its range, with localized variation linked to prey availability and various physiochemical variables, such as temperature and pH (Duggins 1983; Herrlinger 1983; Eckert 2007; Rassweiler et al. 2010; Montecino-LaTorre et al. 2016; Schultz et al. 2016; Bonaviri et al. 2017; Harvell et al. 2019; Konar et al. 2019; OCNMS 2019; Rogers-Bennett and Catton 2019; Eisaguirre et al. 2020; Smith et al. 2021). Many of these surveys occurred at depth reachable with conventional SCUBA gear, i.e., <25 m deep, but OCNMS (2019) used a remotely operated vehicle and encountered individuals from 150–350 m deep. While population connections between these sea stars and those in shallow water remain unknown, this suggests deep waters may serve as a biomass reservoir for the species.

The pattern of decline by latitude as a consequence of the SSWS pandemic is striking. Hamilton et al. (2021) noted a 94.3% decline throughout the range of the sunflower sea star after the pandemic. The 12 regions defined by Hamilton et al. (2021) encompass the known range of the species, and every one exhibited a decline in density and occurrence from approximately 2013 to 2017, with the six more northern regions declining less (40 to 96% declines) than the six regions south of the Washington outer coast (99.6 to 100% declines), where the sunflower sea star is now exceptionally rare. Expanding on this analysis, and including a single data set that spanned much of the known range of the species (i.e., the IPHC fishery independent setline survey), Lowry et al. (2024) demonstrated that declines in Alaskan waters were likely substantially higher than previously predicted and that overall population decline was best modeled as a single rate throughout the range. Further, while anecdotal observations indicate recruitment continues in the U.S. portion of the Salish Sea, British Columbia, and Alaska, few of these juveniles appear to survive to adulthood (A. Gehman, University of British Columbia and the Hakai Institute, pers. comm.). While variability in abundance estimates was high prior to the pandemic and boom/bust cycling was apparent in many areas, detection rates have been very low since approximately 2015 in the majority of time series datasets. There are very few reported observations of sunflower sea star recruits or adults in southern California or Mexico since 2017 despite continued, and in some cases enhanced, survey effort in these areas. In areas where adults have not been detected for several years, the potential for deleterious stochastic events, such as marine heat waves, to destroy what remains of the population is likely to be considerably increased.

There are not, to date, any range-wide or regional assessments of systematic variation in life history parameters, morphological characteristics, genetic traits, or other attributes that can be used to delineate specific populations of sunflower sea stars. As such, there is no direct biological data to establish that the species is anything but a single, panmictic population throughout its range (Gravem et al. 2021; Lowry et al. 2024). As habitat generalists that use a wide variety of substrates over a broad depth range, and dietary generalists that consume diverse

prey based largely on their availability and encounter rate, differentiation of subpopulations is not expected to be driven by strong selection for particular environmental needs. In the 2020 IUCN status assessment report (Gravem et al. 2021), putative population segments were identified largely based on a combination of legal and geographic boundaries/barriers and data provided in response to a broad request distributed to natural resource managers and academic researchers. These regions may serve a practical purpose in terms of administrative regulation, but without further demographic information their biological relevancy is unknown. Comparisons among putative population trends at a variety of geographically based levels demonstrates shared declines, speaking to broad-scale connectivity among and between all portions of the range (Lowry et al. 2024).

The current range-wide (i.e., global) population estimate for the sunflower sea star is nearly 600 million individuals, based on a compilation of the best available science and information (Gravem et al. 2021; Lowry et al. 2022; 2024). While substantial, this represents less than 10% of the estimated abundance prior to 2013 and likely reflects an even greater decrease in biomass due to the loss of adults from SSWS. There is considerable uncertainty in this global abundance estimate, however, and in regional estimates that contribute to it. Low sampling effort prior to the pandemic, depth-biased disparities in data richness, inadequate species-specific documentation of occurrence, and missing information about several crucial life history parameters all contribute to this uncertainty (Lowry et al. 2022; 2024). While confidence is relatively high in estimates from more southerly, nearshore areas that are well-sampled via SCUBA, the majority of the species' range consists of deep, cold, and/or northern waters that are less well sampled. In waters of the West Coast from Neah Bay, WA, southward to Mexico the population is estimated to be approximately 7.8 million individuals (~1.3% of the global population). This region was not determined to be a biologically significant portion of the range of the species given the comparatively low historical and current abundance (Lowry et al. 2022; 2024).

Little is known about the natural productivity of the sunflower sea star on both an individual and population basis. Lack of information about growth rate, longevity, age at maturity, fecundity, natural mortality, the influence of larval cloning, and other fundamental biological attributes require broad assumptions be made to inform estimates (Lowry et al. 2022; 2024). Regardless, the loss of over 95 percent of the global population of the sunflower sea star from 2013-17 is likely to have had profound impacts on population-level productivity. The standing crop of individuals capable of generating new recruits has been decreased, possibly to levels where productivity will be compromised on a regional or global basis (Gravem et al. 2021; Hamilton et al. 2021; Lowry et al. 2022; 2024).

As a broadcast spawner with indeterminate growth, traits shared with many other echinoderms, the capacity for allometric increases in fecundity and high reproductive output certainly exists in the sunflower sea star. Hodin et al. (2021) noted that gonads are small in sunflower sea stars compared to other sea stars, but also documented prolonged periods over which spawning apparently occurs (i.e., gonads are ripe). If the pandemic resulted in the loss of the large, most reproductively valuable individuals across both nearshore and deep-water habitats, it could take a decade or more for sub-adults to mature, settlement to occur at detectable levels, and population rebounds to be documented (Lowry et al. 2022; 2024). The ongoing threat of a second pandemic dictates that caution is warranted when predicting population growth rate.

Provided reproduction continues to occur, even on a local basis, the prolonged planktonic period of larval sunflower sea stars affords the opportunity for substantial dispersal prior to settlement. During this period, however, larvae are at the mercy of prevailing currents, temperature variation, and a suite of biophysical variables that affect survival. Even if populations maintain relatively high levels of productivity, recent conditions in the northeast Pacific Ocean have not been favorable to larval survival for many species due to repeated marine heat waves, falling pH, and localized oxygen minimum zones (Boldt et al. 2020; Shelton et al. 2021; Starko et al. 2022). Studies of genetic connectivity across the range of the sunflower sea star are largely lacking, minimizing understanding of how large-scale population patterns are affected by local and regional productivity now and in the future.

Despite substantial population declines from 2013-17, sunflower sea stars still occupy the whole of their historical range from Alaska to northern Mexico, though in nearshore areas from the outer coast of Washington to Mexico the species is now rare where it was once common (Gravem et al. 2021; Lowry et al. 2022; 2024). Natural resource managers and researchers in the contiguous United States consider several local populations off Oregon and California to be functionally extirpated, but reports of newly settled juveniles and occasional adults in these regions demonstrate continued occupancy (Gravem et al. 2021; Lowry et al. 2022; 2024). Additionally, the lack of adequate sampling of deep waters and patchy encounter reporting in bottom-contact fisheries with a high likelihood of interaction (e.g., crustacean pot/trap fisheries) introduces sufficient uncertainty to preclude a firm statement regarding lack of occurrence.

Spatial distribution and connectivity are integrally related with the abundance and productivity criteria. As a habitat generalist with broad resilience to physiochemical environmental variables, the sunflower sea star utilizes most available benthic habitats from the nearshore down to several hundred meters deep throughout its range. Loss of over 95 percent of the population between 2013 and 2017 in southern portions of the range almost certainly resulted in population fragmentation, but the only areas where data exist to confirm this are shallow, SCUBA-accessible habitats. Kelp forests and rocky reefs, in particular, are well sampled, but regular occurrence on mud, sand, and other soft-bottom habitats is also well documented (Gravem et al. 2021; Lowry et al. 2022; 2024). Undersampled, deep-water habitats represent the majority of suitable habitat for the sunflower sea star by area; however, additional effort is needed to characterize both how individuals in these waters are distributed and how they are connected with populations in shallow waters.

Broad-scale, systematic evaluations of variation in morphology, life history, behavior, physiology, genetic traits, and other aspects of diversity do not exist for the sunflower sea star (Gravem et al. 2021; Lowry et al. 2022; 2024). While some authors note animals in the northern portion of the range grow to a large diameter and mass, this general statement is not supported by data. As a result of this lack of information, adequately evaluating diversity is difficult. Data from proxy species, such as the ochre star (*Pisaster ochraceus*), demonstrate that variation in physical characteristics such as color can be both genetically and ecologically controlled in sea stars (Harley et al. 2006; Raimondi et al. 2007). While examples exist of echinoderm species with both substantial population structuring and a complete lack of population structure on the West Coast, where the sunflower sea star falls along this spectrum is unknown (Gravem et al. 2021; Lowry et al. 2022; 2024).

Following the 2020 IUCN assessment of the sunflower sea star (Gravem et al. 2021), the species was conferred Critically Endangered status on the Red List of Threatened Species[6]. Subsequent to this, The Nature Conservancy convened a working group made up of state, tribal, Federal, and provincial government; academic; and non-profit partners to create a roadmap to recovery for the species. This document uses the best available science and information to identify specific, targeted research and management efforts needed to address what workgroup participants identify as the greatest threats facing long-term persistence of the sunflower sea star (Heady et al. 2022). The roadmap also includes an inventory of knowledge gaps that can be used as a guidance tool by partner organizations to coordinate collaborative research and management directed at sunflower sea star recovery (Heady et al. 2022). As noted above, the sunflower sea star was proposed for listing as threatened under the ESA (88 FR 16212) due to compromised population viability. In the proposed rule, we found that existing conservation efforts, including the roadmap, did not offset this risk.

2.3. Action Area

Action area means all areas affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For the Pacific Coast groundfish fishery the action area includes the EEZ and state waters of the Pacific Ocean. Although the proposed action does not apply to state-managed groundfish fisheries in state waters, vessels participating in federally-managed fisheries transit through state waters and land fish within the states. Thus, some effects of the federally managed groundfish fishery may occur in state waters. Where fishing has previously occurred is assumed to represent where direct effects to the ESA-listed species are most likely to occur as it is reasonable to expect that future fishing will occur in the same areas, though the distribution of effort may shift annually based on regulations, weather conditions, and other factors.

2.4. Environmental Baseline

The "environmental baseline" refers to the condition of the proposed listed species in the action area, without the consequences to the listed species 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 that are contemporaneous with the consultation in process. The impacts to the proposed listed species from 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). The environmental baseline associated with continued operation of the Pacific Coast groundfish fishery as implemented under the FMP has been repeatedly assessed for an array of listed species (Table 1), and those analysis are incorporated by reference for additional context here.

Intentional harvest of the sunflower sea star for human consumption has not been documented, and no directed fisheries exist for the species (Gravem et al. 2021; Lowry et al. 2024). Bycatch in

[6] https://www.iucnredlist.org/species/178290276/197818455

a wide variety of fisheries employing bottom-contact gear (e.g., pots, trawls, hook-and-line, longline) is well documented, but has been ongoing for decades without apparent appreciable impact to species status or viability (Gravem et al. 2021; Hamilton et al. 2021; Lowry et al, 2022; 2024). In 2023, we consulted on the impacts of continued operation of targeted Pacific halibut fisheries (commercial and recreational) on the West Coast and the associated catch sharing plan, and found the action would not jeopardize, but would adversely affect, the sunflower sea star. (NMFS 2023). This represented our first conference opinion for the species, which had been proposed for listing at that time. Occasional collection and drying of, mostly small, sunflower sea stars as curios was documented by Gravem et al. (2021) but was, again, deemed not to have demonstrable population-level impacts. There is no reason to suspect that intentional harvest/collection of sunflower sea stars will increase in the foreseeable future.

Various marine fisheries targeting organisms other than groundfish occur in state and federal waters off Washington, Oregon, and California. Some of these, such as hand collection of urchins and sea cucumbers, are highly selective and pose no risk to sunflower sea stars. Others, such as pot-based fisheries for crab and shrimp, use bottom contact gear that may attract and/or capture sunflower sea stars (Antonelis et al. 2011; Gravem et al. 2021; Lowry et al. 2022; 2024). These fisheries may also result in lost gear that becomes derelict, further increasing capture risk, though regulations for escapement rings/panels may offset this (Antonelis et al. 2023). State fisheries for marine organisms using non-selective gear have been occurring on the West Coast for decades with no apparent population-level risk to sunflower sea stars (Gravem et al. 2021; Lowry et al. 2022; 2024). After the SSWS pandemic in 2013-17, encounters with sunflower sea stars in these fisheries decreased substantially and, in most places along the West Coast, are now rare. Impacts from these fisheries were not identified as a limiting factor in the current population status of the sunflower sea star (Lowry et al. 2022; 2024; 88 FR 16212).

One factor affecting the status of sunflower sea stars, as well as aquatic habitat and ecology in the action area at large, is anthropogenic climate change. The best available information indicates that the earth's climate is warming, and that this will significantly impact ocean conditions, and thus the survival of species that interact with sunflower sea star. Recent evidence suggests that climate and weather is expected to become more extreme, with an increased frequency of drought and flooding (IPCC 2019). Heavier winter rainstorms from warming may lead to increased flooding and high-flow events that result in increasing suspended sediment in estuary and nearshore systems.

Anthropogenic influences on climate, as well as projections of climate change over the next century, are anticipated to continue. Recent warming bears the signature of rising concentrations of greenhouse gas emissions and it is anticipated that the 30-year average temperature in the Northern Hemisphere is now higher than it has been over the past 1,400 years (IPCC 2013; Melillo et al. 2014). In addition, there is high certainty that ocean acidity has increased, with a drop in pH of 0.1 (NWFSC 2015).

Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species and the conservation value of designated critical habitats along the U.S. West Coast. These changes will not be spatially homogeneous across the region. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snow pack, increases winter flows, and advances the timing of spring

melt (Mote et al. 2014; 2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013; Mote et al. 2014). These changes in water quality and quantity being delivered from upland areas will directly impact environmental conditions in estuarine and nearshore waters in habituated by the sunflower sea star.

In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest as a result of climate change include increasing surface water temperature, increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et al. 2014; Boldt et al. 2020; Shelton et al. 2021; Starko et al. 2022). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0–3.7 °C (1.8–6.7 °F) by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences for anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011; Reeder et al. 2013). Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. Acidification also affects sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012; Boldt et al. 2020).

Warming ocean temperatures will likely alter all biological communities in cool or cold ocean regions, making it more difficult for organisms to locate or capture prey (Roemmich and McGowan 1995; Zamon and Welch 2005). Warmer waters could also allow for the northward expansion of predator and competitor ranges (Rexstad and Pikitch 1986; McFarlane et al. 2000; Phillips et al. 2007). A change to a warm-water regime in the ocean creates larger areas of hypoxia or anoxia because warmer water holds less dissolved oxygen. This shifts more species into shallower waters where atmospheric oxygen mixes more freely into the water column (Meyer-Gutbrod et al. 2021) and could have future impacts on predation and feeding in the nearshore environment. Combined shifts in broadscale forcing factors from both upland and marine systems will result in substantial environmental variability, the impact of which on sunflower sea star populations is difficult to predict given current gaps in our understanding of the species' physiology.

The adaptive ability of threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions will likely reduce long-term viability and sustainability of populations in many species (NWFSC 2015). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney et al. 2012). These conditions will possibly intensify the climate change stressors inhibiting recovery of imperiled species in the future.

From 2013 to 2017, the sunflower sea star experienced a range-wide epidemic of sea star wasting syndrome (SSWS) (Gravem et al. 2021; Hamilton et al. 2021; Lowry et al. 2022). While the cause of this disease remains unknown, prevalence of the outbreak has been linked to a variety of environmental factors, including temperature change, sustained elevated temperature, low dissolved oxygen, and decreased pH (Hewson et al. 2018; Aquino et al. 2021; Heady et al. 2022;

Oulhen et al. 2022). As noted above, changes in physiochemical attributes of nearshore waters are expected to change in coming decades as a consequence of anthropogenic climate change, but the specific consequences of such changes on SSWS prevalence and severity are currently impossible to accurately predict.

The sunflower sea star is a habitat generalist that has been recorded on a wide diversity of substrate types, of varying complexity, with and without vegetative cover (Gravem et al. 2021; Lowry et al. 2022; Galloway et al. 2023; Tolimieri et al. 2023; Smith et al. 2024). Furthermore, evaluations of habitat associations for this species are characterized by a substantial bias toward both depths that can be accessed using scuba gear and complex habitat, such as rock piles and kelp forests (Lowry et al. 2022; 2024).

2.5. Effects of the Proposed Action

Under the ESA, "effects of the action" are all consequences to the proposed listed species that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action but that are not part of the 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).

Data on groundfish fishery interactions with sunflower sea stars are sparse because the species: 1) has effectively no fishery value, even as bycatch, and is not retained; and 2) was not a species of special conservation concern or attention prior to ~2013. Bottom trawls, longlines, and pots are the gear types most likely to impact sunflower sea stars, due to their interaction with the seafloor (Gravem et al. 2021; Lowry et al. 2022; 2024). Bottom trawls can pick up sunflower sea stars along with target catch, such as flatfish or other groundfish, over relatively flat, generally muddy bottoms along the West Coast. After stars are tumbled into the net by the footrope, they interact with biological (i.e., fish, invertebrates) and inorganic (e.g., rocks, mud) catch, which can result in loss of arms/rays, pulverization, laceration, and other damage. Effort in the bottom trawl fishery is widespread and has substantial overlap with the known range of the sunflower sea star, but is also restricted by a variety of spatial closures that prevent direct interaction with the species in high-relief, complex, and/or ecologically important areas designed to protect other marine species (i.e., RCAs, CCAs, MPAs) (see section 1.3.8.1 Closed Areas that Apply to All Groundfish Fisheries). Sunflower sea stars can be attracted by bait in pots or on longlines, although they can also voluntarily leave pots and let go of bait on longlines prior to handling. Adverse effects to individuals may include stress upon being brought to the surface and handled, as well as a small risk of inadvertent impalement on hooks (longline only). Pot and longline fisheries are also widespread along the West Coast, but are generally limited to shore-side delivery and, thus, effort is focused around major ports. Similar to bottom trawl fisheries, pot and longline fisheries are regulated through use of various closure areas. Hook-and-line fisheries also have the possibility of encountering sunflower sea stars but bottom contact time is generally very short, limiting exposure, and creel sampling data indicate bycatch is very unlikely to occur (i.e., no records exist despite tens of thousands of interviews with anglers).

Observers aboard commercial vessels participating in the PCGF process and record catch to species, when possible, but also use aggregate categories for some non-target species groups.

Prior to 2023, the WCGOP[7] combined sunflower sea stars with other sea stars in observer data. Between 2013 and 2023, the WCGOP estimated that an average of 13.98 metric tons (30,820 lbs) of "sea stars" are caught and discarded each year in commercial groundfish fisheries.[8] Sea star species on the west coast range considerably in average weight, but this likely represents tens of thousands of individuals. Recognizing emerging management concerns associated with loss of sunflower sea stars during the 2013-17 SSWS pandemic, and the pending proposed listing (88 FR 16212), WCGOP observers were instructed to identify and record sunflower sea stars separately as of 2023 to improve information on commercial groundfish fishery interactions with the species. No sunflower sea stars were observed on commercial groundfish trips in 2023, or in 2024 through May 30. Given the limited length of time data on sunflower sea starts has been collected, the current rarity of the species in the environment, and the lack of information regarding historical representation of the sunflower sea star in documented sea star bycatch, fishery-dependent data cannot be directly used to estimate effects of the action on the sunflower sea star.

The NMFS Northwest Fisheries Science Center's (NWFSC) West Coast Bottom Trawl Survey[9] (WCBTS) collects species-specific data for a wide array of invertebrate species, including the sunflower sea star. In the absence of direct observations of sunflower sea stars in the fishery, trawl survey data can provide a reasonable quantitative estimate of the potential impact of the commercial groundfish bottom trawl fishery on sunflower sea stars, as the WCBTS uses standardized bottom trawl gear similar to that used in the commercial fishery, and survey fishing operations are similar except that locations are selected via a stratified random sampling design. A proxy catch-per-unit-effort metric was developed for the WCBTS and applied to recent commercial bottom trawl effort, as follows:

- WCBTS data for 2017-19 and 2021-23 was reviewed (the annual survey did not occur in 2020 due to the COVID-19 pandemic). This time period was selected to represent recent years after the rapid sunflower sea star population decline due to the SSWS pandemic.
- Hauls with both start and end locations in an area closed to commercial bottom trawling in 2024 were assumed to have occurred in an area that is currently closed to the fishery and expected to remain closed in at least the near term (no changes to these areas are pending or anticipated at this time). These were excluded from the analysis as they represent catch in areas where the fishery is not anticipated to operate.
- Hauls with only one of the start or end location, or neither, in an area currently closed to commercial bottom trawling were assumed to have occurred in areas currently open to the commercial bottom trawl fishery and anticipated to remain so. These hauls were included in the analysis.
- A total of 2,998 survey hauls occurred in areas currently open to the commercial bottom trawl fishery. These had a combined haul duration of 937 hours.
- On those hauls, five sunflower sea stars were reported in a total of four survey hauls. Two individuals were caught in 2017 in a single haul, and one each in 2018, 2022, and 2023.
- A catch rate of 0.0053 sunflower sea stars per haul hour was calculated (five sunflower

[7] https://www.fisheries.noaa.gov/west-coast/science-data/fisheries-observation-science-west-coast
[8] https://www.webapps.nwfsc.noaa.gov/data/metadata/observer.gemm_fact
[9] https://www.fisheries.noaa.gov/west-coast/science-data/us-west-coast-groundfish-bottom-trawl-survey

sea stars/937 survey haul hours), and applied to the average annual median number of commercial fishery bottom trawl hours from 2017-19 and 2021-23 (20,624 fishery hours/year as calculated from observers and logbooks) (Somers et al. 2023a), to yield a rough estimate of the number of sunflower sea stars potentially caught by groundfish bottom trawl gear each year.

- This estimate of potential catch in the groundfish bottom trawl fishery is up to 110 sunflower sea stars per year (0.0053 sunflower sea stars per hour * 20,624 fishery hours per year, and rounding up any fraction of an individual).

Despite representing the best proxy information available, this estimate has several potential sources of error as a result of notable differences between survey trawling and fishery trawling operations that may mean catch per unit effort (CPUE) is not directly comparable. These include, but are not limited to: average tow duration (longer in the fishery); time of year (May to October for the survey, and year-round with peaks in April/May and October for the fishery); net mesh size (smaller liner mesh for the survey); and fishing gear configuration (e.g., warp scope, footrope diameter, door weight). In addition, the survey is designed to systematically sample benthic habitats and biota along the West Coast using highly standardized gear and deployment practices (Keller et al. 2017), while commercial fishers have more leeway with regard to when, where, and how they fish, within regulations. Most groundfish bottom trawling off the West Coast is concentrated off Oregon and Washington, with less occurring in northern and central California, and none in southern California (Somers et al. 2023a). The sunflower sea star range extends as far south as Baja California, but they are now very uncommon south of the Monterey, CA, area (Gravem et al. 2021; Lowry et al. 2022;2024). However, the survey is West Coast-wide, and hauls occurring in southern California (in areas open to commercial bottom trawling for groundfish, as described above) were included in the CPUE calculation.

Given that sunflower sea stars are rarely encountered by the WCBTS in recent years, and none were recorded by either the WCGOP or trawl fishery in 2023 or 2024, it is impossible to generate a valid confidence interval for estimated impacts. Observer coverage varies considerably by sector (see Table 3 above) and, because they are not the target, sea stars may be missed. Additionally, because observer encounters with the sunflower sea star were not separated from all other sea stars prior to 2022, it is unknown what proportion of the "sea star unidentified" WCGOP reporting category may consist of this species. Catch in this category has averaged nearly 14 mt annually, as noted above. Sunflower sea stars are known to aggregate seasonally, such that either fishery or survey hauls could encounter patches of high abundance. Prior to 2015, survey estimates of sunflower sea star density were orders of magnitude higher than current (Lowry et al. 2024 App A), with several hauls capturing dozens of individuals. A high-abundance catch or two in the fishery is still possible, given patchy documentation of species occurrence in areas that are regularly fished. Recognizing temporal and spatial catch variability in the survey, the assumptions and uncertainties described above, and the current population status of the sunflower sea star along the West Coast, an estimated catch of up to 110 individuals per year in the trawl fishery accounts for likely impact scenarios for the foreseeable future.

There is no coastwide groundfish pot gear or longline survey for any target species or species group that could be used to develop a proxy bycatch CPUE for the groundfish fixed gear (pot and longline) fishery. Pot-based survey efforts for groundfish along the West Coast are entirely lacking. The IPHC fishery-independent setline survey: does not extend south of Point Reyes,

CA; only overlaps a portion of the fishery timing window; fishes a systematic grid rather than focusing on areas targeted in the groundfish fishery; and uses longline gear optimized for halibut rather than sablefish or other groundfish species (e.g., larger hooks) (Soderlund et al. 2012; IPHC 2024; Lowry et al. 2024). Despite WCGOP implementing procedures to identify and document sunflower sea stars by species beginning in 2023, none were observed in 2023 (or in 2024 through May 30) on any vessel fishing fixed gear.

Given the number of participants in the LEFG fleet, the depth range fished, logistics of gear soak time and configuration, and the ability of sunflower sea stars to volitionally leave traps or drop bait before capture, we expect bycatch of sunflower sea stars in pot and longline gear to be exceedingly low in the foreseeable future, but have no method by which to develop a metric to assess this. Further, we expect individuals have a high likelihood of survival following movement in and out of pots, as well as after consumption of bait on longlines.

There is no coastwide recreational bycatch survey that reports data for sunflower sea stars adequate to develop a metric of impact from this fishing sector. The RecFIN database only includes bony fish and elasmobranchs in its sampling frame, providing no information about encounters with any invertebrate species (https://reports.psmfc.org/recfin/f?p=601:1000). While the terminal tackle of recreational anglers certainly comes into contact with the bottom, lures/bait are typically bounced, jigged, or mooched in such a way that contact time is considerably shorter than for pots or longlines. As with these other gear types, sunflower sea stars may also volitionally drop any bait they do come into contact with. There is some risk for inadvertent impalement of a sunflower sea star on a recreational angler's hook, but no evidence exists to suggest this is by any means a common occurrence. Recreational interaction with sunflower sea stars by spear is not known to occur. See 2.9.4 Terms and Conditions below for additional detail on efforts to close this data gap.

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). 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.

Some infrastructure development and/or maintenance associated with docks, piers, shoreline armoring, etc. may occur in the action area under the auspices of state or private entities. Regulatory authority for these actions resides with different state-level agencies in Washington, Oregon, and California. Such activities may involve interaction with sunflower sea stars ranging from minimally intrusive to lethal handling. In an effort to minimize impacts from such activities, a consortium of researchers and natural resource managers led by The Nature Conservancy formalized a "roadmap to recovery" for the species in 2022 (Heady et al. 2022). This document identifies scientific data gaps and outreach/education needs pertinent to a wide array of activities that occur in the action area. Working with members of this consortium, we have developed safe and soft handling guidance to the sunflower sea star that will be broadly distributed if/when the species is listed under the ESA. Until that time, the consortium will continue to independently spread information through a variety of media outlets. These

conservation efforts should help minimize impacts to the species now and in the foreseeable future.

Some continuing non-federal activities are reasonably certain to contribute to climate effects within the action area. 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 above (Section 2.4 Environmental Baseline).

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses to species and critical habitat. 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 biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) when applicable, appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

The primary threat to the population status and viability of the sunflower sea star is SSWS, the prevalence and virility of which may be exacerbated by global climate change and the ecological impacts thereof (Lowry et al. 2022; 2024). The global population of sunflower sea stars is currently estimated to be approximately 600 million individuals distributed over the whole of their historical range, but with higher average abundance in more northerly waters of British Columbia and Alaska (Gravem et al. 2021; Hamilton et al. 2021; Lowry et al. 2022; 2024). In waters of the West Coast from Neah Bay, WA, southward to Mexico the population is estimated to be approximately 7.8 million individuals (~1.3% of the global population). This region was not determined to be a biologically significant portion of the range of the species given the comparatively low historical and current abundance (Lowry et al. 2022; 2024) and the sum total of any impacts there are unlikely to have a major effect on the global population.

To date, several conference opinions have evaluated potential impacts to the sunflower sea star from federal activities such as halibut fisheries (NMFS2023c), derelict gear removal surveys (e.g., NMFS 2024b), dredging (e.g., NMFS 2024c), and nearshore development (e.g., NMFS 2024d). The vast majority of these conference opinions have been restricted to action areas in waters off Alaska, and the estimated impacts have ranged from no effect to likely to adversely affect. In all cases where impacts from federal actions are likely to occur, the number of individuals experiencing adverse effects are limited to the tens or hundreds – representing a tiny fraction of the estimated abundance of the species. Furthermore, these impacts have been determined to occur at a local scale, are often focused near human population centers, and rarely influence waters across the full depth range known to be occupied by the sunflower sea star.

The Proposed Action could reduce abundance or population productivity of sunflower sea stars via gear interactions and handling mortality, but anticipated impacts are localized, minor compared to overall population size, and ephemeral across space and time as vessels target groundfish. Annual catches from the Proposed Action are estimated not to exceed 110 sunflower sea stars. A conservative approach is applied here, and using the best information available we anticipate annual catch of sunflower sea stars associated with the groundfish fishery will be up to 110 individuals, with sublethal handling occurring in some cases. Due to the lack of established mortality rates, however, all catches are assumed to result in mortality. Actual mortality rates are likely to be low considering the resiliency of sunflower sea stars to handling stress and their ability to regrow limbs after injury. How handling affects susceptibility to SSWS is unknown, and this uncertainty further justifies our conservative assumption that all encounters will be lethal. In total, estimated annual mortality from the proposed action is 0.0014% of sunflower sea star abundance throughout the action area, and occurs in offshore, benthic areas affected by few other direct human activities.

In summary, the effects of the Proposed Action (Section 2.5), when added to the Environmental Baseline (Section 2.4) and the Cumulative Effects (Section 2.6), and taking into account the status of the species, would not reduce the likelihood of either the survival or recovery of the sunflower sea star.

2.8. Conclusion

After reviewing and analyzing the current status of the sunflower sea star species, the environmental baseline within the action area, the effects of 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 sunflower sea star. No critical habitat has been designated or proposed for this species; therefore, none was analyzed.

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). "Harass" is further defined by guidance as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." "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.

The sunflower sea star has been proposed for ESA listing (88 FR 16212), and NMFS is currently working on a final listing decision. Given that the primary threats to the species are SSWS and climate change, in the proposed listing we indicated our intent not to issue protective regulations that would prohibit take under section 4(d) of the ESA.

2.9.1. Amount or Extent of Take

In this biological opinion, we determined that incidental take is reasonably certain to occur as follows:

- All trawl-based fisheries considered part of the proposed action are expected to take no more than 110 individuals of a size likely to be retained given mesh size (i.e., subadults and adults) annually

2.9.2. Effect of the Take

In this biological opinion, we determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species.

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 following reasonable and prudent measure applies to this incidental take statement:

- Monitor, document, and report incidental take of sunflower sea stars encountered in fisheries covered under this Opinion on an annual basis, and compare this with regional abundance estimates for the species to evaluate impacts.

2.9.4. Terms and Conditions

In order to be exempt from any potential take prohibitions under the ESA, the federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. NMFS, the Council, or any subsidiary applicant 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. There are not currently take prohibitions associated with the sunflower sea star, but these terms and conditions are included here in the case that the pending listing decision results in such regulations.

The following terms and conditions implement the reasonable and prudent measure above:

- NMFS shall continue to train fishery observers to properly identify sunflower sea stars and report their occurrence in bycatch as a stand-alone component separated from all other sea star species.
- NMFS shall monitor, document, and report incidental take of sunflower sea stars on an annual basis via the Groundfish Expanded Mortality Multi-year data product (GEMM),

or like product (https://www.fisheries.noaa.gov/west-coast/fisheries-observers/west-coast-fishery-observer-bycatch-and-mortality-reports).

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 critical habitat or regarding the development of information (50 CFR 402.02).

The following conservation recommendations are made for the proposed action:

- Encourage participation of commercial and recreational groundfish harvesters in special physiological, genetic, bycatch reduction, and population demography studies of the sunflower sea star as such projects arise.
- NMFS shall Coordinate with the WCR Protected Resources Division to disseminate safe and soft handling practice guidance for the sunflower sea star, once finalized.

2.11. Reinitiation of Consultation

This concludes our formal conference opinion for impacts of the continued operation of the groundfish fishery under the Pacific Coast Groundfish Fishery Management Plan (FMP) on the sunflower sea star.

Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the federal agency, where discretionary federal involvement or control over the action has been retained or is authorized by law and if: 1) the amount or extent of taking specified in the incidental take statement is exceeded; 2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; 3) 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) a new species is listed or critical habitat designated that may be affected by the identified action."

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 NMFS

and the Council. Other interested users could include recreational and commercial fishers, the general public, and diverse conservation organizations. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adhere 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 part 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 ESA, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

4. References

Antonelis, K., J. Drinkwin, P. Rudell, J. Morgan, J. Selleck, D. Velasquez, and D.P. Rothaus. 2023. Determining effectiveness of Dungeness crab escapement in derelict traps. *Marine Policy*. 149:105499.

Antonelis, K., D. Huppert, D. Velasquez, and J. June. 2011. Dungeness crab mortality due to lost traps and a cost–benefit analysis of trap removal in Washington State waters of the Salish Sea. *North American Journal of Fisheries Management*. 31:880-893.

Aquino, C. A., R. M. Besemer, C. M. DeRito, J. Kocian, I. R. Porter, P. T. Raimondi, J. E. Rede, L. M. Schiebelhut, J. P. Sparks, J. P. Wares, and I. Hewson. 2021. Evidence that microorganisms at the animal-water interface drive sea star wasting disease. *Frontiers in Microbiology*. 11(3278).

Boldt, J. L, A. Javorski, and P. C Chandler. 2020. State of the physical, biological and selected fishery resources of Pacific Canadian marine ecosystems in 2019. Canadian Technical Report of Fisheries and Aquatic Sciences. Report 3377. Sidney, B.C., Canada. 288 pp.

Bonaviri, C., M. Graham, P. Gianguzza, and N. T. Shears. 2017. Warmer temperatures reduce the influence of an important keystone predator. *Journal of Animal Ecology*. 86(3):490-500.

Brewer, R. S. and B. H. Konar. 2005. Chemosensory responses and foraging behavior of the seastar *Pycnopodia helianthoides*. *Marine Biology*. 147:789-795.

Dean, T. A and S. C. Jewett. 2001. Habitat-specific recovery of shallow subtidal communities following the *Exxon Valdez* oil spill. *Ecological Applications*. 11:1456-1471.

Doney, S. C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, and L. D. Talley. 2012. Climate change impacts on marine ecosystems. *Annual Review of Marine Science*. 4: 11-37.

Duggins, D. O. 1983. Starfish predation and the creation of mosaic patterns in a kelp-dominated community. *Ecology*. 64(6):1610-1619.

Eckert, G. L. 2007. Spatial patchiness in the sea cucumber *Pachythyone rubra* in the California Channel Islands. *Journal of Experimental Marine Biology and Ecology*. 348(1):121-132.

Eisaguirre, J. H., J. M. Eisaguirre, K. Davis, P. M. Carlson, S. D. Gaines, and J. E. Caselle. 2020. Trophic redundancy and predator size class structure drive differences in kelp forest ecosystem dynamics. *Ecology*. 101(5):e02993.

Feder, H. M. 1980. Chapter 8. Asteroidea: The sea stars. In: R. H. Morris, D. P. Abbott, and E. C. Haderlie, eds. Intertidal invertebrates of California. Stanford, CA.: Stanford University Press. 117-135.

Feely, R. A., T. Klinger, J. A. Newton, and M. Chadsey (eds). 2012. Scientific summary of ocean acidification in Washington state marine waters. NOAA Office of Oceanic and Atmospheric Research Special Report.

Fisher, W. K. 1928. Asteroidea of the North Pacific and adjacent waters. Washington, D.C.: United States National Museum. 445 pp.

Galloway, A. W. E., S. A. Gravem, J. N. Kobelt, W. N. Heady, D. K. Okamoto, D. M. Sivitilli, V. R. Saccomanno, J. Hodin, and R. Whippo. 2023. Sunflower sea star predation on urchins can facilitate kelp forest recovery. *Proceedings of the Royal Society B*. 290 (1993):20221897.

Gehman, A. 2023. Discussion with Dayv Lowry about recent laboratory studies while conducting work at USGS Marrowstone Island research facility on August 16, 2023. Personal communication.

Gravem, S. A., W. N. Heady, V. R. Saccomanno, K. F. Alvstad, A. L. M. Gehman, T. N. Frierson, and S. L. Hamilton. 2021. IUCN Red List of Threatened Species: Pycnopodia helianthoides. International Union for the Conservation of Nature. 20 pp.

Hamilton, S. L., V. R. Saccomanno, W. N. Heady, A. L. Gehman, S. I. Lonhart, R. Beas-Luna, F. T. Francis, L. Lee, L. Rogers-Bennett, A. K. Salomon, and S. A. Gravem. 2021. Disease-driven mass mortality event leads to widespread extirpation and variable recovery potential of a marine predator across the eastern Pacific. *Proceedings of the Royal Society B*. 288(1957):20211195.

Harley, C. D., M. S. Pankey, J. P. Wares, R. K. Grosberg, and M. J. Wonham. 2006. Color polymorphism and genetic structure in the sea star *Pisaster ochraceus*. *Biological Bulletin*. 211:248-262.

Harvell, C. D., D. Montecino-Latorre, J. M. Caldwell, J. M. Burt, K. Bosley, A. Keller, S. F. Heron, A. K. Salomon, L. Lee, O. Pontier, C. Pattengill-Semmons, and J. K. Gaydos. 2019. Disease epidemic and a marine heat wave are associated with the continental-scale collapse of a pivotal predator *Pycnopodia helianthoides*. *Science Advances*. 5(1):eaau7042.

Heady, W. N., R. Beas-Luna, M. N. Dawson, N. Eddy, K. Elsmore, F. T. Francis, T. Frierson, A. L. Gehman, T. Gotthardt, S. A. Gravem, J. Grebel, S. L. Hamilton, L. Hannah, C. D. Harvell, J. Hodin, I. Kelmartin, C. Krenz, L. Lee, J. Lorda, D. Lowry, S. Mastrup, E. Meyer, P. T. Raimondi, S. S. Rumrill, V. R. Saccomanno, L. M. Schiebelhut, and C. Siddon. 2022. Roadmap to recovery for the sunflower sea star (*Pycnopodia helianthoides*) along the West Coast of North America. The Nature Conservancy. Sacramento, CA. 44 pp.

Hemery, L. G., S. R. Marion, C. G. Romsos, A. L. Kurapov, and S. K. Henkel. 2016. Ecological niche and species distribution modelling of sea stars along the Pacific Northwest continental shelf. *Diversity and Distributions*. 22:1314-1327.

Herrlinger TJ. 1983. The diet and predator-prey relationships of the sea star *Pycnopodia helianthoides* (Brandt) from a central California kelp forest. [San Jose, CA]: San Jose State University. 57 pp.

Hewson, I., K. S. I. Bistolas, E. M. Quijano Cardé, J. B. Button, P. J. Foster, J. M. Flanzenbaum, J. Kocian, and C. K. Lewis. 2018. Investigating the complex association between viral ecology, environment, and Northeast Pacific sea star wasting. *Frontiers in Marine Science*. 5.

Hodin, J., A. Pearson-Lund, F. P. Anteau, P. Kitaeff, and S. Cefalu. 2021. Progress toward complete life-cycle culturing of the endangered sunflower star, *Pycnopodia helianthoides*. *Biological Bulletin*. 241(3):243-258.

Intergovernmental Panel on Climate Change (IPCC). 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Available from: http://www.climatechange2013.org/ Cambridge, United Kingdom and New York, NY, USA.

IPCC. 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

[Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.
IPCC. 2019. IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [Pörtner, H.-O., D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N.M. Weyer (eds.)].
International Pacific Halibut Commission (IPHC). 2024. International Pacific Halibut Commission Fishery-Independent Setline Survey sampling manual (2024). International Pacific Halibut Commission, Seattle, WA. 39 pp.
Jewett, S. C., R. N. Clark, H. Chenelot, S. Harper, and M. K. Hoberg. 2015. Field guide to sea stars of the Aleutian Islands. Alaska Sea Grant, University of Alaska Fairbanks, Fairbanks, AK. 165 pp.
Keller, A. 2024. Comments on occurrence of sunflower sea stars in the West Coast groundfish trawl survey send via e-mail to Dayv Lowry on August 19, 2024. Personal communication.
Keller, A. A, B. H. Horness, E. L. Fruh, V. H. Simon, V. J. Tuttle, K. L. Bosley, J. C. Buchanan, D. J. Kamikawa, and J. R. Wallace. 2008. The 2005 U.S. West Coast bottom trawl survey of groundfish resources off Washington, Oregon, and California: Estimates of distribution, abundance, and length composition. National Oceanic and Atmospheric Administration, 153 pp.
Keller, A. A., J. R. Wallace, and R. D. Methot. 2017. The Northwest Fisheries Science Center's West Coast Groundfish Bottom Trawl Survey: History, Design, and Description. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-136. DOI: 10.7289/V5/TM-NWFSC-136. 38 pp.
Konar, B, T. J. Mitchell, K. Iken, H. Coletti, T. Dean, D. Esler, M. Lindeberg, B. Pister, and B. Weitzman. 2019. Wasting disease and static environmental variables drive sea star assemblages in the northern Gulf of Alaska. *Journal of Experimental Marine Biology and Ecology*. 520:151209.
Lambert, P. 2000. Sea stars of British Columbia, Southeast Alaska and Puget Sound. Vancouver: UBC Press.
Lowry, D., S. Wright, M. Neuman, D. Stevenson, J. Hyde, M. Lindeberg, N. Tolimieri, S. Lonhart, S. Traiger, and R. Gustafson. 2022. Endangered Species Act Status Review Report: Sunflower Sea Star (*Pycnopodia helianthoides*). Final Report to the National Marine Fisheries Service, Office of the Protected Resources. October 2022. 100 pp. + App.
Lowry, D., S. K. Wright, M. Neuman, D. Stevenson, J. Hyde, M. Lindeberg, N. Tolimieri, S. I. Lonhart, S. Traiger, and R. Gustafson. 2024. Final Endangered Species Act Status Review Report: Sunflower Sea Star (*Pycnopodia helianthoides*). Report to the National Marine Fisheries Service, Office of the Protected Resources. October 2024. 96 pp. + App.
Mauzey, K. P, C. Birkeland, and P. K. Dayton. 1968. Feeding behavior of asteroids and escape responses of their prey in the Puget Sound region. *Ecology*. 49(4):603-619.
McFarlane, G. A., J. R. King, and R. J. Beamish. 2000. Have there been recent changes in climate? Ask the fish. *Progress in Oceanography*. 47(2-4): 147-169.
Melillo, J. M., T. C Richmond, and G. W. Yohe. 2014. Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program.

Meyer-Gutbrod, E., L. Kui, R. Miller, M. Nishimoto, L. Snook, and M. Love. 2021. Moving on up: Vertical distribution shifts in rocky reef fish species during climate-driven decline in dissolved oxygen from 1995 to 2009. *Global Change Biology*. 27(23): 6280-6293.

Montecino-Latorre, D., M. E. Eisenlord, M. Turner, R. Yoshioka, C. D. Harvell, C. V. Pattengill-Semmens, J. D. Nichols, and J. K. Gaydos. 2016. Devastating transboundary impacts of sea star wasting disease on subtidal asteroids. *PLOS ONE*. 11(10):e0163190.

Mote, P. W, A. K. Snover, S. Capalbo, S. D. Eigenbrode, P. Glick, J. Littell, R. R. Raymondi, and W. S. Reeder. 2014. Ch. 21: Northwest. in Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, T.C. Richmond, and G.W. Yohe, Eds., U.S. Global Change Research Program. 487-513.

Mote, P. W., D. E. Rupp, S. Li, D. J. Sharp, F. Otto, P. F. Uhe, M. Xiao, D. P. Lettenmaier, H. Cullen, and M. R. Allen. 2016. Perspectives on the cause of exceptionally low 2015 snowpack in the western United States. Geophysical Research Letters. 43: 10980-10988.

National Marine Fisheries Service (NMFS). 1990. Endangered Species Act Consultation. Biological Opinion. Amendment 4 to the Pacific Coast Groundfish Management Plan. National Marine Fisheries Service, Northwest Region, Sustainable Fisheries Division, Seattle, WA. August 10, 1990. 16 pp.

NMFS. 1991. Endangered Species Act Consultation. Biological Opinion. Pacific Coast Whiting Fishery and Modifications in Structure of the Fishery. National Marine Fisheries Service, Northwest Region, Sustainable Fisheries Division, Seattle, WA. November 26, 1991. 18 pp.

NMFS. 1992. Endangered Species Act - Reinitiated Section 7 Consultation. Biological Opinion. Fishing Conducted under the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery. National Marine Fisheries Service, Northwest Region, Sustainable Fisheries Division, Seattle, WA. August 22, 1992. 53 pp.

NMFS. 1993. Endangered Species Act - Reinitiated Section 7 Consultation. Biological Opinion. Fishing Conducted under the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery. National Marine Fisheries Service, Northwest Region, Sustainable Fisheries Division, Seattle, WA. September 27, 1993. 4 pp.

NMFS. 1996. Endangered Species Act - Reinitiated Section 7 Consultation. Biological Opinion. Fishing Conducted under the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery. National Marine Fisheries Service, Northwest Region, Sustainable Fisheries Division, Seattle, WA. March 14, 1996. 9 pp.

NMFS. 1999. Endangered Species Act – Section 7 Consultation. Biological Opinion. Fishing Conducted under the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery. National Marine Fisheries Service, Northwest Region, Sustainable Fisheries Division, Seattle, WA. December 15, 1999. 64 pp.

NMFS. 2006a. Endangered Species Act – Section 7 Consultation. Supplemental Biological Opinion. Reinitiation of Section 7 consultation regarding the Pacific Fisheries Management Council's Groundfish Management Plan. National Marine Fisheries Service, Northwest Region, Sustainable Fisheries Division, Seattle, WA. Consultation No: 206/00754. March 11, 2006. 34 pp.

NMFS. 2006b. Magnuson-Stevens Act Provisions; Fisheries off West Coast States; Pacific Coast Groundfish Fishery. *Federal Register*. 71:27408-27426.
NMFS. 2012. Endangered Species Act Section 7(a)(2) Biological Opinion and Section 7(a)(2) "Not Likely to Adversely Affect" Determination - Continuing Operation of the Pacific Coast Groundfish Fishery. NMFS, Northwest Region, Seattle, WA. Consultation No.: NWR-2012-876. December 7, 2012. 156 pp. + App.
NMFS. 2018. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion on Continuing Operation of the Pacific Coast Groundfish Fishery. NMFS West Coast Region. Consultation No. WCR-2018-8635. 55 pp.
NMFS. 2020. Endangered Species Act (ESA) Section 7(a)(2) Biological and Conference Opinion on continuing operation of the Pacific Coast groundfish fishery (Reinitiation of consultation #NWR-2012-876) -- humpback whale (*Megaptera novaeagliae*). NMFS, West Coast Region. Consultation No. WCRO-2018-01378. 83 pp.
NMFS. 2021. Endangered and Threatened Wildlife; 90-Day Finding on a Petition to List the Sunflower Sea Star as Threatened or Endangered Under the Endangered Species Act. *Federal Register*. 86:73230-73233.
NMFS. 2022a. Endangered Species Act Section 7(a)(2) Concurrence Letter for the Reinitiation of consultation on continued operation of the groundfish fishery under the Pacific Coast Groundfish Fishery Management Plan and the effects of the fishery on Southern Resident killer whales. NMFS West Coast Region, Seattle, WA. Consultation No. WCRO-2022-02582. 48 pp.
NMFS. 2022b. Magnuson-Stevens Act Provisions; Fisheries Off West Coast States; Pacific Coast Groundfish Fishery; Pacific Coast Groundfish Fishery Management Plan; Amendment 30; 2023–24 Biennial Specifications and Management Measures. *Federal Register*. 87:77007-77036.
NMFS. 2023a. 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. *Federal Register.* 88:83830-83860.
NMFS. 2023b. Proposed rule to list the sunflower sea star as threatened under the Endangered Species Act. *Federal Register.* 88:16212-16229.
NMFS. 2023c. National Marine Fisheries Service Endangered Species Act (ESA) Section 7(a)(2) Biological and Conference Opinion and Magnuson-Stevens Act Essential Fish Habitat (EFH) Consultation: Consultation on the implementation of Area 2A (U.S. West Coast) Pacific halibut fisheries and catch sharing plan. NMFS West Coast Region, Seattle, WA. Consultation No. WCRO-2023-00394. 280 pp.
NMFS. 2024. Endangered Species Act Section 7(a)(2) Biological Opinion on Continuing Operation of the Pacific Coast Groundfish Fishery and Effects to Humpback whale (*Megaptera novaeangliae*) and leatherback sea turtle (*Dermochelys coriacea*). NMFS West Coast Region, Seattle, WA. Consultation No. WCRO-2024-00905. 325 pp.
NMFS. 2024b. Endangered Species Act Section 7(a)(2) Concurrence Letter for Marine Debris Program Derelict Fishing Gear Removal Surveys. NMFS Alaska Region, Juneau, AK. Consultation No. AKRO-2024-00818. 61 pp.
NMFS. 2024c. Endangered Species Act Section 7(a)(2) Concurrence Letter for Ketchikan Bar Harbor Marine Project. NMFS Alaska Region, Juneau, AK. Consultation No. AKRO-2024-0190531. 31 pp.

NMFS. 2024d. Endangered Species Act Section 7(a)(2) Concurrence Letter for Whiskey Cove Float and Pier Project. NMFS Alaska Region, Juneau, AK. Consultation No. AKRO-2024-02406, POA-2024-00460. 38 pp.

Northwest Fisheries Science Center. 2015. Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest. December 21, 2015.

Olympic Coast National Marine Sanctuary (OCNMS). 2019. Patterns in deep sea coral and sponge communities of Olympic coast 2019. Olympic Coast National Marine Sanctuary. 10 pp.

Oulhen, N., M. Byrne, P. Duffin, M. Gomez-Chiam, I. Hewson, J. Hodin, B. Konar, E. Lipp, B. Miner, A. Newton, L. M. Schiebelhut, R. Smolowitz, S. Wahltinez, G. Wessel, T. Work, H. Zaki, and J. Wares. 2022. A review of asteroid biology in the context of sea star wasting: possible causes and consequences. *The Biological Bulletin*. 243:50-75.

Pacific Fishery Management Council (PFMC). 1997. Pacific Whiting Allocation and Seasons Environmental Assessment and Regulatory Impact Review of the Anticipated Biological, Social and Economic Impacts of a Proposal to Allocate Pacific Whiting Among Non-Tribal Sectors and to Establish a Framework for Modifying Season Opening Dates. February 1997. Pacific Fishery Management Council.

PFMC. 2020. Preliminary analysis of gear-switching alternatives. Pacific Fishery Management Council. Report to the Council on Agenda item G.1, Attachment 3. 47 pp. Available at: www.pcouncil.org/documents/2020/10/g-1-attachment-3-preliminary-analysis-of-gear-switching-alternatives.pdf/

PFMC. 2023. Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery, Pacific Fishery Management Council. Portland, OR. December 2023. 145 pp. Available at: http://www.pcouncil.org/groundfish/fishery-management-plan/

PFMC. 2024. Status of the Pacific Coast Groundfish Fishery: Stock Assessment and Fishery Evaluation. Pacific Fishery Management Council Portland, OR. August 2024. 402 pp. Available at: https://www.pcouncil.org/documents/2024/08/status-of-the-pacific-coast-groundfish-fishery-stock-assessment-and-fishery-evaluation-august-2024.pdf/

Phillips, A. J., S. Ralston, R. D. Brodeur, T. D. Auth, R. L. Emmett, C. Johnson, and V. G. Wespestad. 2007. Recent pre-recruit Pacific hake (*Merluccius productus*) occurrences in the northern California Current suggest a northward expansion of their spawning area. *California Cooperative Oceanic Fisheries Investigations Report*. 108(1): 16-48.

Raimondi, P. T., R. D. Sagarin, R. F. Ambrose, C. Bell, M. George, S. F. Lee, D. Lobse, M. C. Miner, and S. N. Murray. 2007. Consistent frequency of color morphs in the sea star *Pisaster ochraceus* (Echinodermata: Asteriidae) across open-coast habitats in the Northeast Pacific. *Pacific Science.* 61:201-210.

Rassweiler, A., R. J. Schmitt, and S. J. Holbrook. 2010. Triggers and maintenance of multiple shifts in the state of a natural community. *Oecologia*. 164(2):489-498.

Reeder, W. S., P. R. Ruggiero, S. L. Shafer, A. K. Snover, L. L Houston, P. Glick, J. A. Newton, and S. M. Capalbo. 2013. Coasts: Complex Changes Affecting the Northwest's Diverse Shorelines. in Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, M. M. Dalton, P. W. Mote, and A. K. Snover, Eds. Island Press, Washington, DC. 41-58.

Rexstad, E. A., and E. K. Pikitch. 1986. Stomach contents and food consumption estimates of Pacific hake, *Merluccius productus*. *Fishery Bulletin*. 84(4): 947-956.

Robinson, B. 2002. Assistant Regional Administrator, Sustainable Fisheries Division, NMFS Northwest Region. April 25, 2002. Memorandum to the record regarding review of Chinook bycatch during 2000 and 2001 Pacific Coast Whiting fisheries and National Marine Fisheries Serves (NMFS) Endangered Species Act (ESA) Section 7 Consultation of 1999 for the Pacific Coast Groundfish Fishery Management Plan. On file with NMFS West Coast Region, Sand Point office.

Roemmich, D., and J. McGowan. 1995. Climate warming and the decline of zooplankton in the California Current. *Science*. 267: 1324-1326.

Sakashita, M. 2021. Petition to lit sunflower sea star as threatened or endangered under the U.S. Endangered Species Act. Center for Biological diversity, Oakland, CA. 26 pp.

Schultz, J. A., R. N. Cloutier, and I. M. Côté. 2016. Evidence for a trophic cascade on rocky reefs following sea star mass mortality in British Columbia. *PeerJ*. 4:e1980.

Shelton, A. O., G. H. Sullaway, E. J. Ward, B. E. Feist, K. A. Somers, V. J. Tuttle, J. T. Watson, and W. H. Satterthwaite. 2021. Redistribution of salmon populations in the northeast Pacific Ocean in response to climate. *Fish and Fisheries*. 22:503-517.

Shivji, M., D. Parker, B. Hartwick, M. J. Smith, and N. A. Sloan. 1983. Feeding and distribution study of the sunflower sea star *Pycnopodia helianthoides* (Brandt, 1938). *Pacific Science*. 37(2):133-140.

Smith, J. G., D. Malone, and M. H. Carr. 2024. Consequences of kelp forest ecosystem shifts and predictors of persistence through multiple stressors. *Proceedings of the Royal Society B*. 291 (2016):20232749.

Smith, J. G., J. Tomoleoni, M. Staedler, S. Lyon, J. Fujii, and T. M. Tinker. 2021. Behavioral responses across a mosaic of ecosystem states restructure a sea otter-urchin trophic cascade. *Proceedings of the National Academy of Sciences*. 118(11):e2012493118.

Soderlund, E., D. L. Randolph, and C. Dykstra. 2012. IPHC setline charters 1963 through 2003. IPHC Technical Report No. 58. International Pacific Halibut Commission, Seattle, WA. 264 pp.

Somers, K. A., K. E. Richerson, V. J. Tuttle, and J. T. McVeigh. 2023b. Fisheries Observation Science Program Coverage Rates, 2002-2022. U.S. Department of Commerce, NOAA Data Report NMFS-NWFSC-DR- 2023-01 Available at: https://repository.library.noaa.gov/view/noaa/52078#tabs-3.

Somers, K. A., C. E. Whitmire, E. Steiner, J. E. Jannot, K. Richerson, V. J. Tuttle, and J. T. McVeigh. 2023a. Fishing Effort in the 2002-2021 U.S. Pacific Coast Groundfish Fisheries. West Coast Groundfish Observer Program. National Marine Fisheries Service, NWFSC, 2725 Montlake Blvd E., Seattle, WA 98112 Available at: https://repository.library.noaa.gov/view/noaa/52077.

Starko, S., C. Neufeld, L. Gendall, B. Timmer, L. Campbell, J. Yakimishyn, L. Druehl, and J. Baum. 2022. Microclimate predicts kelp forest extinction in the face of direct and indirect marine heatwave effects. *Ecological Applications*. 2022:e2673.

Tague, C. L., J. S. Choate, and G. Grant. 2013. Parameterizing sub-surface drainage with geology to improve modeling streamflow responses to climate in data limited environments. *Hydrology and Earth System Sciences*. 17(1): 341-354.

Tillmann, P., and D. Siemann. 2011. Climate Change Effects and Adaptation Approaches in Marine and Coastal Ecosystems of the North Pacific Landscape Conservation Cooperative Region. National Wildlife Federation. 264 pp.

Tolimieri, N., A. O. Shelton, J. F. Samhouri, C. J. Harvey, B. E. Feist, G. D. Williams, K. S. Andrews, K. E. Frick, S. Lonhart, G. Sullaway, O. Liu, H. D. Berry, and J. Waddell.

2023. Changes in kelp forest communities off Washington, USA, during and after the 2014-2016 marine heatwave and sea star wasting syndrome. *Marine Ecology Progress Series*. 703:47-66.

United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 2019. Endangered and Threatened Wildlife and Plants; Regulations for interagency cooperation. *Federal Register.* 84:44976-45018.

USFWS and NMFS. 2024. Endangered and Threatened wildlife and plants: regulations for interagency cooperation. *Federal Register.* 89:24268-24298.

Zamon, J. E., and D. W. Welch. 2005. Rapid shift in zooplankton community composition on the northeast Pacific shelf during the 1998 1999 El Niño La Niña event. *Canadian Journal of Fisheries and Aquatic Sciences*. 62(1): 133-144.