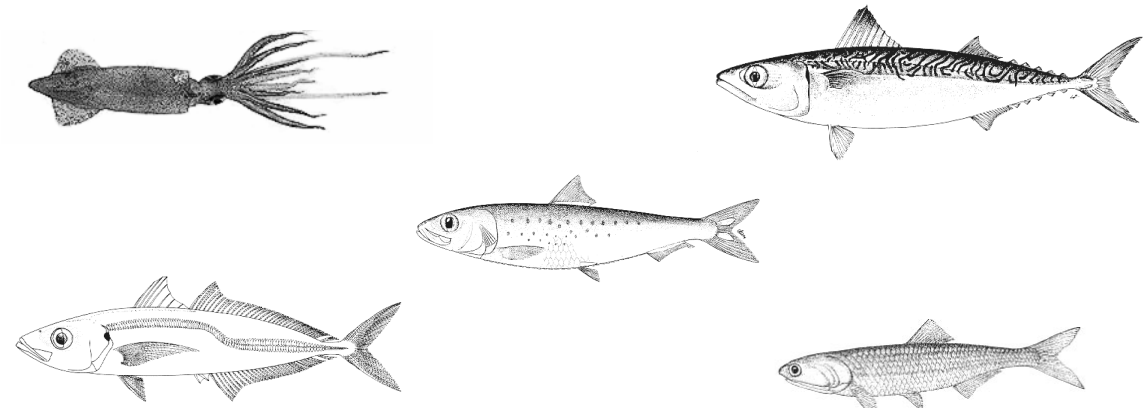
STATUS OF THE PACIFIC COAST COASTAL PELAGIC SPECIES FISHERY AND RECOMMENDED ACCEPTABLE BIOLOGICAL CATCHES

STOCK ASSESSMENT AND FISHERY EVALUATION 2021

INCLUDING INFORMATION THROUGH JUNE 2021



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LIST OF ACRONYMS AND ABBREVIATIONS

ABC	acceptable biological catch
ACL	annual catch limit
ACT	annual catch target
BO	Biological Opinion
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CC	California Current
CCLME	California Current Large Marine Ecosystem
CDFW	California Department of Fish and Wildlife
CFGC	California Fish and Game Commission
Council	Pacific Fishery Management Council
CPFV	commercial passenger fishing vessel
CPS	coastal pelagic species
CPSAS	Coastal Pelagic Species Advisory Subpanel
CPSMT	Coastal Pelagic Species Management Team
CPSPDT	Coastal Pelagic Species Plan Development Team
CPUE	catch per unit effort
CS	catch shares
CUTOFF	The lowest estimate of biomass at which directed harvest is allowed
EBFM	ecosystem based fishery conservation and management
EEZ	exclusive economic zone
EFH	essential fish habitat
EFMP	ecosystem fishery management plan
EIS	environmental impact statement
ENSO	El Niño southern oscillation
ESA	Endangered Species Act
FMP	fishery management plan
GT	gross tonnage
HCR	harvest control rule
HG	harvest guideline
LE	limited entry
LME	large marine ecosystem
Magnuson Act	Magnuson-Stevens Fishery Conservation and Management Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MAXCAT	maximum harvest level parameter
MEI	Multivariate El Niño Index
MSFMP	Market Squid Fishery Management Plan
MSST	Minimum Stock Size Threshold
MSY	maximum sustainable yield
mt	metric ton
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NSNA	Northern subpopulation of northern anchovy
NWFSC	Northwest Fisheries Science Center (NMFS)
NWR	National Marine Fisheries Service (NMFS) Northwest Region
ODFW	Oregon Department of Fish and Wildlife

OFL	overfishing limit
OFWC	Oregon Fish and Wildlife Commission
OMB	Office of Management and Budget
OY	optimum yield
PacFIN	Pacific Coast Fisheries Information Network
PDO	Pacific Decadal Oscillation
PFAU	Pelagic Fisheries Assessment Unit
PRD	Protected Resource Division
RecFIN	Recreational Fishery Information Network
ROV	remotely operated vehicle
SAFE	stock assessment and fishery evaluation
Secretary	U.S. Secretary of Commerce
SFD	Sustainable Fisheries Division
SS	Stock Synthesis
SSC	Scientific and Statistical Committee
SST	sea surface temperature
st	short ton
STAR	Stock Assessment Review (Panel)
STAT	Stock Assessment Team
SWFSC	Southwest Fisheries Science Center (NMFS)
SWR	Southwest Region (NMFS)
USFWS	U.S. Fish and Wildlife Service
WCR	NMFS West Coast Region
WDFW	Washington Department of Fish and Wildlife

1 INTRODUCTION

The purpose of this report is to briefly summarize aspects of the coastal pelagic species (CPS) Fishery Management Plan (FMP) and to describe the history of the fishery and its management. This report includes information generally through calendar year 2020, and some sections include more recent information through June 30, 2021. The guidelines for FMPs published by the National Marine Fisheries Service (NMFS) require that a stock assessment and fishery evaluation (SAFE) report be prepared and reviewed annually for each species managed under this FMP: Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicus*), northern anchovy (*Engraulis mordax*), jack mackerel (*Trachurus symmetricus*), market squid (*Doryteuthis opalescens*), and krill (*euphausiid spp.)*. Pacific herring (*Clupea pallasi*) and jacksmelt (*Atherinopsis californiensis*) were added as Ecosystem Component species, concurrent with Council approval of Amendment 13 to the CPS FMP. Shared ecosystem component species were subsequently added with Amendment 15. The SAFE report for Pacific Coast CPS fisheries was developed by the Council's Coastal Pelagic Species Management Team (CPSMT) from information contributed by scientists at NMFS, the Southwest and Northwest Fisheries Science Centers (SWFSC, NWFSC), California Department of Fish and Wildlife (CDFW), Oregon Department of Fish and Wildlife (ODFW), and Washington Department of Fish and Wildlife (WDFW). Included in this report are descriptions of landings, fishing patterns, estimates of the status of stocks, and acceptable biological catches (ABCs). Stock assessments for Pacific sardine are typically published in briefing book materials annually in April. Stock assessments for Pacific mackerel are typically published in briefing book materials in June, in alternating years. Stock assessments are typically included as appendices to the SAFE report, when there is a new full or updated assessment, or a projection estimate available. The ABC recommendations, together with social and economic factors, are considered by the Council in determining annual harvest guidelines and other measures for actively [1]managed fisheries (i.e., Pacific mackerel and Pacific sardine).

[1] In November 2021 the Council considered eliminating the CPS management categories while retaining the individual management descriptions for each stock. Until that action is finalized, this document retains references to Active and Monitored management categories.

2 THE CPS FISHERY

2.1.1 Management History

The CPS FMP builds on the *Northern Anchovy Fishery Management Plan*, which was implemented in September 1978. The Council began to consider expanding the scope of the northern anchovy FMP in 1990, with development of the seventh amendment to the FMP. The intent was to develop a greatly modified FMP, which included a wider range of coastal pelagic finfish and market squid. A complete draft was finished in November of 1993, but the Council suspended further work because NMFS withdrew support due to budget constraints. In July 1994, the Council decided to proceed with public review of the draft FMP. NMFS agreed with the decision on the condition that the Council also consider the options of dropping or amending the northern anchovy FMP. Four principal options were considered for managing CPS fisheries:

1. Drop the anchovy FMP (results in no Federal or Council involvement in CPS).
2. Continue with the existing FMP for anchovy (status quo).
3. Amend the FMP for northern anchovy.
4. Implement an FMP for the entire CPS fishery.

In March 1995, after considering the four options, the Council decided to proceed with option four, developing an FMP for the entire CPS fishery. Final action was postponed until June 1995 when the Council adopted a draft plan that had been revised to address comments provided by NMFS and the Council's Scientific and Statistical Committee (SSC). Amendment 7 was submitted to the U.S. Secretary of Commerce (Secretary) but rejected by NMFS Southwest Region (SWR) as being inconsistent with National Standard 7. NMFS announced its intention to drop the FMP for northern anchovy in a proposed rule published in the *Federal Register* on March 26, 1996 (61*FR*13148). The proposed rule was withdrawn on November 26, 1996 (61*FR*60254). Upon implementation of Amendment 8 (see below), the northern anchovy FMP was renamed the Coastal Pelagic Species Fishery Management Plan.

2.2 Recent Management

For a complete listing of formal Council actions and NMFS regulatory actions since implementation of the CPS FMP see Tables 2-1 and 2-2, respectively.

2.2.1 Amendment 8

Development of Amendment 8 to the northern anchovy FMP began during June 1997 when the Council directed the Coastal Pelagic Species Plan Development Team (CPSMT) to amend the FMP for northern anchovy to conform to the recently revised Magnuson-Stevens Fishery Conservation and Management Act (MSA) and to expand the scope of the FMP to include other species harvested by the CPS fishery.

In June 1999, NMFS partially approved the CPS FMP. Approved FMP elements included: (1) the management unit species; (2) CPS fishery management areas, consisting of a limited entry (LE) zone and two subareas; (3) a procedure for setting annual specifications including harvest guidelines (HG), quotas, and allocations; (4) provisions for closing directed fisheries when the

directed portion of an HG or quota is taken; (5) fishing seasons for Pacific sardine and Pacific mackerel; (6) catch restrictions in the LE zone and, when the directed fishery for a CPS is closed, limited harvest of that species to an incidental limit; (7) an LE program; (8) authorization for NMFS to issue exempted fishing permits for the harvest of CPS that otherwise would be prohibited (Tables 2-7, 2-8); and (9) a framework process to make management decisions without amending the FMP.

At that time, NMFS disapproved the optimum yield (OY) designation for market squid, because there was no estimate of maximum sustainable yield (MSY). Bycatch provisions were disapproved for lack of standardized reporting methodology to assess the amount and type of bycatch and because there was no explanation of whether additional management measures to minimize bycatch and the mortality of unavoidable bycatch were practicable.

On December 15, 1999, final regulations implementing the CPS FMP were published in the *Federal Register* (64*FR*69888). Provisions pertaining to issuance of LE permits were effective immediately. Other provisions, such as harvest guidelines, were effective January 1, 2000.

2.2.2 Amendment 9 – Bycatch Provisions; Treaty Indian Fishing Rights

During 1999 and 2000, the CPSMT developed Amendment 9 to the CPS FMP. Originally, Amendment 9 addressed the disapproved provisions of the FMP – bycatch and market squid MSY. The amendment also included provisions to ensure that treaty Indian fishing rights are implemented according to treaties between the U.S. and specific Pacific Northwest tribes.

The Council distributed Amendment 9 for public review on July 27, 2000. At its September 2000 meeting, the Council reviewed written public comments, received comments from its advisory bodies, and heard public comments. Based on advice about market squid MSY determination, the Council decided to include in Amendment 9 only the provisions for bycatch and treaty Indian fishing rights. The Council decided to conduct further analysis of the squid resource and prepare a separate amendment to address OY and MSY for squid. The Secretary approved Amendment 9 on March 22, 2001, and the final rule implementing Amendment 9 was published August 27, 2001 (66*FR*44986).

2.2.3 Amendment 10 – Limited Entry Capacity Goal; Permit Transfers; Market Squid OY/MSY

In April 2001, the Council adopted a capacity goal for the CPS LE finfish fishery and asked the CPSMT to begin work on a 10th amendment to the FMP. Amendment 10 included the capacity goal, provisions for permit transferability, a process for monitoring fleet capacity relative to the goal, and a framework for modifying transferability provisions as warranted by increases or decreases in fleet capacity. The amendment also addressed determination of OY and MSY for market squid.

In June 2002, the Council adopted Amendment 10 to the CPS FMP. Relative to the LE fishery, the amendment established a capacity goal, provided for LE permit transferability to achieve and maintain the capacity goal, and established a process for considering new LE permits. The purpose of this action was to ensure fishing capacity in the CPS LE fishery is in balance with resource availability. Relative to market squid, Amendment 10 established an MSY (or proxy) for market squid to bring the FMP into compliance with the MSA. The purpose of this action was to minimize

the likelihood of overfishing the market squid resource. On December 30, 2002, the Secretary approved Amendment 10. On January 27, 2003, NMFS issued the final rule and regulations implementing Amendment 10 (68*FR*3819).

2.2.4 Sardine Allocation Regulatory Amendment

In September 2002, a majority of the Coastal Pelagic Species Advisory Subpanel (CPSAS) recommended the Council initiate a regulatory or FMP amendment and direct the CPSMT to prepare management alternatives for revising the sardine allocation framework. The Council directed the CPSMT to review CPSAS recommendations for revising the allocation framework. At the March 2003 Council meeting, the SSC and CPSAS reviewed analyses of the proposed management alternatives for sardine allocation. Based on the advisory body recommendations and public comment, the Council adopted five allocation management alternatives for public review. In April 2003, the Council took final action on the regulatory amendment. This change was implemented by NMFS on September 4, 2003 (68*FR*52523).

The new allocation system: (1) changed the definition of Subarea A and Subarea B by moving the geographic boundary between the two areas from 35° 40' N. latitude (Point Piedras Blancas, California) to 39° N. latitude (Point Arena, California); (2) moved the date when Pacific sardine that remains unharvested is reallocated to Subarea A and Subarea B from October 1 to September 1; (3) changed the percentage of the unharvested sardine that is reallocated to Subarea A and Subarea B from 50 percent to both subareas, to 20 percent to Subarea A and 80 percent to Subarea B; and (4) provided for coastwide reallocation of all unharvested sardine that remains on December 1. This revised allocation framework was in place for the 2003 and 2004 fishing seasons. It was also used in 2005 because the 2005 HG was at least 90 percent of the 2003 harvest guideline.

2.2.5 Amendment 11 - Allocation

The Council began developing options for a new allocation framework for the coastwide Pacific sardine fishery in 2003 while the fishery operated under the regulatory amendment described in the previous section. This revision to the sardine allocation framework occurred through Amendment 11 to the CPS FMP in 2006. The FMP amendment was intended to achieve optimal utilization of the resource and equitable allocation of harvest opportunity.

The Council tasked the CPSAS with initial development of a range of allocation alternatives. At the November 2004 meeting, the CPSAS presented several program objectives and a suite of alternative allocation formulae. The Council adopted for preliminary analysis a range of alternatives, including the CPSAS recommendations, as well as the following program objectives:

- Strive for simplicity and flexibility in developing an allocation scheme.
- Transfer quota as needed.
- Utilize OY.
- Implement a plan that balances maximizing value and historic dependence on sardine.
- Implement a plan that shares the pain equally at reduced HG levels.
- Implement a plan that produces a high probability of predictability and stability in the fishery.

For the analysis of the alternatives, the Council gave specific direction to the CPSMT, including:

- Analyze each alternative in a consistent manner.

- Review differential impacts on northern and southern sectors for each alternative.
- Review effects of high and low catch years by sector for each alternative.
- Review resulting effects at various HG levels ranging from 25,000 metric tons (mt) 200,000 mt (at appropriate intervals) for each alternative.
- At the discretion of the CPSMT, combine aspects of the various alternatives to create new alternatives that meet program objectives.

At the April 2004 Council meeting, the CPSMT presented preliminary economic analyses of these alternatives to the Council and its advisory bodies. The economic analysis of alternative allocation schemes included five-year projections of the incremental change in producer surplus and landings projections for each fishing sector and subarea. Monthly landings projections were based on 2004 landings and were inflated by 10 percent annually to account for expected growth in the regional fishery sectors over the next five years. These projections identified months in which there would be a shortfall in landings, and months which would start out with no available allocation. These landings projections were conducted under three HG scenarios: (1) low HG = 72,000 mt, (2) Base case HG = 136,000 mt, and (3) high HG = 200,000 mt.

The Council reviewed the preliminary results and public testimony before following the advice of both the CPSAS and CPSMT when adopting the remaining range of alternatives for further analysis and public review. The Council directed the CPSMT to take into account the advice of the SSC as they proceeded with the analysis. Specifically, the Council requested a sensitivity analysis of the effects of future fishery growth where varying growth assumptions by subarea are applied, rather than the previously assumed 10 percent growth of the fishery coastwide. The Council also recommended that two different provisions for the review of a sardine allocation framework be included in the documentation for public review. The first is based on time, where sardine allocation would be reviewed after three, five, or seven years of implementation; the second is based on the size of the HG, where sardine allocation would be revisited if the HG falls below 75,000 mt or 100,000 mt.

In June 2005, the Council adopted a long-term allocation framework to apportion the annual Pacific sardine harvest guideline among the various non-tribal sectors of the sardine fishery. The Council followed the opinion of the CPSAS when adopting a seasonal allocation scheme, which provides the following allocation formula for the non-tribal share of the HG:

(1) January 1, 35 percent of the harvest guideline to be allocated coastwide;

(2) July 1, 40 percent of the HG, plus any portion not harvested from the initial allocation, to be reallocated coastwide; and

(3) September 15, the remaining 25 percent of the harvest guideline, plus any portion not harvested from earlier allocations, to be reallocated coastwide.

The Council also heeded the advice of the CPSAS, CPSMT, and SSC regarding the dynamic nature of the Pacific sardine resource and uncertainties inherent in long-term projections and scheduled a formal review of the allocation formula in 2008. The review was intended to provide a comparison of the performance of the fishery to the projections used to evaluate the adopted allocation scheme and will include any new information from Pacific sardine research. The review was postponed and has not been re-scheduled.

2.2.6 Amendment 12 – Krill Fishing Prohibition

At its November 2004 meeting the Council initiated development of a formal prohibition on directed fisheries for krill and directed staff to begin developing management measures to regulate directed fisheries for krill in Council-managed waters. The proposal for a krill ban was first proposed for West Coast National Marine Sanctuary waters by the National Marine Sanctuary Program.

This Amendment was in recognition of the importance of krill as a fundamental food source for much of the marine life along the West Coast. Moreover, state laws prohibit krill landings by state-licensed fishing vessels into California, Oregon, and Washington. Thus, the action could provide for consistent Federal and state management. There are currently no directed krill fisheries in Council-managed waters.

At the November 2005 Council meeting, the Council recommended that all species of krill be included in the CPS FMP as prohibited harvest species and approved a range of krill fishing alternatives for public review and additional analysis over the winter. The Council narrowed the range of alternatives to: 1) status quo, 2) a prohibition on krill fishing in all Council-managed waters, and 3) an initial prohibition combined with the establishment of a process for considering future krill fishing opportunities. Of these alternatives, the Council adopted the second, a complete ban on krill fishing as a preliminary preferred alternative.

In March 2006, the Council adopted a complete ban on commercial fishing for all species of krill in West Coast Federal waters and made no provisions to allow future fisheries. They also specified essential fish habitat (EFH) for krill, making it easier to work with other Federal agencies to protect krill. This broad prohibition will apply to all vessels in Council-managed waters.

Amendment 12 was approved by the Secretary and in 2009, NMFS published the implementing regulations in a final rule (74*FR33372*).

2.2.7 Amendment 13 – Annual Catch Limits

The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (MSRA) established several new fishery management provisions pertaining to National Standard 1 (NS1) of the MSA. The MSA sought to end overfishing and required rebuilding plans for those stocks considered to be overfished. It also introduced new fishery management concepts including overfishing levels (OFLs), annual catch limits (ACLs), annual catch targets (ACTs), and accountability measures (AMs) that are designed to better account for scientific and management uncertainty. Council action on Amendment 13 also included a recommendation to add Pacific herring and jacksmelt to the FMP, as Ecosystem Component Species.

At its June 2010 meeting, the Council selected preferred alternatives and approved a draft alternatives document that forms the backbone of Amendment 13 to the CPSMP. Draft implementing regulations and Amendment 13 text were released for a 60-day public review on June 3, 2011. The Secretary of Commerce, via NMFS, gave final approval of Amendment 13 in September 2011.

2.2.8 Sardine Start Date Change

At its June 2013 meeting, the Council adopted an annual start date of July 1 for the Pacific sardine fishery. The previous start date was January 1 each year. The change to a different start date was made to allow more time for spring and summer sampling results to be analyzed and organized, and subsequently to become available to the Stock Assessment Team. The new schedule would allow for more confidence in the spring/summer sampling results because there is more time available for analysis, interpretation, and organization. The period allocations were not changed with the new start date. However, with the fishing year ending June 30, there will be no rollover of unused quota into the July 1-September 14 fishing period.

2.2.9 Amendment 14 – Northern Anchovy MSY

In November 2013, in response to a lawsuit by the conservation group Oceana, the Council took final action to establish an MSY value for the northern subpopulation of northern anchovy (NSNA). At its November 2010 meeting, the Council had considered two options that were analyzed by the CPSMT but ended up not adopting either one. One of those analyzed values was an MSY reference point of Fmsy = 0.30, which was subsequently formally adopted by the Council in November 2013. This reference point was incorporated into the FMP as part of Amendment 14, which was approved by the Secretary of Commerce on March 23, 2015.

2.2.10 Amendment 15 – Unmanaged Forage Fish

Amendment 15 addressed protections for unfished and unmanaged forage fish and incorporated them as Ecosystem Component species in each of the Council's four FMPs. Amendment 15 prohibits the development of new directed fisheries on forage species that are not currently managed by the Council, or the States, until the Council has had an adequate opportunity to assess the science relating to any proposed fishery and any potential impacts to our existing fisheries and communities. This is not a permanent moratorium on fishing for forage fish. Instead, the Council adopted COP 24, which outlines a review process for any proposed fishery. Amendment 15 was approved by the Secretary of Commerce in March 2016.

2.2.11 Amendment 16 – Small Scale Directed Fisheries

Amendment 16 allows for minor directed CPS fishing to take place on stocks that are otherwise closed to directed fishing. The estimated biomass of Pacific sardine fell below the Cutoff value of 150,000 mt in 2015, resulting in a closure of directed fishing. The Council adopted incidental allowance limits for harvest of sardine while fishing for other CPS. However, fishing that targets Pacific sardine is not allowed when the biomass drops below 150,000 mt. Several small-scale harvesters catch small amounts for the bait market or specialty human market (e.g., restaurants). The new amendment allows for these activities to continue, with limits of one mt per day, and only a single vessel trip per day. Amendment 16 also applies to northern anchovy and Pacific mackerel, but not market squid. Amendment 16 was approved by the Secretary of Commerce on January 31, 2018.

2.2.12 Amendment 17 – Live Bait Fishing Allowance

In November 2018, the Council adopted an FMP amendment regarding CPS live bait harvest when a CPS stock is in an overfished condition. Previously, if a CPS stock were to become overfished, directed live bait fishing would be precluded, and harvest would be limited to a 15 percent incidental landing limit. In response to concerns that the incidental landing limit would make it impossible to prosecute a live bait fishery (which depends on pure loads for sale to the recreational fleet and commercial albacore fleet), the Council removed that predetermined limit and instead will require the Council to make decisions about landing limits in the live bait fishery based on the specific environmental and socio-economic considerations at the time. Harvest will be subject to ACLs and other management measures, and the Council (and NMFS) will retain authority to prohibit live bait fishing and/or apply incidental landings restrictions, as warranted. Amendment 17 was approved by the Secretary of Commerce on June 10, 2019.

2.2.13 Amendment 18 – Sardine Rebuilding Plan

In July 2019 NMFS notified the Council that the Pacific sardine stock had been declared overfished, thereby necessitating development of a rebuilding plan within two years. At its September 2020 meeting the Council approved a rebuilding plan that adopted status quo management as the rebuilding plan preferred alternative. The CPSMT and SSC were directed to develop a plan for monitoring rebuilding progress, and Amendment 18 to the CPS FMP was approved by the Secretary of Commerce in June 2021.

2.3 CPS Fisheries – History and Description

In the first half of the 20th century areas of fishing for Pacific sardine included the waters off Vancouver Island, Canada, Grays Harbor Washington, Astoria and Coos Bay Oregon, San Francisco, Monterey, San Pedro, and San Diego, California, and Ensenada and Cedros Island, Mexico (Clark and Marr, 1955). The fishery eventually contracted, with successive closures. Sardines were last landed in British Columbia in the 1947-1948 season, in Oregon and Washington in the 1948-1949 season, and in San Francisco Bay in the 1951-1952 season (Radovich 1982).

The fishery for Pacific sardine operated off Oregon and Washington again starting in 1999. This fishery targeted the larger sardines prevalent in the Pacific Northwest, which were typically sold as bait for Asian longline tuna fisheries. A sardine fishery in British Columbia, Canada also operated in this time frame. Beginning in 2006, this fishery expanded into human consumption markets. However, after a peak in 2012, the coastwide sardine stock declined, and has been closed to directed commercial fishing since 2015. See individual state description below for more detailed information.

2.3.1 Federal Limited Entry Fishery

The CPS LE fleet currently consists of 65 permits and 55 vessels (Table 2-3), operating under a Federal permit program. The LE vessels range in age from three to 74 years, with an average age of 39 years (Table 2-4). The capacity goal and transferability provisions established under Amendment 10 are based on calculated gross tonnage (GT) of individual vessels. Calculated GT

serves as a proxy for each vessel's physical capacity and is used to track total fleet capacity. Calculated GT incorporates a vessel's length, breadth, and depth, which are consistent measures across vessel registration and U.S. Coast Guard documentation lists. As described at 46 CFR § 69.209, GT is defined as:

GT=0.67(length*breadth*depth)/100

Vessel dimension data were obtained from the U.S. Coast Guard database, and each vessel's calculated GT was attached to the permit under Amendment 10. Original GT endorsements (specified in Table 2-3) remain with the permit, regardless of whether the permit is transferred to a smaller or larger vessel.

GT values for the current fleet range from 26.4 GT to 182.5 GT, with an average of 84.3 GT (Tables 2-3 and 2-4). The fleet capacity goal established through Amendment 10 is 5,650.9 GT, and the trigger for restricting transferability is 5,933.5 GT (Goal + 5 percent). The current LE fleet is 4,887.6 GT, well within the bounds of the capacity goal.

2.3.2 California Fisheries Overview

In the 1940s, more than 100 canneries and reduction plants from San Francisco to San Diego employed thousands of workers to process sardines. At its peak in the 1937-38 season, the fishing fleet numbered 379 vessels and averaged 268 vessels over the next decade. (CA Fish Bulletin 74). In California, some present-day CPS vessels are remnants of that fleet. CPS finfish landed by the roundhaul fleet (fishing primarily with purse seine or lampara nets) are sold around the world in many product forms. For example, Pacific mackerel are typically sold to Asian and European, Middle Eastern and Baltic markets for human consumption or sold as crab bait. Sardines are largely exported for canning for human consumption, high value table consumption products, and long-line bait, or sold for tuna or animal feed. Individually quick frozen (IQF) sardine sold as 'zoo' food is a value-added product. Although the percent of CPS sold for tuna feed or bait fluctuates based on demand, fish size and oil content, product availability, etc., the percent sold in higher value categories is generally growing (Pleschner-Steele, pers comm, 2014). In addition to fishing for CPS finfish, many of these vessels fish for market squid, Pacific bonito, bluefin, and yellowfin tuna (which are fished primarily in California), and Pacific herring (fished primarily in Oregon/Washington.).

2.3.2.1 California Sardine Fishery

California's sardine fishery began in the 1860s as a supplier of fresh whole fish. The fishery shifted to canning from 1889 to the 1920s in response to a growing demand for food during World War I. Peaking in 1936-37, sardine landings in the three west coast states plus British Columbia reached a record 717,896 mt. In the 1930s and 1940s, Pacific sardine supported the largest commercial fishery in the western hemisphere, with sardines accounting for nearly 25 percent of all the fish landed in the United States by weight. In the 1940s, the fishing fleet consisted of 376 vessels and more than 100 canneries and reduction plants, which employed thousands from San Francisco to San Diego, California.

The fishery declined and collapsed in the late 1940s due to extremely high catches and changes in environmental conditions and remained at low levels for nearly 40 years. The fishery declined southward, with landings ceasing in Canadian waters during the 1947-1948 season, in Oregon and

Washington in the 1948-1949 season, and in the San Francisco Bay in the 1951-1952 season. The California Cooperative Fisheries Investigations (CalCOFI), a consortium of state and Federal scientists, emerged to investigate the causes of the sardine decline. Analyses of fish scale deposits in deep ocean sediments off southern California found layers of sardine and anchovy scales, with nine major sardine recoveries and subsequent declines over a 1700-year period (Baumgartner et al. 1992). Sardines and anchovies both vary in abundance over periods of about 60 years. Warm-water oceanic cycles favor sardine recruitment and cold-water cycles favor anchovy recruitment. The decline of the sardine fishery became a classic example of a "boom and bust" cycle, a characteristic of clupeid stocks.

In 1967, the California Department of Fish and Game (CDFG) implemented a moratorium that lasted nearly 20 years. The remaining vessels diversified into other coastal pelagic "wetfish" fisheries. Sardines began to return to abundance in the late 1970s, when the Pacific Decadal Oscillation (PDO) shifted to a warm cycle again, but this time fishery managers adopted a highly precautionary management framework. California's sardine fishery reopened in 1986 with a 1,000 st quota, authorized by the Legislature when the biomass exceeded 20,000 mt. The sardine resource grew exponentially in the 1980s and early 1990s, with recruitment estimated at 30 percent or greater each year. In 1998, the sardine resource was declared "recovered," with a biomass estimated at slightly more than 1 million mt. The quota set by CDFG had increased to 43,545 mt, and it was virtually completely utilized.

In 1999, the new coastwide harvest guideline (HG) jumped to 186,791 mt, based on a 1999 biomass estimate of 1.58 million mt. In 2000, California harvested 53,611 mt. About 71 percent of the catch was exported, valued at $23.3 million, and approximately 17 percent of the catch went to canneries. However, the last cannery in southern California was sold in December, leaving only one cannery remaining in Monterey, in a fishery that had employed more than 100 canneries and reduction plants statewide during the fishery's heyday in the 1930s and 1940s.

The sardine recovery appeared to level off during 1999-2002. By August 2002, the Northern fishery attained its allocation and was forced to close early. Northwest sardine interests lobbied the Council for an emergency reopening and revision to the allocation framework because thousands of tons of sardine were available and going unharvested in the Southern fishery.

In the early 2000s, the California fishery encountered an abundance of small sardines on traditional fishing grounds, for which markets were very limited. The larger fish appeared to move offshore in their northern migration, out of the range of California seiners who made most of their catches inside the 3-mile state boundary. The lack of canning-size sardines caused the last cannery in Monterey to sell its canning equipment. Still, sardines ranked among the top fisheries in California for volume and sixth in value with ex-vessel ranging from $4.5 million to more than $5 million. With a main focus now on export markets, California shipped sardines to as many as 22 countries worldwide, and annual export values exceeded $20 million.

From 1998-2006, California sardine landings averaged 47,394 mt. In 2005, Oregon landings surpassed California for the first time since the fishery reopened. California caught nearly 81,000 mt of the 152,564 mt HG in 2007 – the highest landings since the 1960s. Ex-vessel value exceeded $8 million, and 66,896 tons of sardine were exported to 37 countries, with an export value of $40.4 million.

In 2008, the HG declined 42 percent, to 89,093 mt, and the sardine fishery closed early in all three allocation periods, with California catching 57,803 mt of the total. Beginning in 2008, California's

sardine fishery was closed more than it was open, and it was closed early, during the peak fall season in all years but 2012 and 2013. In 2009, the annual HG was attained in 77 fishing days. California landings totaled 37,578 mt, with two-thirds of the catch in Monterey. California exported 33,909 mt to 35 countries. In 2010, California landings fell to 33,658 mt of the 72,039 mt quota, and 83 percent of the catch was landed in San Pedro. The 2010 summer period closed July 22, the fishery reopened on September 15, and closed for the year on September 24. The 2011 sardine fishery experienced another 30 percent reduction in HG, with only 50,526 mt allowed to be harvested of a 537,173 mt age 1+ biomass. California caught 27,714 mt in 83 total days of fishing opportunity.

In 2012, although the biomass and HG increased substantially (988,385 mt biomass and 109,409 mt HG), California landings continued declining to only 23,044 mt. Fishermen were unable to find sardines early in the year and then shifted their fishing to a banner squid season during the summer. There was further evidence of a natural sardine decline in 2013 as sardines disappeared from Canadian waters. The 2013 HG decreased 69 percent to 66,495 mt, and California harvested only 7,074 mt of sardines. Pacific mackerel landings surpassed sardine for the first time since 1993. In place of sardine, a decadal squid population explosion occupied the California purse seine fleet until 2015, when an El Niño event sharply reduced squid availability. Since Federal management began in 2000, the sardine biomass has declined more than 70 percent since the 2006 high of 1.3 million mt, and harvest limits have fallen from a high of an HG of 186,971 mt in 2000 to an ACT of 23,293 mt for the 2014-2015 season. The April 2015 biomass estimate fell below the CUTOFF value of 150,000 mt, and has remained below that value, thereby precluding a directed commercial fishery from 2015 to the present (see Section 8). Since the closure of primary directed commercial fishery in 2015, an average of 2,218 mt of sardine has been landed in California through 2020, mostly in the live bait fishery.

2.3.2.2 California Anchovy Fishery

Records of California landings of northern anchovy date back to 1916. Between 1916-1946, anchovy landings averaged 508 metric tons and were used mainly for reduction to meal and oil. Landings were low until scarcity of sardine landings caused processors to begin canning anchovies in large quantities in 1947, whereupon landings increased from 960 tons in 1946 to 9,464 tons in 1947. Anchovy landings declined again with the short resurgence of the sardine in 1951 but picked back up again when the sardine fishery collapsed in 1952. Over the next several years, anchovy landings fluctuated, and then began to decline in 1958 due to low consumer demand for canned anchovy and increased sardine landings. Beginning in 1965, the California Fish and Game Commission managed the U.S. fishery on the basis of a reduction quota, and separate reduction and non-reduction landings statistics have been kept ever since.

For many years, northern anchovy were harvested for reduction by a fleet of approximately forty small purse seine vessels known collectively as the "wetfish" fleet. The fleet also fished for Pacific mackerel (*Scomber japonicus*), jack mackerel (*Trachurus symmetricus*), Pacific bonito (*Sarda chiliensis*), Pacific bluefin tuna (*Thunnus orientalis*), market squid (*Doryteuthis opalescens*) and Pacific sardine (*Sardinops sagax*). Reduction landings increased from 155 mt in 1965 to 24,810 mt in 1966 and ranged from 12,515 mt per year to 84,328 mt per year during 1966-1972. Landings increased to 118,432 mt in 1973 and ranged from 73,400 mt per year to 141,586 mt per year during 1973-1977. In response to decreases in fish meal prices, landings declined to an annual average of

46,500 mt during 1979-1982. Landings intended for processing into fish meal and oil have been extremely low since 1983, largely due to low ex-vessel prices, rather than low anchovy abundance (Thomson et al. 1989).

Live bait vessels are mostly distributed in Southern California to serve the sport fishing markets, and fish for a variety of species, including anchovy, sardine, mackerel, squid, white croaker and queenfish. Anchovies comprised approximately 85 percent of the live bait catch up to 1991. From 1965 to 1991, the anchovy live bait catch ranged from 3,572 to 6,978 mt per year and averaged 5,198 mt annually (2014 SAFE, Table 6-12). Other anchovy landings averaged about 1,973 mt per year from 1965 to 1991.

From 2000-2020, anchovy live bait catch ranged from 114 to 1,519 mt and averaged 667 mt per year comprising about 24 percent of total live bait catch, while commercial landings of anchovy have averaged 8,479 mt annually.

The fishery is far different now from historic times. Today there is virtually no reduction capacity in CA, which is one reason why landings have averaged less than 10,000 mt a year since the mid-1980s (see Section 8.2.1). However, the anchovy fishery is still a very important part of the CPS fishery, as it is the only fishery locally available in Monterey when squid are not available, and the directed sardine fishery is closed. The major processors in Monterey now rely on anchovy for at least six months of the year to sustain the boats and processing crews. Approximately 1,000 people rely directly on anchovy in the Monterey area, with three large processors and 12 to 15 vessels that fish and process anchovy, along with the allied trucking and packing industry. The anchovy fishery takes place in a very limited area, close to port. There are vast unfished areas where anchovy are abundant that are beyond the short travel distances that maintain quality of product.

2.3.2.3 California Other Finfish Fisheries

Pacific mackerel is a targeted fishery in California but landings since the 1980s and 1990s have declined from averaging over 20,000 mt to less than 5,000 mt since 2000. Jack mackerel is currently an incidental fishery to other CPS landings in California, with landings less than 2,000 mt since 2001, compared to historic highs in the tens of thousands of mt between the 1940s and 1980s.

2.3.2.4 California Market Squid Fishery

In 2001, legislation transferred the authority for management of the market squid fishery to the California Fish and Game Commission (CFGC). Legislation required that the CFGC adopt a market squid fishery management plan (MSFMP) and regulations to protect and manage the resource. In August and December of 2004, the CFGC adopted the MSFMP, the environmental documentation, and the implementing regulations, which went into effect on March 28, 2005, just prior to the start of the 2005-2006 fishing season on April 1.

The goals of the MSFMP are to provide a framework that will be responsive to environmental and socioeconomic changes and to ensure long-term resource conservation and sustainability. The tools implemented to accomplish these goals include: (1) setting a seasonal catch limit of 107,048 mt (118,000 st) to prevent the fishery from over-expanding; (2) maintaining monitoring programs designed to evaluate the impact of the fishery on the resource; (3) continuing weekend closures

that provide for periods of uninterrupted spawning; (4) continuing gear regulations regarding light shields and wattage used to attract squid; (5) establishing a restricted access program that includes provisions for initial entry into the fleet, permit types, permit fees, and permit transferability that produces a moderately productive and specialized fleet; and (6) creating a seabird closure restricting the use of attracting lights for commercial purposes in any waters of the Greater Farallones National Marine Sanctuary. Under this framework, the MSFMP provides the CFGC with specific guidelines for making management decisions. The CFGC has the ability to respond to changes in the market squid population off California and implement management strategies without the need for a full plan amendment. The MSFMP framework structure was also designed to achieve the goals and objectives of the Marine Life Management Act and to be consistent with the management outlined in CPS FMP Amendment 10.

Under the restricted access program in the MSFMP, a permit is needed to participate in the fishery. Qualification for different types of permits and transferability options was based on participation in the fishery (2000-2003). In 2020, 72 vessel permits, 32 light boat permits, and 46 brail (netted scoop) permits were issued. Of the 72 vessel permits issued, 59 vessels made commercial landings in 2020. Twenty-nine vessels made 80 percent of the landings (by tonnage) in 2020. Of the 46 brail permits issued, 11 brail vessels landed squid. Market squid vessel permits allow a vessel to attract squid with lights and use large purse seine nets to capture squid. Brail permits allow a vessel to attract squid with lights and use brail gear to capture squid. Light boat permits only allow a vessel to attract squid with lights (30,000 watts, maximum). In 2014, revised regulations went into effect clarifying the take of squid incidentally after a closure of the directed market squid fishery. These regulations require incidental landings of squid to contain 10 percent or less of squid and 2 tons or less of squid, when landed with another targeted species. CDFW revised commercial squid logbooks in 2016, to improve formatting and instructions as well as improve quality of the logbook data collected.

The California market squid fishery is strongly affected by environmental and atmospheric conditions of the California Current. California market squid are extremely sensitive to the warm water trends of El Niño. Historically, overall catches have decreased during El Niño but then rebounded with the increased upwelling of cooler water during La Niña phases. Nutrient poor water occurs during warm water events and can cause landings to disappear entirely in some areas. For example, for years 2012-2015, average SST in southern California was warmest in 2015, which corresponds to the lowest southern California landings. Conversely, average SST for both northern and southern California waters were cooler in 2012, corresponding to higher southern California landings.

The marine heatwave beginning in 2014, coupled with early El Niño signals, had an effect of pushing the squid fishery north, as reflected in the geographic distribution of 2014 landings. With recent warm waters due to El Niño, overall California landings decreased significantly beginning with the 2015-2016 market squid fishing season (the season runs from April 1 to March 31 of the following year). El Niño persisted through 2016 and as a result, squid landings were lower for the 2016-2017 season. Following the weak La Nina from 2017-2018, a weak El Niño occurred in 2018-2019, and landings that season were modest (34,235 mt). Landings for 2019-2020 squid season were minimal (13,801 mt) and there was a weak El Niño during this period as well. Landings for the 2020-2021 squid season were again minimal (18,841 mt), with a moderate La Niña during this period.

2.3.2.5 California Live Bait Fishery

Through much of the 20th century, CDFW monitored the harvest of CPS finfish in the California live bait fisheries by requiring live bait logs. Northern anchovy and Pacific sardine are the main species targeted in this fishery, with a variety of other nearshore or CPS taken incidentally. An estimated 20 percent of this harvest is sold to private fishing vessels, with the remainder to the CPFV fleet, where payment to the bait haulers is on a percentage basis of the CPFV revenues (Thomson et al. 1994). An example of the first Live Bait Log from 1939, termed a "Daily Bait Record" as printed for the State of California, Department of Natural Resources, and Division of Fish and Game can be found in Alpin (1942). The data collected were self-reported daily estimates of the number of "scoops" taken and sold by the fishermen, by species. Although this variety of data does not lend itself readily to rigorous scientific analysis, there are at least 74 years of data available, collected in a reasonably uniform manner that can serve as an index to this low volume, high value fishery.

Studies conducted by CDFW, NMFS, and others have examined this fishery, generally with a focus on the dominant species taken over a given period. As in the directed commercial CPS fisheries, the local availability of each CPS to the bait fleet changes periodically. Problems with the live bait data such as conversion factors for scoops of live fish to weight, the economics of the fishery, the character of the fleet, and compliance rates in submitting logs have been addressed in various agency reports (Maxwell 1974; and Thomson et al. 1991, 1992, 1994).

2.3.2.5.1 Legislative History

Alpin (1942) describes the earliest implementation of the live bait log program in 1939, which followed a pilot program of verbal interaction with the fishermen that established four categories describing the variation in abundance or availability of CPS to the recreational industry.

Live bait logs have been at different times mandated by state law or submitted to the CDFW on a voluntary basis. In the early 1990s, sardine became more prevalent in the bait fishery, and quotas were imposed on their annual take pursuant to management efforts to recover the sardine population off California. In 1995, CDFW lifted quotas restricting the quantity of sardines that the live bait industry could harvest. The sardine population along the California Coast was increasing toward a "recovered" level, as anchovy showed a decline, and sardines became the preferred live bait over anchovy. With the sardine quota lifted, the level of scrutiny on the harvest of the live bait industry lessened.

2.3.2.5.2 Species Composition

The ratio of anchovy to sardine in the southern California live bait harvests shifts significantly as the populations of these two fish expand and contract over periods of years or decades. Much of the early reported harvest consisted of anchovy, following the collapse of the sardine fishery in the 1940s. Through the years 2010 to 2019, the proportion of anchovy to sardine in the total reported harvest ranged from a high of 42 percent anchovy to 58 percent sardine in 2014, to eight percent anchovy to 92 percent sardine in 2019 (Table 4-13).

Market squid are also taken as live bait in Southern California. However, the amount of market squid harvested and the value of the fishery has been uncertain, as there were no permitting and reporting requirements except for squid permit holders who reported live bait on their squid fishing logs. Live bait is now required to be reported on electronic fish tickets. This live bait fishery has

likely been a low-volume, high-value endeavor, as recreational anglers targeting mainly white seabass are willing to pay up to $85 for a “scoop” of live squid, approximately 12 pounds.

2.3.2.5.3 Logbook Information

Until 2000, the CDFW Live Bait Log (Title 14, Section 158, California Code of Regulations: DFG 158, October 1989) required only the estimated scoops taken daily of either anchovy or sardine be reported, and a check mark be made if certain other species were taken, with space for comments related to fishing. Other species noted, but not consistently enumerated in the live bait harvest, include white croaker (*Genyonemus lineatus*), queenfish (*Seriphus politus*), Pacific and jack mackerels, and various small fishes collectively known as "brown bait" that could include juvenile barracuda (*Sphyraena argentea*), Osmerids, Atherinids, and market squid (Table 4-11). Estimates of ancillary catch data have been documented in earlier reports, and in CPS FMP Amendment 9. Beginning in 2000, the live bait logs were no longer mandatory, but submitted on a voluntary basis. In 2015, CFDW met with live bait and CPFV fishery participants to increase participation in the log program and discuss improving the log form to better describe live bait catch. In fall of 2015, a revised log form was issued to bait haulers, and by 2016 was used by all log submitters. The new form called for reported catch in pounds, not scoops, to better standardize reporting.

The CDFW Pelagic Fisheries and Ecosystem Program presently archives the CDFW live bait logs. Preliminary estimates of the reported total live bait harvest in California through 2015 have been appended to previously reported estimates from Thomson *et al.* (1991, 1992, 1994) (Table 4-12). Since 2013, sardine (northern subpopulation) biomass estimates have sharply declined. Consequently, all sources of sardine mortality, including live bait catch, have received renewed attention. Beginning in 2019, CDFW required the live bait industry to report catches using California reporting systems (electronic fish tickets) and logs are no longer used for catch records.

2.3.2.6 California Minor Directed Fisheries

Beginning in 2018 with the implementation of Amendment 16 to the CPS FMP (See Section 2.1), minor directed fishing of CPS stocks otherwise closed to directed fishing has been permitted, with a daily limit of one mt per vessel. The first full fishing year for sardine under this new provision in 2018-2019 had 67 mt landed, while 65 mt were landed in 2019-2020.

2.3.3 Oregon CPS Fisheries Overview

A variety of CPS fisheries have operated in waters off Oregon dating back to the early 1900s with the sardine fishery. The sardine fishery has been subject to resource availability. When the sardine biomass declined that early fishery ended in 1948, but then revived in 1999 when sardine were again found in harvestable quantities. The directed commercial sardine fishery in Oregon closed again in 2015 when the resource again declined and has remained closed since that time. There has also been limited harvest of other CPS finfish including Pacific mackerel and northern anchovy over the years, but these were never of similar magnitude to the sardine fishery in terms of participation, harvest, or economic importance. A market squid fishery occurred in the early 1980s, with landings also occurring in the 1990s. There has been a more substantial fishery for market squid that has developed beginning in 2016. These fisheries as well as the limited live bait together with minor directed fisheries for CPS are described below.

2.3.3.1 Oregon State Limited Entry Sardine Fishery

The Pacific sardine fishery off Oregon started in 1935, but there are recorded landings of sardine in Oregon dating back to 1928. The catch dropped off in the 1940s with 1948 being the last year of directed fishery landings until 1999 when the fishery was revived. Pacific sardine was managed as a developmental fishery from 1999 to 2005. In 2004, the sardine industry asked ODFW to remove Pacific sardines from the developmental species list and create a LE system for the fishery.

ODFW began work with the Developmental Fisheries Board and the industry to develop alternatives for the fishery. In December 2005, the Oregon Fish and Wildlife Commission (OFWC) moved the Pacific sardine fishery from a developing fishery into a state-run LE fishery system. Twenty Oregon permits were initially established and made available to qualifying participants for the 2006 fishery. The OFWC amended a LE permit eligibility rule in August 2006, which resulted in an immediate addition of six permits for a total of 26 LE sardine fishery permits.

In April 2009, the OFWC enacted a number of rule changes for the Pacific sardine fishery. First, the OFWC modified the requirement for minimum landings of sardines into Oregon to qualify for permit renewal that was enacted in 2006. These minimum landing requirements for permit renewal were effective only when the Federal coastwide maximum HG for the fishing year exceeded 100,000 mt. The minimum landing requirements themselves, either a minimum of ten landings of at least five mt each or landings totaling at least $40,000 ex-vessel price, were not changed. Next, the OFWC eliminated a rule that became effective in 2008, which specified that permit holders must either own or operate a vessel that is permitted. The OFWC also established a lottery system for sardine permits. If the number of permits issued falls below 24, a lottery may be held the following year, but the total number issued shall not exceed 26 LE permits. A new rule defined catching vessels and limited catch sharing to catching vessels with state LE sardine permits. In 2012, the OFWC eliminated the landings requirements for permit renewal. The number of LE sardine permits issued dropped from 26 to 25 in 2008, and to 24 in 2014 and has remained at that level since that time.

The Pacific sardine fishery in Oregon operates as a day fishery with vessels based primarily in Astoria where processing plants for sardine operate. Many vessels utilize aircraft to assist in locating schools of sardine and setting their nets when weather permits. Weather and tides are major factors in fishing operations and timing of vessels transiting in and out of the Columbia River.

The directed sardine fishery in Oregon has been closed since July 1, 2015 when the stock assessment estimated stock biomass at less than CUTOFF value of 150,000 mt. Subsequent assessments indicated that the stock biomass estimates have remained below CUTOFF value and the directed sardine fishery remained closed each fishing year coast wide through June 2021. With the long closure of the directed fishery, processing capacity for sardine has declined as plants have closed or converted to processing other species (ODFW observation, 2020).

Permanent regulations for the sardine fishery were extended in June 2016 to cover other CPS fisheries in order to add more protection to bycatch species, reduce the potential for wastage of CPS, and

increase regulatory consistency. These rules applied to purse seine fishing for CPS, including anchovy in the ocean and in the Columbia River. They require a purse seine logbook to be maintained, prohibit a reduction fishery, allow pumping of catch (up to 20 percent) from another vessel's seine, require dipnetting of salmon and groundfish from the seine before pumping, and added mackerels to the list of prohibited species in the Cape Perpetua Seabird Protection Area. In addition, for all CPS except market squid, a grate with at least 2 3/8 inches between the bars must be placed over the intake of the hold to sort out larger species of fish**.**

2.3.3.2 Oregon Anchovy Fishery

State developmental fishery permits for harvesting anchovy were issued from 1995 to 2009. All developmental fisheries in Oregon had a limited number of permits available and landing requirements for permit renewal, but the number of permits and landing requirements differed by target species. In 2009, Oregon issued four of the 15 developmental fishery permits available for the anchovy fishery. In December 2009, all developmental fisheries programmatic activities including permitting were suspended due to lack of funding. The OFWC moved the anchovy fishery to a Category C developmental fishery, those that are managed under a state or Federal FMP which has established permit and/or gear limitations. Because the Federal CPS FMP does not have permit restrictions for vessels operating north of 39°N. Latitude, the ocean fishery for northern anchovy is now an open access fishery off Oregon limited to legal gear under the CPS FMP and state regulations. Until recent years, northern anchovy were infrequently targeted during open periods for the sardine fishery. These anchovies were sold either as bait or processed as a local specialty product for human consumption. A significant fishery began to develop in 2015 and increased substantially in 2016. These landings were sold overseas mainly for human consumption with lesser amounts sold for bait. Landing of anchovies have declined in recent years.

2020

Anchovy were not targeted by CPS fisheries in Oregon in 2020. Landings of anchovy in Oregon totaled 35 pounds in 2020. Thirty pounds were landed in CPS fisheries as bycatch in the market squid fishery and 5 pounds were landed as bycatch by non-CPS midwater trawl fisheries.

2.3.3.3 Oregon Other CPS Finfish Fisheries

Jack mackerel have not been a CPS fishery target species in Oregon and they rarely show up as incidental catch. Pacific mackerel have been landed in Oregon both as a target species for a brief period in the early 2010s when the sardine fishery was winding down and as incidental catch in other CPS fisheries. Neither species was targeted by CPS fisheries in 2020.

2.3.3.4 Oregon Market Squid Fishery

In Oregon, market squid fishing dates back to the 1980s with most fishery activity associated with strong *El Niño* conditions, but with some targeting in other years when sufficient market squid are available. The first Oregon fishery for market squid after this species became part of the CPS FMP occurred in 2014. In 2014, targeted fishing by fewer than three vessels landed less than 0.5 mt. No market squid were landed in 2015. In 2016 the fishery off Oregon landed 1,260 mt of market squid

in 83 vessel-days during May to June. Oregon adopted permanent rules in 2016 for the market squid and other CPS fisheries as mentioned above. There were no Oregon market squid landings in 2017. In 2018, 3,203 mt of market squid were landed by 11 boats. Participation in the fishery increased to 23 boats making landings totaling 2,386 mt in 2019. The total ex-vessel value was approximately $2.9 million. Incidental catch in the market squid fishery included 2.4 mt of Pacific mackerel, 0.9 mt of Pacific herring, 0.04 mt of Pacific sardine, 6 pounds of jack mackerel and the 5 pounds of northern anchovy mentioned above in section 2.3.4. Incidental landings of market squid in non-CPS fisheries totaled 0.04 mt.

2020

Forty vessels made market squid landings into the Oregon ports of Astoria, Newport, Winchester Bay and Charleston in 2020. Landings totaled 4,656 mt for an ex-vessel value of approximately $6.0 million. There was 20 pounds of incidental catch of market squid landed in non-CPS midwater trawl fisheries and 155 pounds caught in crab pots. An additional 720 pounds of market squid bycatch was landed in all non-CPS fisheries combined. Landed bycatch in the market squid fishery totaled 4.5 mt or less than 1% of target species catch. There were 41 species or species groups of landed bycatch, but just 3 species, Pacific herring, Dungeness crab and English sole in decreasing order, accounted 3.6 mt (81%) of the bycatch. Other landed bycatch species included miscellaneous flatfishes, jellyfish, Pacific sardine, smelt species, northern anchovy, various groundfish species, salmon and several other miscellaneous fish and invertebrate species. More than half of the landed bycatch by weight were species that are prohibited to sell if caught by seine gear making it regulatory bycatch.

In March of 2020 the OFWC adopted several new regulations for the market squid fishery. The new rules close the fishery for 48 hours each week from noon Fridays to noon Sundays, require a logbook be kept by light boats, and require that purse seine nets used in the fishery be pursed with a rib line at least 18 inches above the lead line in the current fishing year and 36 inches above the lead line starting in January 2022.

2.3.3.5 Oregon Live Bait and Minor Directed Fisheries

Historically, commercial capture of CPS for live bait has primarily occurred in the Umpqua River estuary where Pacific sardine, northern anchovy, and a number of other species not under Federal management may be taken by beach seine and sold as bait, some of which is sold as live bait. In recent years, small amounts (<1 mt annually) of live bait of various CPS species have been landed in Oregon and minor directed catch of CPS has also occurred. There were no landings of CPS live bait or minor directed fisheries reported in 2020.

In 2009, the Oregon Fish and Wildlife Commission implemented rules to allow capture of northern anchovy in a limited number of Oregon estuaries. All other species must be released unharmed. This harvest of anchovy is limited to commercial vessels that use the anchovy as live bait in commercial fishing operations on the catching vessel. The gear used to capture anchovy is restricted to purse seines with a maximum length of 50 fathoms (300 ft), lampara nets, and hook and line. This live bait fishery for anchovy is open from July 1 to October 31. Fishers intending to fish for anchovy in this manner must notify Oregon State Police with the vessel name, fishing location and estimated time of the activity 12 hours prior to fishing activity. Information on live

bait catch must be recorded in logbooks provided by ODFW. No attempts to harvest anchovy in estuaries for use as live bait by commercial fishing vessels occurred in 2020.

2.3.4 Washington Fisheries Overview

Generally harvested with a variety of "round haul" gears elsewhere, only purse seines, lampara nets, and dip nets are authorized for targeted commercial harvest of sardine, mackerel, and anchovy in Washington. Incidental catch does occur with other gears, e.g., trawl nets. Recreational gears include jig, dip net, and cast net, but the latter gear is only legal for sardine and anchovy in Washington.

Sardines were first harvested in Washington in 1936 and through the heyday of the "cannery row" era, up to 1950 (PFMC 1948). Then, due to a combination of less favorable environmental conditions (sardine prefer warmer water temperatures) and over-exploitation, the population began to collapse and contracted to its range in southern California. The California fishery closed in 1968. A population rebound was evident by the 1990s and sardine were again observed as far north as British Columbia (McFarlane 2005). The latter part of the 1990s saw continued expansion of sardine into waters off Oregon and Washington in sufficient enough numbers to spur interest in commercial fishing once again. In contrast, mackerel did not garner similar attention and have been harvested only incidentally by fishers targeting sardine.

Northern Anchovy have long supported a small-scale, but important fishery on the Washington coast. Aside from some experimental attempts at canning and preservation in the 1940's, this fishery has and continues to primarily provide bait for other high-value fisheries such as commercial albacore tuna and recreational fisheries (PMFC 1948).

2.3.4.1 Sardine

Pacific sardines are the primary coastal pelagic species harvested in large-scale fisheries in Washington waters, although the sardine fishery has been closed since 2015. From 2000 through 2009, participation in the sardine fishery was managed under Washington's Emerging Commercial Fishery Act (ECFA), which provides for the harvest of a newly classified species or harvest of a classified species in a new area or by new means. The ECFA offers two choices for fishery-permit designations: trial, which does not limit the number of participants or experimental, which does limit participation and prohibits the transfer or sale of the permit. From 2000 through 2002, WDFW managed the purse seine fishery for sardine under the trial designation to a state HG of 15,000 mt.

The Pacific Northwest sardine fishery saw a rapid expansion of catch between the years 1999 to 2002 when landings increased from 771 mt to 15,820 mt. In response to this situation, WDFW engaged in an extensive public process to address management needs in the fishery. In 2003, following this public process, a formal Sardine Advisory Board (Board) was created, and the WDFW Director, in collaboration with the Board, advanced the sardine fishery designation from trial to experimental as provided for under the ECFA. The number of experimental fishery permits was capped at 25. The experimental fishery program continued through June 2009. Besides limiting participation, WDFW also restricted the amount of sardines sold for reduction to a 15 percent season cumulative total by weight by individual vessel.

During the 2009 Washington State legislative session, WDFW proposed legislation to establish a commercial license limitation program specifically for the harvest and delivery of Pacific sardines into the state. The legislation was passed into law in July 2009, establishing 16 permanent licenses. In addition, the new law provides criteria for the issuance of temporary annual licenses at the discretion of the WDFW Director. In combination, the number of permanent and temporary annual licenses cannot exceed 25. The law did not set any vessel capacity restrictions for the Washington limited entry fishery.

After the creation of the sardine license in July 2009, licenses could be transferred (sold). To maintain a sardine license, yearly renewal is required and is accomplished by paying an annual fee. In 2010 and 2012, a single temporary annual license was also issued. All 16 Washington permanent licenses were available for renewal in 2018 and 2019. No temporary permits were issued.

Washington State waters (0-3 miles) are closed to directed commercial sardine fishing. Fishing for or possessing sardine taken with any commercial gear is prohibited January 1 through March 31. However, fishing opportunity is typically limited until late spring or early summer, due to adverse weather and/or too few fish. When a directed fishery is authorized, in some years the coast-wide period (January 1 – June 30) allocation is attained before April 1, while in others, sardine abundance offshore is not sufficient to support commercial activity until early or mid-June. Pacific sardines are the targeted catch in the Washington fishery, but anchovy, mackerel, and squid may be incidentally retained and landed.

To document bycatch levels in the Pacific sardine fishery WDFW conducted a five-year observer program from 2000 through 2004 (see Section 4.3.2). Overall observer coverage in this program was in excess of 25 percent of trips and results showed bycatch of non-targeted species in the Washington sardine fishery to be relatively low. A mandatory state logbook program has been in place since the fishery began in 2000. The logbook requires skippers to report incidental catch and bycatch. The logbook data are maintained in electronic format at the WDFW regional office at Montesano, Washington.

Subject to the Pacific sardine moratorium, no directed sardine purse seine landings were made into Washington during the 2020-2021 fishing year. Landings from other fisheries included 0.02 mt by the Pacific Whiting fishery.

2.3.4.2 Anchovy

Anchovy fisheries in Washington are conducted primarily to provide live bait for recreational and commercial fisheries. Smaller amounts of anchovy are sold as packaged bait to recreational fishermen. In 2010, WDFW adopted permanent rules restricting northern anchovy catch and disposition. These rules were intended to accommodate the traditional bait fishery and discourage the development of high-volume fisheries for anchovy. The rules limit the catch, possession, or landing of anchovy to 5 mt daily and to 10 mt weekly. In addition, the rules limit the amount of anchovy taken for reduction (or the conversion of fish to products such as fish meal or fertilizer) to 15 percent of a landing by weight.

Unlike the directed fisheries for Pacific sardine and Pacific mackerel, Washington regulations allow directed fishing for anchovy in state waters (0-3 miles) of the Pacific Ocean, the Lower Columbia River, Willapa Bay and Grays Harbor. See also 2.3.4.5 Washington State Live Bait Fishery

2.3.4.3 Other finfish

In 2016, the Washington Department of Fish and Wildlife authorized a trial directed mackerel purse seine fishery under Washington's Emerging Commercial Fishery Act (ECFA), which provides for the harvest of a newly classified species or harvest of a classified species in a new area or by new means. The ECFA offers two choices for fishery-permit designations: trial, which does not limit the number of participants, or experimental, which does limit participation and prohibits the transfer or sale of the permit. The primary purpose for initiating this trial fishery is to improve opportunity for coastal commercial purse seine fishers by increasing the flexibility to balance fishing efforts across the assemblage of mackerel and sardine.

No vessels participated in the Pacific mackerel directed fishery during the 2020-2021 fishing year. However, one trial license – which are valid for a calendar year – was issued in 2020. No trial license was issued in 2021.

There were no directed fishery landings during 2020-2021. Incidental landings of Pacific mackerel totaled 3.14mt, all from the Pacific Whiting fishery.

2.3.4.4 Squid

Squid species in Washington historically have not been commercially targeted or incidentally landed by CPS fisheries. The abundance of market squid off Washington has not been sufficient to support a commercial directed fishery. However, in, eight purse seine squid licenses with endorsements (permits) to fish state waters as well as federal waters were issued for the calendar year 2020. The interest in the license was primarily to provide the flexibility to deliver, into Washington, squid harvested off Oregon.

In 2020, there were no directed landings of squid. Incidental landings of market squid totaled 7.9 mt, all from the Pacific Whiting fishery. This is an increase compared to the 2019 calendar year when 1.4 mt were landing in the Pacific Whiting fishery.

2.3.4.5 Live Bait

Washington Live Bait Fishery

Northern anchovy support important baitfish fisheries on the Washington Coast (ocean, lower Columbia River, Grays Harbor and Willapa Bay). Distinguished by gear type, fisheries for anchovy include a lampara gear fishery and a seine gear fishery. The lampara-gear fishery is primarily comprised of albacore tuna fishers that catch and hold anchovy in onboard live-wells to meet their own bait needs. The purse-seine fishery harvests and holds live bait in dockside net pens for retail sale to recreational and commercial fishers. The fishery occurs in Federal waters (3-200 miles), inside three miles (state waters) on the southern Washington coast, as well as within the estuaries of Grays Harbor and Willapa Bay, and in the lower Columbia River.

Except for herring, which is under a license limitation program, participation in baitfish fisheries is not limited. About two dozen baitfish-lampara gear licenses and two or three baitfish-purse seine licenses are issued annually.

Since 2007, WDFW has required fishers to document all forage fish used for bait in another fishery on the fish receiving ticket for the target species. Although all Washington anchovy landings are reported on fish tickets, no distinction is made between anchovy destined for packaged product

versus anchovy destined for use as live bait. In the past, landings from the lampara gear fishery were typically reported by the scoop and converted to weight upon data entry; this practice has shifted with pounds being reported directly by the fisher. Incidentally caught species include other forage fish species (e.g., sardine, herring) which have species-specific landing limits. Bycatch of non-forage fish species is not documented but includes rare encounters with sturgeon by purse seine gear. Since fish quality is paramount in the live bait fishery, fishermen avoid encountering non-forage fish species; any that are encountered are released quickly. To protect out-migrating salmon, regulations include seasonal closures of Grays Harbor and Willapa Bay.

In 2020, the Washington non-treaty fishery for anchovy was affected by the global Covid-19 pandemic and the corresponding impacts to recreational fisheries which in part drive demand for live bait. Total landings declined as detailed below, while the number of fishery participants was largely unchanged from previous years. Licenses to target anchovy are non-limited and gear-specific, and gear type denotes the target fishery. Four licenses were issued for purse-seine gear (baitfish fishery) and 24 licenses for lampara gear (used by albacore tuna fishers to catch bait for personal use in the albacore tuna fishery). Actual landings were reported by three purse-seine gear and six lampara gear vessels.

WDFW conducted weekly port visits to collect biological samples from purse-seine gear landings and also maintained contact with dealers to monitor the fishery. Based on anecdotal reports, anchovy were heavily distributed shore-ward, continuing a pattern in recent years. In 2020, directed fishing by purse seine vessels based at Westport fished Grays Harbor and Willapa Bay, and in the adjacent nearshore. Albacore tuna vessels reported fishing in Grays Harbor for personal-use bait.

At 77.0 mt, Washington total landings for 2020, including purse seine and lampara gears, were down approximately 13 percent compared to 2019 (88.8 mt), and 37.5 percent comparted with 2018 (123.2 mt). Purse seine landings spanned June through early October, with the majority – 72 percent- landed in, August and September.

2.3.4.6 Treaty Tribe Fisheries

The CPS FMP recognizes the rights of treaty Indian tribes to harvest CPS stocks and provides a framework for the development of a tribal fishery. Pacific Ocean waters and estuaries north of Point Chehalis, Washington include the usual and accustomed fishing areas (U & A) of four treaty Indian tribes which may initiate their right to harvest CPS stocks in any fishing year by submitting a written request to the NMFS Regional Administrator at least 120 days prior to the start of the fishing season.

Treaties between the United States and Pacific Northwest Indian Tribes reserve the rights of the Tribes to take fish at usual and accustomed fishing grounds. The Council's CPS FMP, as amended by Amendment 9 and codified in NMFS regulations (50 CFR 660.518), outlines a process for the Council and NMFS to consider and implement tribal allocation requests for CPS.

The Quinault Indian Nation (QIN) has exercised their rights to harvest Pacific sardine and northern anchovy in their Usual and Accustomed Fishing Area off the coast of Washington State, pursuant to the 1856 Treaty of Olympia (Treaty with the Quinault). The Quinault U & A is defined in §660.50(c)(4) and represents an area directly off Westport/Grays Harbor, Washington, and waters

to the north of this area along with the Grays Harbor estuary. There have been no QIN landings of sardines or anchovies since 2017.

2.3.4.7 References

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3 REFERENCE POINTS AND MANAGEMENT FRAMEWORK

3.1 Optimum Yield

The MSA defines the term "optimum," with respect to the yield from a fishery, as the amount of fish which:

- will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems;
- is prescribed on the basis of the MSY from the fishery, as reduced by any relevant social, economic, or ecological factor; and
- in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the MSY in such fishery ([50 C*FR* §600.310(f)(1)(i)]).

OY for a CPS stock is defined to be the level of harvest which is less than or equal to ABC estimated using an ABC control rule, consistent with the goals and objectives of this FMP, and used by the Council to manage the stock. In practice, OY is determined with reference to ABC. As necessary, additional OY considerations (economic, social, and ecological) will be used to set ACLs, ACTs, and/or HGs on an annual or multi-year basis. In particular, OY will be set less than OFL/ABC to the degree required to prevent overfishing.

3.2 Definition of Overfishing Limits, MSY, and OFL and ABC Control Rules

The harvest control rules for CPS are defined to be a harvest strategy that provides biomass levels at least as high as the F_{MSY} approach while also providing relatively high and relatively consistent levels of catch. The CPS harvest control rules are more conservative than MSY-based management strategies, because the focus for CPS is oriented primarily towards stock biomass levels at least as high as the MSY stock size, while reducing harvest as biomass levels approach overfished levels. The primary focus is on biomass, rather than catch, because most CPS (Pacific sardine, northern anchovy, and market squid) are very important in the ecosystem for forage.

3.3 Definition of Overfishing

Overfishing occurs whenever a stock or stock complex is subjected to a level of fishing mortality or annual total catch that jeopardizes the capacity of a stock or stock complex to produce MSY on a continuing basis. In general, overfishing criteria for CPS are based on MSY or MSY proxy harvest rates applied to the best available estimate of biomass. In cases where biomass estimates or stock distributions include portions of the population in foreign waters, a DISTRIBUTION term will be used to estimate the percentage of the population in the U.S. EEZ.

In operational terms, overfishing occurs in the CPS fishery whenever catch exceeds the overfishing limit; an annual amount of catch. This annual amount of catch corresponds to the estimate of MSY fishing mortality on an annual basis.

3.4 Definition of an Overfished Stock

By definition, an overfished stock in the CPS fishery is a stock at a biomass level low enough to jeopardize the capacity of the stock to produce MSY on a continuing basis. An overfished condition is approached when projections indicate that stock biomass will fall below the overfished level within two years. The Council must take action to rebuild overfished stocks and to avoid overfished conditions in stocks with biomass levels approaching an overfished condition. MSSTs for actively-managed stocks were established in Amendment 8. Pacific sardine MSST is 50,000 mt and Pacific mackerel MSST is 18,200 mt. MSSTs are unspecified for Monitored CPS stocks.

According to National Standard 1 guidelines of the MSA (50 CFR 600.310(e)(2)(F) a minimum stock size threshold (MSST) is the level of biomass below which the stock or stock complex is considered to be overfished, meaning the capacity of the stock or stock complex to produce MSY on a continuing basis has been jeopardized. Stock-specific MSSTs have been adopted for Pacific sardine and Pacific mackerel. The CPS FMP (PFMC 1998, 2016) defines an overfished sardine population as one with an age 1+ stock biomass on July 1 of 50,000 mt or less. The CPS-FMP defines an overfished Pacific mackerel stock as one with 18,200 mt or less of age 1+ biomass (PFMC 1998, 2016). The MSST for the northern anchovy central subpopulation is not currently specified in the CPS FMP, given the monitored classification for this species (PFMC 1998, 2016). However, the sixth amendment to the northern anchovy FMP implemented an 'overfishing' definition for the stock (PFMC 1990). In Amendment 6, 'overfishing' was defined as fishing when the stock drops below 50,000 mt of spawning biomass, so this was a de facto biomass-based 'overfished' criterion, which was previously reviewed by the SSC and adopted by the Council. MSSTs have not yet been specified for jack mackerel or the northern subpopulation of northern anchovy because neither of these stocks have been formally assessed for management.

3.5 Rebuilding Programs

Management of overfished CPS stocks must include a rebuilding program that can, on average, be expected to result in recovery of the stock to MSY levels in ten years. It is impossible to develop a rebuilding program that would be guaranteed to restore a stock to the MSY level in ten years, because CPS stocks may remain at low biomass levels for more than ten years even with no fishing. The focus for CPS is, therefore, on the average or expected time to recovery based on realistic projections. If the expected time to stock recovery is associated with unfavorable ecosystem conditions and is greater than ten years, then the Council and the Secretary may consider extending the time period as described at 50 CFR § 600.310(e).

Rebuilding programs for CPS are an integral part of general control rule for actively managed stocks but may be developed or refined further in the event that biomass of a CPS stock reaches the overfished level.

Active CPS rebuilding programs include Pacific sardine, via Amendment 18, approved by NMFS June 24, 2021.

3.6 Harvest Control Rules

Harvest control rules in the CPS fishery may vary depending on the nature of the fishery, management goals, assessment and monitoring capabilities, and available information. Under the framework management approach used for CPS it is not necessary to amend the CPS FMP in order to develop or modify harvest control rules or definitions of overfishing.

The use of harvest control rules for actively managed stocks is to provide managers with a tool for setting and adjusting harvest levels on a periodic basis while preventing overfishing and overfished stock conditions. All actively managed stocks must have stock-specific harvest control rules, a definition of overfishing and a definition of an overfished stock.

Along with preventing overfishing, the main use of control rules for the monitored stocks is to help gauge the need for active management. Harvest control rules and harvest policies for monitored CPS stocks may be more generic and simple than those for actively managed stocks with significant fisheries. Any stock supporting catches approaching the ABC levels should be actively managed unless there is too little information available or other practical problems.

In 2011, Amendment 13 to the CPS FMP was adopted to ensure the FMP was consistent with new aspects of the advisory guidelines published at 50 CFR 600.310 with respect to a process for setting ACLs and accountability measures (AMs). Amendment 13 modified management measures to include the specification of new reference points such as ACLs. This included the process for annually setting ACLs and associated AMs, as well as other provisions for preventing overfishing, such as the potential of setting ACTs.

The formulas established by Amendment 13 for actively managed species such as Pacific sardine and Pacific mackerel are shown below.

OFL	BIOMASS * F_{MSY} * DISTRIBUTION
ABC	BIOMASS * BUFFER * F_{MSY} * DISTRIBUTION
ACL	LESS THAN OR EQUAL TO ABC
HG	(BIOMASS - CUTOFF) * FRACTION * DISTRIBUTION
ACT	EQUAL TO HG OR ACL, WHICHEVER VALUE IS LESS

The OFL is an annual catch amount that corresponds to the estimate of (annual) MSY fishing mortality. The OFL is expressed in terms of numbers or weight of fish; overfishing occurs if catch exceeds the OFL. For Pacific sardine, the OFL is based on a MSY proxy harvest rate, determined by the best available scientific information, and applied to the best available estimate of biomass. Additionally, because a portion of the sardine population is in foreign waters, the OFL is adjusted using a DISTRIBUTION to estimate the percentage of the population in the U.S. EEZ.

The ABC is a harvest specification set below the OFL and is a threshold that incorporates a scientific uncertainty buffer against overfishing (i.e., exceeding the OFL). The ABC is decided by the Council based on its preferred level of overfishing risk aversion. The ABC incorporates a

percentage reduction of the OFL selected according to an SSC determination on scientific uncertainty and a risk policy determined by the Council. In cases where scientific uncertainty (σ) associated with estimating an OFL is quantified by the SSC, the percentage reduction that defines the scientific uncertainty buffer and the ABC can be determined by translating the estimated σ to a range of probability of overfishing (Pstar) values. After the Council decides on its level of preferred risk (Pstar), that value is matched to its corresponding BUFFER fraction. The BUFFER fraction then is applied to the OFL according to the ABC control rule.

An ACL is the level of annual catch of a population or population complex that is set to help prevent overfishing from occurring and, if met or exceeded, that triggers accountability measures such as a closure of the fishery or a review the management strategy of the fishery. The Pacific sardine fishery is managed to keep total catch from all sources below the ACL. ACLs are set no higher than ABC, and the HG cannot exceed the ACL or ABC. In cases where the result of the HG formula exceeds the ABC value, the Council will set a lower ACL, HG, or ACT in response. Along with optimum yield (OY) considerations, an HG or ACT may be utilized below an ACL or sector-specific ACL to account for management uncertainty, discard or bycatch mortality and research take. These provisions will be considered on an annual basis in response to changing resource status and fishery dynamics.

Along with the setting of HGs or ACTs below the ACL, accountability measures (AMs) are in place, such as inseason management controls and post-season review processes, to prevent ACLs from being exceeded and to correct or mitigate overages of the ACL if they occur.

To some extent, the previously existing HG control rules for actively managed species also merge scientific uncertainty and OY considerations thereby providing additional reductions from OFL levels. Therefore, HG control rules are considered in conjunction with ABC control rules to prevent overfishing (see Section 4.6).

For monitored stocks, Amendment 13 maintained the previously existing harvest control rules but modified them so as to specify the new necessary management reference points. Amendment 13 stated that for the monitored finfish stocks (Northern anchovy [northern and central subpopulations] and jack mackerel) the OFL would be based on existing species-specific MSYs, if previously specified, or other MSY proxies. The existing 75 percent reduction buffer in the ABC control rule (ABC equals 25 percent of MSY) would remain in use until recommended for modification by the Council's Scientific and Statistical Committee (SSC) based on best available science and approved by the Council (below). ABCs are further reduced based on estimated resident stock size in U.S. waters. ACLs would be specified for multiple years until such time as the species becomes actively managed or new scientific information becomes available.

Default control rules for CPS Finfish Monitored Stocks:

OFL	STOCK SPECIFIC MSY OR MSY PROXY
ABC	OFL * 0.25
ACL	Equal to ABC or reduced by other OY considerations

Reference points for monitored CPS stocks are difficult to determine due to limited data to estimate biomass and productivity, however current landings of CPS finfish monitored stocks are extremely low. While landings remain low, the stock remains in the monitored category, ACLs are specified for multiple years, and stock status is assessed infrequently; any stock supporting catches approaching or exceeding the ACL levels will be reviewed to see if they should be moved to active management.

The default control rules and overfishing specifications are generally used for these monitored stocks. Stock specific MSY proxies, ABC, and ACLs can be revised based on the best available science as recommended by the SSC and as adopted through the annual harvest specification process and will be reported in the CPS SAFE.

3.6.1 General Harvest Guideline/Harvest Control Rule for Actively Managed Species

The general form of the harvest control rule used for actively managed CPS fisheries was designed to continuously reduce the exploitation rate as biomass declines. The general formula used is:

HG = (BIOMASS-CUTOFF) x FRACTION x DISTRIBUTION

where HG is the harvest target level, CUTOFF is the lowest level of estimated biomass at which directed harvest is allowed, and FRACTION is the fraction of the biomass above CUTOFF that can be taken by the fishery. The BIOMASS is generally the estimated biomass of fish age 1+ at the beginning of the fishing season. The purpose of CUTOFF is to protect the stock when biomass is low. The purpose of FRACTION is to specify how much of the stock is available to the fishery when BIOMASS exceeds CUTOFF. DISTRIBUTION is the prorated proportion of a stock's biomass estimated to be in U.S. waters. It may be useful to define any of the parameters in this general harvest control rule, so they depend on environmental conditions or stock biomass. Thus, the harvest control rule could depend explicitly on the condition of the stock or environment.

The formula generally uses the estimated biomass for the whole stock in one year (BIOMASS) to set harvest for the entire stock in the following year (HG), although projections or estimates of BIOMASS, index of abundance values, or other data may be relied upon as well. The BIOMASS represents an estimate and thus is subject to some amount of uncertainty. For example, recent CPS stock assessments resulted in coefficients of variation associated with terminal biomass estimates of roughly 30 percent. Scientific uncertainty around biomass estimates (stock assessment error) is accounted for in the current harvest guideline rule for Pacific mackerel and Pacific sardine.

The general harvest control rule for CPS (depending on parameter values) is compatible with the MSA and useful for related species that are important as forage. If the CUTOFF is greater than zero, then the harvest rate (HG/BIOMASS) declines as biomass declines. By the time BIOMASS falls as low as CUTOFF, the harvest rate is reduced to zero. The CUTOFF provides a buffer of spawning stock that is protected from fishing and available for use in rebuilding if a stock becomes overfished. The combination of a spawning biomass buffer equal to CUTOFF and reduced harvest rates at low biomass levels means that a rebuilding program for overfished stocks may be defined implicitly. Moreover, the harvest rate never increases above the FRACTION. If the FRACTION is approximately equal to F_{MSY}, then the harvest control rule harvest rate will not exceed F_{MSY}. In addition to the CUTOFF and FRACTION parameters, a maximum harvest level parameter (MAXCAT) was established so that total harvest specified by the general formula never exceeds

the 200,000 mt. The MAXCAT is used to protect against extremely high catch levels due to errors in estimating biomass, to reduce year-to-year variation in catch levels, and to avoid overcapitalization during short periods of high biomass and high harvest. Also, the MAXCAT distributes the catch from strong year classes across a wider range of fishing seasons.

Other general types of control rules may be useful for CPS and this FMP does not preclude their use as long as they are compatible with National Standards and the MSFCMA.

3.6.2 Harvest Guideline Control Rule for Pacific Sardine

The harvest control rule for Pacific sardine sets an HG for the U.S. fishery based on an estimate of biomass for the whole sardine stock, a minimum biomass threshold (CUTOFF) equal to 150,000 mt, a harvest FRACTION between 5 percent and 20 percent (depending on oceanographic conditions as described below), and maximum allowable catch (MAXCAT) of 200,000 mt (PFMC 1998). The U.S. HG is calculated from the target harvest for the whole stock by prorating the total HG based on 87 percent DISTRIBUTION of total biomass in U.S. waters, e.g.:

$$\text{HG} = (\text{BIOMASS} - \text{CUTOFF}) \bullet \text{FRACTION} \bullet \text{DISTRIBUTION}$$

Harvest FRACTION depends on recent ocean temperatures, because sardine stock productivity is typically higher under ocean conditions associated with warm water temperatures. An estimate of the relationship between F_{MSY} for sardine and ocean temperatures is:

$$F_{MSY} = -18.46452 + 3.25209(T) - 0.19723(T^2) + 0.0041863(T^3)$$

where T is the average three-season sea surface temperature (SST) (C°) at Scripps Pier (La Jolla, California) during the three preceding seasons. Thus, the control rule for Pacific sardine sets the control rule parameter FRACTION equal to F_{MSY} over a narrow range of temperatures, such that FRACTION is never allowed to be higher than 20 percent or lower than 5 percent.

Although F_{MSY} may be lesser or greater, FRACTION can never be less than 5 percent or greater than 20 percent unless the control rule for sardine is revised, because the 5 percent and 20 percent bounds are policy decisions based on social, economic, and biological criteria. In contrast, relationships between FRACTION, F_{MSY} and environmental conditions are technical questions and estimates or approaches may be revised by technical teams (e.g., the CPSMT) to accommodate new ideas and data.

In February 2013, the Council and the NOAA Southwest Fisheries Science Center convened a workshop of experts to re-visit parameters of Pacific sardine harvest control rule. The workshop participants found that the California Cooperative Oceanic Fisheries Investigations (CalCOFI) temperature series provides a better relationship to sardine productivity than the SIO temperature series. Subsequently, the Council initiated a process to use the CalCOFI temperature index in sardine management, eventually adopting the revised F_{MSY} relationship, the new CalCOFI temperature index, and a revised harvest FRACTION range bounded by 5 percent and 20 percent. The Council used the revised F_{MSY} relationship beginning with the April 2014 meeting and adopted the new temperature index and harvest FRACTION range at its November 2014 meeting. Annual calculations of the OFL and ABC, recommended by the Council and approved by NMFS since that time have subsequently used this new relationship.

3.6.3 Harvest Control Rule for Pacific Mackerel

The HCR for Pacific mackerel sets the CUTOFF and the definition of an overfished stock at 18,200 mt and the FRACTION at 30 percent. Overfishing is defined as any fishing in excess of the OFL calculated using the OFL control rule. No MAXCAT is defined, given the U.S. fishery appears to be limited by markets and resource availability to about 40,000 mt per year; however, in the event landings increase substantially, then the need for such a cap should be revisited. The target harvest level is defined for the entire stock in Mexico, Canada, and U.S. waters (i.e., not just the U.S. portion), and the U.S. target harvest level is prorated based on 70 percent relative abundance (i.e., DISTRIBUTION) in U.S. waters.

3.6.4 Default CPS Control rule and Monitored Stocks

Northern anchovy (northern and central subpopulations), jack mackerel and market squid are currently classified under monitored status in CPS FMP. In June 2010, the Council adopted the default harvest control rule (ABC = OFL*0.25) to account for scientific uncertainty in the OFL. The Council may use the default harvest control rule for setting ABC for Monitored stocks unless a better species-specific rule is available, as is the case for market squid. The default harvest control rule can be modified under framework management procedures.

3.6.4.1 Northern Anchovy-Central Subpopulation

The central subpopulation of northern anchovy ranges from approximately San Francisco, California, to Punta Baja, Mexico. The OFL or ABC is prorated by the DISTRIBUTION of the stock in U.S. waters to arrive at ABC in U.S. waters. The OFL is 94,290 mt and the ABC and ACL are set equal at 23,573 mt. A proposed rule was published November 18, 2020 as required by a lawsuit and court order, proposing an OFL of 119,153 mt and an ACL of 25,000 mt. That rule is scheduled to be final in January, 2021.

3.6.4.2 Northern Anchovy-Northern Subpopulation

The northern subpopulation of northern anchovy ranges from San Francisco north to British Columbia, with a major spawning center off Oregon and Washington that is associated with the Columbia River plume. The northern subpopulation supports small but locally important bait and human consumption fisheries. Northern anchovy is an important source of forage to local predators, including depleted and endangered salmonid stocks. The U.S. OFL is 39,000 mt and the ABC and ACL are set equal at 9,750 mt, The ACT is 1,500 mt, which serves as a check-in point for the states of Oregon and Washington.

In addition, the portion of the northern subpopulation of northern anchovy resident in U.S. waters is unknown. Some biomass occurs in Canadian waters off British Columbia. Historically landings up to a few thousand mt were recorded in British Columbia. However, the commercial fishery for anchovy has been closed in British Columbia since 2002.

3.6.4.3 Jack Mackerel

The MSY level for jack mackerel is calculated by age/area from mid-range potential yield values. OFL or ABC in U.S. waters is prorated according to the DISTRIBUTION of the stock in U.S. waters (65 percent). The OFL is 126,000 mt and the ABC and ACL are set equal at 31,000 mt.

3.6.4.4 Market Squid

The MSY Control Rule for market squid is founded generally on conventional "eggs per recruit" model theory. Specifically, the MSY Control Rule for market squid is based on evaluating (throughout a fishing season) levels of egg escapement associated with the exploited population. The estimates of egg escapement are evaluated in the context of a "threshold" that is believed to represent a minimum level that is considered necessary to allow the population to maintain its level of abundance into the future (i.e., allow for "sustainable" reproduction year after year). In practical terms, the Egg Escapement approach can be used to evaluate the effects of fishing mortality (F) on the spawning potential of the stock, and in particular, to examine the relation between the stock's reproductive output and candidate proxies for fishing mortality rates that would result in MSY (F_{MSY}).

The fishing mortality (F_{MSY}) that results in a threshold level of egg escapement of at least 30 percent is used as a proxy for MSY. However, it is important to note that the level of egg escapement is reviewed periodically, as new information becomes available concerning the dynamics of the stock and fishery, to ensure that the threshold meets its objective as a long-term, sustainable biological reference point for this marine resource. This is not a trivial exercise, given the need for ongoing research regarding the biology of this species, which may result in revised recommendations in the future. Current studies include sampling reproductive status of squid landed in the fishery, assessing the quality of spawning habitats, estimating mortality rates and modeling squid movement from paralarval to adult stages, and a collaboration with industry to develop a long-term index of paralarval abundance. Note that in an experiment conducted by McDaniel et al. (2015) new methods were developed for drying mantle punches to derive "the mantle condition index", which is a critical parameter of the egg escapement model. These newer procedures allow CDFW staff to processes mantles punches at a rate that is approximately 100 times faster than the rate of processing established in the original method by Macewicz et al. (2004). Since 2010, CDFW has also been measuring fresh instead of formalin preserved gonad weight of market squid, which is another important parameter of the egg escapement model. Likewise, a new equation has been developed by McDaniel et al. (2015) to convert fresh gonad weight into formalin preserved weight, and thus allowing the continuity of the time series of gonad weight data from 1999-2006 (Dorval et al. 2013) based on preserved gonad weight) to 2007-2014.

The market squid fishery operates within the constraints of currently adopted regulations of the MSFMP (e.g., annual landings cap, weekend closures, closed areas, limited entry), and also monitored by NMFS, as long as egg escapement on average is equal to, or greater than, the threshold value. In the event that egg escapement is determined to be below the 30 percent threshold for two successive years, a point-of-concern would be triggered under the FMP's management framework, and the Council could consider moving market squid from Monitored to Active management status. Current state regulations for squid are not anticipated to change in the near future. However, should existing laws limiting effort or harvest be rescinded, further management actions by the Council could also be considered. In November 2010, the Council

adopted an ABC proxy of F_{MSY} resulting in egg escapement ≥ 30 percent. Recent research has provided new information regarding squid egg escapement (Dorval et al. 2013).

3.7 Annual Specifications and Announcement of Harvest Levels

Each year, the Secretary will publish in the *Federal Register* the final specifications for all CPS Actively managed by the Council. The total U.S. harvest will be allocated to the various fisheries as ACLs, HGs or ACTs, or as quotas.

In calculating ACLs, ACTs, HGs and quotas for each species, an estimate of the incidental catch of each species caught while fishermen are targeting other species will be taken into account. Therefore, the total HG will consist of an incidental catch portion and a directed fishery portion. In general, HGs or ACTs will be used to describe direct and incidental commercial fishery take, will be set in accordance with harvest control rules, and may be below the ACL to take into account management uncertainty and additional known sources of mortality such as recreational harvest, discards, bycatch, research take, and live bait fisheries. This will be done to minimize the chances of exceeding the target harvest levels and the ACL.

If the HG or ACL for the directed fishery is reached, the directed fishery will be closed by an automatic action and incidental catch will continue to be allowed under the incidental catch allowance, which is expressed in an amount of fish or a percentage of a load (Section 5.1). When the ACT is reached, the action taken depends on how the ACT has been specified. It does not necessarily mean the directed fishery will be closed. If the estimated incidental catch portion of the HG, ACL, or ACT has been set too high, resulting in the probability of not attaining the target harvest level by the end of the fishing season, the remaining incidental catch portion may be allocated to the directed fishery through the "routine" management procedures described in the CPS FMP. This reallocation of the remaining incidental catch portion of the HG to the directed fishery is not likely to be necessary unless substantial errors are discovered in calculations or estimates.

3.7.1 General Procedure for Setting Annual Specifications

The intent of the management approach under the FMP is to reassess the status of each actively managed species at frequent intervals and preferably every year (although a full analytic stock assessment may not be necessary or possible in some cases). The general procedure for making the annual specifications for CPS is as follows:

1. The CPSMT will produce a SAFE report that documents the current estimates of biomass for each CPS assessed and status of the fishery. In the report, the CPSMT will include the most recent harvest specifications and the stock assessment used to inform harvest specifications.

2. The Council will review all information compiled for the annual specifications, consider recommendations of the SSC, CPSMT, CPSAS, and will hear public comments. The Council also will review any important social and economic information at that time, then make a recommendation to the NMFS Regional Administrator on the final specifications, including OFL, ABC, OY levels, ACLs, ACTs, HGs, quotas, allocations, and other management measures for the fishing season.

3. Following the Council meeting, the NMFS Regional Administrator will make a determination of the final specifications. This determination will be published in the *Federal Register* with a request for additional public comment.

4. Alternate Procedure: If assessment and season schedules warrant, the NMFS Regional Administrator may make preliminary harvest specifications quickly (without prior discussion at a Council meeting) to allow fishing to begin without delay. As soon as practicable, the Council will review all background documents contributing to the determination of the biomass estimates and make a final recommendation for the resulting target harvest level, HGs, and quotas. Following the meeting of the Council, the NMFS Regional Administrator will consider all comments and make a determination of whether any changes in the final specifications are necessary. If such changes are warranted, they will be published in the *Federal Register*.

   The intention of the proposed regulations is to have public review of and a Council recommendation on the estimated biomass and HGs before the fishing season begins; however, the NMFS Regional Administrator is not precluded from announcing the HGs in the *Federal Register* before the process is completed so that fishermen can plan their activities and begin harvesting when the fishing season begins.

   If assembling the data and producing a report would require enough time that permitting a complete public review before the beginning of the fishing season could reduce the season, then this alternate procedure should be used.

5. NMFS and the west coast states will monitor the fishery throughout the year, tracking directed landings and incidental catch against ACTs, ACLs, HGs, and quotas. If an HG or quota for any species is or is likely to be reached prematurely, a "point of concern" may occur, triggering a possible review of the status of the stock. If the directed harvest portion of an ACL, HG, or quota is reached, then directed fishing will be prohibited and the pre-specified incidental trip limit will be imposed as an automatic action through publication of a notice in the *Federal Register*.

3.8 Section References:

California Department of Fish and Game (CDFG). 2005. Final market squid fishery management plan. Document can be obtained from State of California Resources Agency, Department of Fish and Game, Marine Region, 4665 Lampson Avenue (Suite C), Los Alamitos, CA 90720. 124 p.

Dorval, E., J. McDaniel, and P. Crone. 2008. Squid population modeling and assessment (January 2008). Final report submitted to the California Department of Fish and Game (Marine Region) and the Southwest Fisheries Science Center. 30 p.

Dorval, E., Crone, P.R., and McDaniel, J.D. 2013. Variability of egg escapement, fishing mortality and spawning population in the market squid fishery in the California Current Ecosystem. Marine and Freshwater Research. 64(1): 80-90.

Macewicz, B.J.; J.R. Hunter; N.C.H. Lo; and E.L. LaCasella. 2004. Fecundity, egg deposition, and mortality of market squid (*Loligo opalescens*). Fish. Bull. 102: 306-327.

Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). 1990. Public Law 94-265.

Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSRA). 2006. Public Law 109-479.

McDaniel, J.M., E. Dorval, J. Taylor, and D. Porzio. 2015. Optimizing biological parameterization in the egg escapement model of the market squid, (*Doryteuthis opalescens*), population off California. NOAA-TM-NMFS-SWFSC-551. doi:10.7289/V5/TM-SWFSC-551.

Restrepo, V. R., and ten co-authors. 1998. Technical guidance on the use of precautionary approaches to implementing National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act. NOAA Technical Memorandum NMFS-F/SPO-31.

Pacific Fishery Management Council (PFMC). 1998. Amendment 8 (To the northern anchovy fishery management plan) incorporating a name change to: the coastal pelagic species fishery management plan. Document can be obtained from Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 200, Portland, OR 97220.

Pacific Fishery Management Council (PFMC). 2002. Status of the Pacific Coast coastal pelagic species fishery and recommended acceptable biological catches: stock assessment and fishery evaluation (2002). Appendix 3: market squid MSY. Document can be obtained from Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 200, Portland, OR 97220.

4 BYCATCH, DISCARD MORTALITY, AND INCIDENTAL CATCH

Fishery management plans prepared by a fishery management council or by the Secretary must, among other things, establish a standardized bycatch reporting methodology (SBRM) to assess the amount and type of bycatch occurring in the fishery, and include conservation and management measures to the extent practicable and in the following priority:

1. Minimize bycatch.
2. Minimize the mortality of bycatch that cannot be avoided.

The MSA defines bycatch as "fish which are harvested in a fishery, but which are not sold or kept for personal use and includes economic discards and regulatory discards. Such term does not include fish released alive under a recreational catch and release fishery management program" (16USC1802).

CPS vessels fish with roundhaul gear (purse seine or lampara nets). These are encircling type nets, which are deployed by a skiff around a school of fish or part of a school. The end of the float line is then attached back to the vessel. With purse seines, the bottom of the net (the lead line) is then pulled closed. Lampara nets do not purse the bottom. The area including the free-swimming fish is diminished by bringing one end of the net aboard the vessel. When the fish are crowded near the fishing vessel, pumps are lowered into the water to pump fish and water into the ship's hold. Another technique is to lift the fish out of the net with netted scoops (e.g., stocking brails). Roundhaul fishing results in little unintentionally caught fish, primarily because the fishermen target specific schools, which usually consists of one species. CPS typically school with similarly sized fish. The most common incidental catch in the CPS fishery is another coastal pelagic species (e.g., Pacific mackerel incidental to the Pacific sardine fishery). If larger fish are in the net, they can be released alive before pumping or brailing by lowering a section of the cork-line or by using a dip-net. The load is pumped out of the hold at the dock, where the catch is weighed and incidentally-caught fish can be observed and sorted. Because pumping at sea is so common, any incidental catch of small fish would not be sorted at sea. Grates can be used to sort larger non-CPS from the catch. Grates are mandatory in Oregon to sort larger non-CPS from the catch. At-sea observers have recorded discard at one time or another since the year 2000 off the states of Oregon, Washington, and California. Incidental harvest of non-prohibited larger fish are often taken home for personal use or processed.

Historically, market squid have been fished at night with the use of powerful lights, which cause squid to aggregate, allowing fishermen to pump squid directly from the sea or to encircle them with a net. California actively manages the market squid fishery in waters off California and has developed an FMP for the state-managed fishery. Management measures pertinent to bycatch include establishing a prohibition on use of lights in the Greater Farallones National Marine Sanctuary to eliminate the potential of future negative interactions with seabirds.

Additionally, several circumstances in the fishery tend to reduce bycatch:

1. Most of what would be called bycatch under the MSA is caught when roundhaul nets fish in shallow water over rocky bottom. Fishermen try to avoid these areas to protect their gear. Also, they may be specifically prohibited to fish these areas because of closures.
2. South of Pt. Buchon, California, many areas are closed to roundhaul nets under California law and the FMP, which reduces the chance for bycatch.

3. In California, a portion of the sardine caught incidentally by squid or anchovy harvesters can be sold. In Washington, all incidentally caught CPS can be sold when another CPS species is targeted, e.g., Pacific mackerel can be sold when fishing is directed at Pacific sardine or vice versa, or Pacific sardine can be sold when fishing is targets Northern anchovy.
4. A provision in the CPS FMP allowing landings of less than five tons without a LE permit should reduce regulatory discard, because those fish can be landed without penalty. LE permits otherwise are required south of Point Arena, California.
5. From 2007 - 2016, bycatch from the live bait logs was reported with an incidence of 10 percent. The primary species taken as incidental catch was barracuda. Virtually all fish caught incidentally in this fishery are either used for bait, for personal use, or released alive. (See Table 4-11).
6. CDFW's logbook program for the squid fishery collects data including bycatch.

All three states have a number of regulations with measures that together comprise the SBRM for CPS fisheries (Table 4.1). These include:

- landings made by commercial fishing vessels must be recorded on fish landing receipts ("fish tickets");
- commercial fishing vessels are subject to having their catch sampled;
- commercial fishing vessels in most CPS fisheries must accommodate observers during fishing trips if requested; and
- logbooks are required for most CPS fisheries.

These programs support management of CPS fisheries and stock assessments through the collection and processing of biological and catch data. The objectives of the monitoring programs are to: (1) collect biological data, such as size and otoliths for ageing from commercially landed fish to support research and stock assessments; and (2) collect catch, including bycatch, data via fish receiving tickets, commercial fisheries logbooks, and species composition sampling, to support fisheries monitoring and in-season management decision making.

Commercial CPS landings are required to be recorded on state fish tickets (Table 4.1). State fish ticket programs provide a continuous, consistent, and long-standing reporting mechanism for CPS SBRM. Catch weight by sorted species category, vessel identification number, and other data elements are required on fish tickets. Fish tickets are produced and issued by the individual states but have been designed and evaluated to ensure they meet record-keeping requirements and/or needs in coordination with state and Federal managers through the Pacific States Marine Fisheries Commission (PSMFC). State fish receiving tickets document landed catch including bycatch (fish landed but not sold, i.e., zero value) and following in-house processing and quality control are reported to the PSMFC Pacific Fisheries Information Network (PacFIN, http://pacfin.psmfc.org).

Commercial CPS landings are sampled in port by state personnel, who confirm species identification, collect species composition data, otoliths for ageing, lengths, and other biological data. Each state mandates access to landed catch by authorized state personnel for sampling (Table 4.1). The design of the fishery monitoring programs may vary between states and within each state program by fishery or region, but they serve the same purpose and are intended to meet the objectives consistent with SBRM and the CPS FMP. The various strategies reflect the specific

fishery and its characteristics of operation, the coverage needed to accomplish sampling objectives, and agency staffing resources.

Likewise, each state fishery logbook or federal program functions separately. Unlike fish receiving tickets, there is no central repository for CPS logbook data. The data collected through logbook programs are maintained by the state or federal agency. Logbook data provides supplemental bycatch information because most catch is landed in CPS fisheries. When vessels are required to maintain and submit logbooks, they must accurately record information such as: date, identification of catcher vessel, time, position, sea depth, and catch by species of each haul or set; retained and released catch amounts, gear information, if applicable; information on other parties receiving fish or fish products; and any other information deemed necessary. Washington mandates logbooks for directed sardine or mackerel fishing but has not implemented a program for anchovy given the small size of the fishery. Oregon mandates logbooks for all CPS fisheries. Logbooks are not currently required for CPS finfish fisheries in California; however, they are required for the market squid fishery.

CPS are generally not targeted by recreational harvesters and catch of CPS is minimal and a miniscule proportion of CPS total catch. Recreational fishing for CPS is typically done with hook and line gear, or small hand deployed cast nests and therefore includes very minimal amounts of bycatch. CPS are typically targeted recreationally on a very limited scale for use as bait or personal consumption.

Washington, Oregon, and California state regulations require access to recreational catches upon request by authorized personnel (Table 4.1). In Washington, recreational sampling programs focus on salmon and groundfish and typically do not collect data on CPS because catch is minimal. Oregon sampling of recreational fishing activity also focuses on salmon and groundfish for the same reasons. The California recreational fishery sampling program surveys recreational fishermen to determine which fish they are targeting and makes note of discarded fish. State monitoring programs collect, process, and report recreational fishing data to the PSMFC Recreational Fishery Information Network (RecFIN, http://www.recfin.org)

Areas of uncertainty in bycatch data produced by these reporting and monitoring systems depend on the data source. Fish tickets will not capture fish released at sea, fish purchasing personnel may misidentify less familiar species, state fish ticket coding systems may use more general categories and not support full reporting to species, or fish may be too degraded to identify accurately. Dockside fishery monitoring programs are typically designed to sample only a percentage of total landings, although they are designed to produce data that is representative of the fishery (i.e., random sampling). These fishery monitoring programs may prioritize the collection of biological data (e.g. length, weight, otoliths) as a primary function and not have species composition sampling or verification of species sorting and identification as a key objective since observer programs have determined that the numbers or volume of bycatch is low. Logbook programs provide valuable information but are dependent on the vessel captain to fully and accurately document observed bycatch. The quality of the data depends on the captain's or vessel crew skill and diligence in identifying and enumerating or estimating bycatch.

Reporting or Data Collection Procedure	**Washington** Administrative Code (WAC)	**Oregon** Administrative Regulations (OARs)	**California** Code of Regulations (CCR)	**Federal**
Fish Landing Receipts	WAC 220-305-030 Chapter 220-352	OAR 635-006-0210	14 CCR § 190	§660.505
Fishery Monitoring- Sampling	WAC 220-305-070 WAC 220-356-040 WAC 220-360-320	OAR 635-001-0035 635-006-0136 635-011-0100	14 CCR § 105.5	§660.505
Logbook	WAC 220-356-040 WAC 220-360-320	OAR 635-004-0376 635-005-0930	14 CCR § 190 14 CCR § 149	
Observers	WAC 220-356-040 WAC 220-360-320	OAR 635-006-0140	14 CCR § 105.5	§660.519
Bycatch and Fishing Gear Restrictions	WAC 220-356-040	OAR 635-004-0378 OAR 635-004-0235		§660.506 §660.511 §660.520

4.1 Federal Protection Measures

NMFS regularly conducts Endangered Species Act (ESA) section 7 consultations to ensure that federally threatened or endangered species are not adversely affected by federally managed fisheries. Since 1999, the NMFS WCR Sustainable Fisheries Division (SFD) has conducted numerous formal and informal consultations with Federal agencies, including the NMFS Protected Resource Division (PRD) and U.S. Fish and Wildlife Service (USFWS) regarding CPS fisheries. In all informal consultations the PRD concurred with the SFD, that the CPS fishery is not likely to adversely affect protected resources. In all formal consultations on the Pacific sardine fishery specifically, no jeopardy determinations were made.

The NMFS WCR Sustainable Fisheries Division initiated a Section 7 consultation with NMFS WCR Protected Resources Division (PRD) on the continued management and prosecution of the Pacific sardine fishery. PRD completed a formal Section 7 consultation on this action and in a biological opinion (BO) dated December 21, 2010, determined that fishing activities conducted under the CPS FMP and its implementing regulations are not likely to jeopardize the continued existence of any endangered or threatened species under the jurisdiction of NMFS or result in the destruction or adverse modification of critical habitat of any such species. Specifically, the current status of the Lower Columbia River Chinook, Snake River Fall Chinook, Upper Willamette Chinook, Puget Sound Chinook, Lower Columbia River coho and Oregon coast coho, were deemed not likely to be jeopardized by the Pacific sardine fishery. Additionally, NMFS determined that the potential for direct incidental take of other ESA-listed salmon, marine mammals, sea turtles, green sturgeon, abalone, or steelhead, through the harvest of sardines in the purse seine fishery was discountable, and the potential indirect adverse effects of sardine harvest on ESA-listed species were insignificant.

NMFS also initiated an ESA Section 7 consultation with USFWS regarding the possible effects of implementing Amendment 11 to the CPS FMP. USFWS concurred with NMFS and determined that implementing Amendment 11 may affect but was not likely to adversely affect: the endangered tidewater goby, the threatened western snowy plover, the Santa Ana sucker, the endangered short-tailed albatross, the endangered California brown pelican, the endangered California least-tern, the threatened marbled murrelet, the threatened bald eagle, the threatened bull trout, and the candidate Xantus's murrelet. Formal consultation, however, was deemed necessary on the possible effects to the southern sea otter. The resulting BO signed June 16, 2006, concluded that fishing activities conducted under Amendment 11 and its implementing regulations were not likely to jeopardize the continued existence of the otter. As a result of this BO new reporting requirements and conservation measures were implemented within the CPS FMP to provide further protection for southern sea otters.

These reporting requirements and conservation measures require all CPS fishermen and vessel operators to employ avoidance measures when sea otters are present in the fishing area and to report any interactions that may occur between their vessel and/or fishing gear and otters. Specifically, these new measures and regulations are:

1. CPS fishing boat operators and crew are prohibited from deploying their nets if a southern sea otter is observed within the area that would be encircled by the purse seine.

2. If a southern sea otter is entangled in a net, regardless of whether the animal is injured or killed, such an occurrence must be reported within 24 hours to the Regional Administrator, NMFS West Coast Region.
3. While fishing for CPS, vessel operators must record all observations of otter interactions (defined as otters within encircled nets or coming into contact with nets or vessels, including but not limited to entanglement) with their purse seine net(s) or vessel(s). With the exception of an entanglement, which will be initially reported as described in #2 above, all other observations must be reported within 20 days to the Regional Administrator.

4.1.1 California Coastal Pelagic Species Pilot Observer Program

NMFS SWR (prior to merging with the NMFS NWR) initiated a pilot observer program for California-based commercial purse seine fishing vessels targeting CPS in July 2004 with hopes of augmenting and confirming bycatch rates derived from CDFW dockside sampling. SWR personnel trained the first group of CPS observers in mid-July in Long Beach, California. Frank Orth and Associates, a private contractor, hired and provided observers for training and subsequent deployment. Six observers who had previous experience in other SWR-observed fisheries attended and completed the course. The training course emphasized a review of ongoing observer programs (drift gillnet, pelagic longline) and introduction to the soon-to-be observed fisheries (purse seine, albacore hook-and-line). The training curriculum included vessel safety, fishing operations, species identification, and data collection.

In late July 2004, observers began going to sea aboard CPS vessels. Observers used ODFW's Sardine Bycatch Observations form to record data on fishing gear characteristics, fishing operations, and target/non-target species catch and disposition. Observers also recorded data on trip specifics and protected species sightings/interactions. Observers had access to data field definitions in their SWR observer program Field Manuals. Most data detailing length, volume, or weight of the catch were obtained verbally from the vessel operator. Position and time data were recorded by the observer directly from hand-held or on-board electronics.

Data from this program have been compiled through 2008 (Tables 6-1 through 6-4). A total of 107 trips by vessels targeting CPS (228 sets) were observed from July 2004 to January 2006. Tables 6-1 through 6-4 show how incidental catch and bycatch data collected during this time and are categorized by target species of the trip (i.e., Pacific sardine, Pacific mackerel, market squid or anchovy). Additionally, from January 2006 to January 2008 a total of 199 trips (426 sets) were observed.

Potential future needs of any CPS observer program include standardization of data fields, development of a fishery-specific Observer Field Manual, construction of a relational database for the observer data, and creation of a statistically reliable sampling plan. A review of the protocol and catch data by NMFS Southwest Science Center staff, the CPS Management team and other CPS interested parties is planned in the future to help address some of these needs.

4.2 Fishery South of Pigeon Point

Information from at-sea observations by the CDFW and conversations with CPS fishermen suggest that bycatch south of Pigeon Point is not significant in these fisheries. However, some individuals have expressed concern that game fish and salmon might constitute significant bycatch in this

fishery. This is a reasonable concern, because anchovy and sardine can be forage for these predators, but there are no data to confirm significant bycatch of these species. CDFW port samples indicate minimal incidental catch in the California fishery (Tables 4-5). The behavior of predators may help to minimize bycatch, as they tend to dart through a school of prey rather than linger in it, and easily avoid encirclement with a purse seine.

CDFW port samplers collect information from CPS landings in Moss Landing and ports to the south. Biological samples are taken to monitor the fish stocks, and port samplers report incidentally caught fish. Reports of incidental catch by CDFW port samplers confirm small and insignificant landings of bycatch at California off-loading sites (Tables 4-5). These data are likely representatives of actual bycatch, because (as noted) fish are pumped from the sea directly into fish holds aboard the vessel. Fishermen do not sort catch at sea or what passes through the pump. Unloading of fish also occurs with pumps. The fish are either pumped into ice bins and trucked to processing facilities in another location, or to a conveyor belt in a processing facility, where fish are sorted, boxed, and frozen.

From 1985 through 1999, there were 5,306 CDFW port samples taken from the sardine and mackerel landings. From 1992 to 1999, incidental catch was reported on only 179 occasions, representing a 3.4 percent occurrence. Up to 1999 reports of incidental catch were sparse, and prior to 1992 none were reported. Earlier incidents of bycatch may not have been noted, because the harvest of anchovy and sardine was small, and only since 1995 did the harvest of sardine increased substantially (see Table 8-3). The incidental catch reported are primarily marketable species that do not meet the definition of bycatch in the MSA. During this period, unless an incidental species represented a significant portion of the load (at least a whole percentage point) the amount of the incidental catch was not recorded. Of the incidental catch reported from 1992 to 1999, the two most prevalent species were market squid at 79 percent, and northern anchovy at 12 percent incidence within samples (not by load composition). CDFW port samples provide useful information for determining the significance of bycatch in the CPS fishery off California (south of Pigeon Point).

In 2001, California wetfish port samplers began tallying undocumented incidental catch observed during landings in greater detail and listed the occurrence of species in each sampled landing. The port sampling program records bycatch observed (i.e., presence or absence evaluations), but actual amounts of incidental catch have not been quantified to date. In 2011, bycatch data were recorded by estimates of pounds observed in an offload at northern California ports. Offloading facilities in northern California allow observations and estimates of bycatch amounts compared to southern California ports. These observations are summarized in Table 4-5 for the 5 years between 2016 and 2020. The dynamic of the 2008 sardine fishery changed due to a decrease in the annual harvest guideline. Since then, fishing activity no longer took place year around, but was truncated within each allocation period. This may have affected the types and frequencies of organisms observed during the offloading process of sardine. The most commonly occurring flora and fauna in wetfish landings during 2020 were Pacific herring, jacksmelt, Pacific sanddab, bat ray, butterfish (Pacific pompano), California halibut, unspecified flatfish, Dungeness crab, salps, jellyfish, market squid egg cases, eelgrass, kelp, feather boa kelp, and surfgrass. For 2020, a total of 56 incidental species were observed during dockside sampling. Since the closure of the directed commercial sardine fishery starting in the 2015-2016 season, opportunistic sampling (non-directed fishery samples) has occurred whenever sardine is found incidentally to another directed CPS catch.

Larger fish and animals are typically sorted for market, personal consumption, or nutrient recycling in the harbor. To document bycatch more fully at sea, including marine mammal and bird interactions, NOAA Fisheries placed observers on a number of California purse seine vessels beginning in the summer of 2004, under a pilot program that continued until 2008 (see Sec. 4.1.1).

4.2.1 Incidental Catch Associated with the Market Squid Fishery

Because market squid frequently school with CPS finfish, mixed landings of market squid and incidentally caught CPS finfish occur intermittently. Typically, less than one percent of round haul market squid landings (by tonnage) included reported incidental catch of CPS (Table 4-6).

Although non-target catch in market squid landings is considered minimal, the presence of incidental catch (species that are landed along with market squid that are not recorded through landing receipt processes [i.e., not sold] as is typically done for incidentally-caught species) has been documented through CDFW's port sampling program. During 2020, incidental catch consisted of 93 species (Table 4-7). Similar to previous years, most of this catch was other pelagic species, including Pacific sardine, northern anchovy, Pacific mackerel, and jack mackerel. However, kelp, jellyfish, and pyrosomes were also observed frequently.

4.3 Fishery North of Point Arena

The Pacific sardine fishery north of Point Arena began again in 1999 after more than a 50-year hiatus. North of Point Arena (approximately 39° N latitude) is open access, while south of this latitude, the CPS Limited Entry program is in effect (per Section 3.5 of the CPS FMP). Oregon and Washington closely monitor these fisheries and collect information about landings. Information on bycatch and incidental catch from Oregon and Washington is summarized in Tables 4-8 through 4-10. The directed sardine fishery has been closed since 2015, with landings limited to small amounts of incidental harvest.

4.3.1 Oregon

CPS vessels landing in Oregon primarily targeted Pacific sardine until the directed fishery closed in 2015. Oregon's LE sardine permit rules stipulate that an at sea observer be accommodated aboard vessels when requested by ODFW. ODFW does not have personnel dedicated to observe and document bycatch of non- target species on sardine vessels and available state personnel were unable to conduct onboard observations of any CPS fishery vessels during the 2014 through 2015-2016 fisheries. Also, no Federal observers were placed on the vessels. To reduce bycatch, the state requires the use of a grate over the intake of the hold to sort out larger species of fish, such as salmon or mackerel. The grate size spacing can be no larger than 2-3/8 inches between bars. Oregon rules require seine gear logbooks that record incidental catch including salmonids and other species. In 2015 Oregon extended these requirements for sardine fishing to purse seine fishing for all coastal pelagic species, including jacksmelt and Pacific herring, except the grate is not required for the market squid fishery.

With adoption of CPS FMP Amendment 13 in September 2011, Pacific herring, which occur in waters off all three states, and jacksmelt, which typically occur only in waters off California, were designated as "ecosystem component species", as defined in National Standard 1 guidelines. The

incidental catch and bycatch of these two species are required to be reported in the SAFE document.

2020-2021

The directed sardine fishery was closed and no directed mackerel fishing was pursued; thus, there was no bycatch of salmon, ecosystem component species, or other species in these fisheries (Table 4-14).

Market squid has been the main CPS fishery target in Oregon since 2016. Bycatch in this fishery has included a wide array of species, but for the majority of landed bycatch species that totaled 11.4 mt in 2020, but the quantities of most species was less than 0.05 mt with several exceptions. There was 6.8 mt of market squid bycatch, 1.4 mt of Pacific herring which is an EC species, 1.2 mt of Dungeness crab landed and 0.9 mt of English sole that was regulatory bycatch. Thus, 10.3 (90.4%) of the 11.4 mt of bycatch was made up of just four species with the majority of that being the target species of the fishery itself that simply was not in suitable shape to be sold.

4.3.2 Washington

From 2000 through 2004, WDFW required fishers to carry at-sea observers, and to provide financial support for this observer effort. Bycatch information was collected in terms of species, amount, and condition; observers noted whether the fish were released or landed, and whether alive, dead, or in poor condition. During the five-year period of the program, overall observer coverage averaged over 25 percent of both total landed catch and number of landings made. Based on observer data, the bycatch of non-targeted species in the Washington sardine fishery was relatively low. Due to low bycatch levels, as well as a WDFW commitment to industry that the observer fee would only be assessed until bycatch in the sardine fishery could be characterized, the mandatory observer program was suspended at the conclusion of the 2004 season.

A comparison of logbook and observer data from 2000 to 2004 indicated that logbook data, in general, tended to under report bycatch by 20 to 80 percent (Culver and Henry, 2006). For this reason, salmon bycatch in the Washington sardine fishery for years subsequent to the observer program is calculated by multiplying total sardine catch and the observed five-year average bycatch rates. Bycatch and mortality estimates of incidentally captured salmon by year and species are shown in Table 4-14.

2020-2021

The directed sardine fishery was closed, and no directed mackerel fishing was pursued; thus, there was no incidental catch or bycatch of salmon, ecosystem component species, or other species in these fisheries (Table 4-14). No incidental catch was reported on fish receiving tickets in the anchovy bait fishery in 2020. However, dockside sampling collected species other than anchovy, including small amounts of herring, Pacific sardine, and juvenile salmon. A WDFW technical report documenting these data is in process.

4.4 Section References

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Culver, M., and C. Henry, 2006. Summary Report of the 2005 Experimental Purse Seine Fishery for Pacific Sardine (*Sardinops sagax*). Washington Department of Fish and Wildlife, Montesano, Washington. 11 pp.

5 SAFETY AT SEA CONSIDERATIONS

The safety of fishing activities is an important management concern. Roundhaul fisheries operating off the Pacific Coast are often limited by environmental conditions, most notably inclement weather. Given that the average age of permitted CPS vessels in the LE fishery is 34 years and many older vessels are constructed of wood, concern has been raised regarding their safety and seaworthiness. Implementing time/area closures or restricting transferability could impact safety by making more difficult to replace an older vessel with a newer, safer vessel; or by promoting fishing during hazardous weather conditions. This concern in part is addressed by Amendment 10 to the CPS FMP (January 2003), which allows LE permits to be transferred to another vessel and/or individual.

Prior to the closure of the directed Pacific sardine fishery in 2015, there were safety concerns resulting from the derby-style fishery where vessels compete for a share of the seasonal harvest guideline over a short period of time. Such derby fisheries can create unsafe conditions, as season duration is compressed and competition increases.

The directed Pacific sardine fishery has been closed since the start of the 2015-2016 season, because the biomass estimate fell below the cutoff value of 150,000 mt. Although some allowance has been made for incidental catch of sardines in other CPS fisheries, Tribal catch, live bait, and other minor sources of mortality, the commercial fishery was essentially shut down again for the 2020 - 2021 season.

There were no fatalities among West Coast fisheries in 2020, although there were several vessel losses and serious injuries. The following is an excerpt from the U.S. Coast Guard report to the Council in April 2021 (April 2021 Informational Report 1) on U.S. West Coast safety incidents from the previous year:

> 2020 boarding statistics indicate approximately 36% of commercial fishing vessels boarded had some type of discrepancy involving safety gear carriage requirements or other federal safety regulations (reversing a downward trend from 26% in 2018 and 21% in 2019). approximately 2% of all commercial fishing vessels boarded had their voyages terminated at sea or were issued a Captain of the Port Order during a post-SAR boarding in port for existence of especially hazardous conditions (roughly the same as in 2019). Especially hazardous conditions, which are defined in Section 46 of the Code of Federal Regulations can include conditions such as the lack of adequate immersion suits, lack of adequate firefighting equipment, and other conditions having the possibility of presenting an immediate threat to a vessel and its crew.

6 ECONOMIC STATUS OF WASHINGTON, OREGON, AND CALIFORNIA CPS FISHERIES

This section is not yet available and will be added at a later date

7 ECOSYSTEM CONSIDERATIONS

7.1 INTRODUCTION

There is a growing national interest in augmenting existing single-species fisheries management approaches with ecosystem-based fishery management principles that could place fishery management decisions and actions in the context of a broader scope. NOAA/NMFS Science Centers around the country are working to improve the science behind ecosystem-based fishery management including status monitoring and reporting on ecosystem health (Levin et al. 2009). A yearly update on the state of the California Current Ecosystem has been provided to the Council by NOAA since outlined in the 2013 Fishery Ecosystem Plan (Section 1.4). Some of this ecosystem information is also presented here. Additional information has been contributed by J. Field and K. Sakuma (SWFSC) and the Peterson Zooplankton Lab (NWFSC).

This section provides a summary of ecosystem trends and indicators being tracked by NOAA and other scientists that are related to CPS. Additionally, Appendix A of Amendment 8 to the CPS FMP (available on the Council's web site) provides a review of the life cycles, distributions, and population dynamics of CPS and discusses their roles as forage. Appendix D provides a description of CPS essential fish habitat that is closely related to ecosystem health and fluctuation. Research efforts into ecosystem functions and trophic interactions will

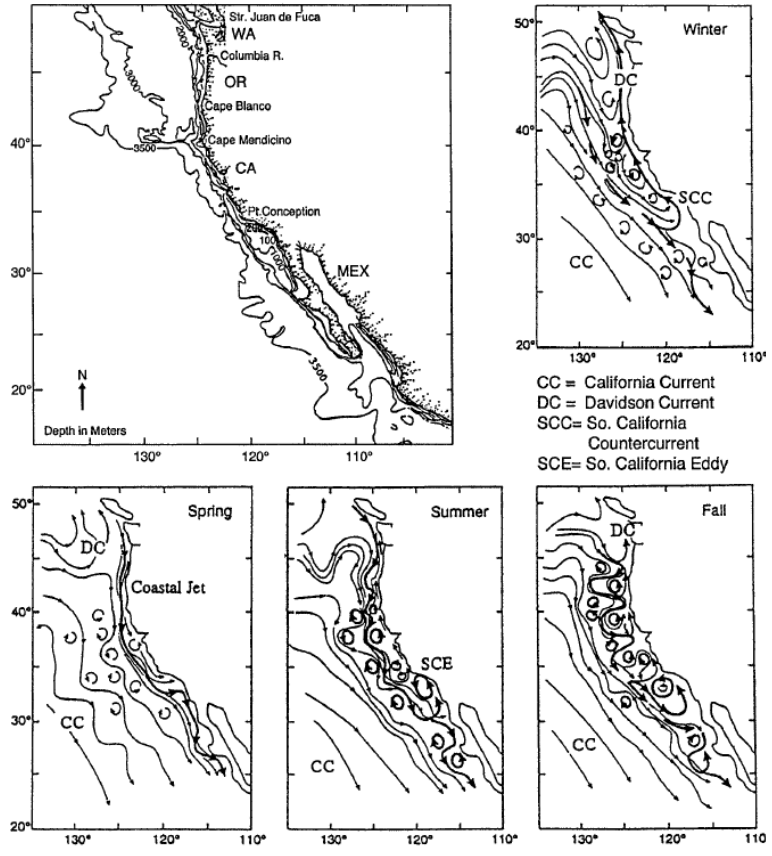

Figure 1. Seasonal variation of large-scale currents along the West Coast with bathymetry illustrating the dynamic conditions in the CCLME. The CC flows southward year round offshore from the shelf break to several hundred kilometers. Along the shelf break, several other currents are found, including the Davidson Current (DC), Southern California Countercurrent, and the Southern California Eddy (SCE). Seasonal panels from Strub and James 2000.

improve our knowledge base and improved CPS management decisions.

7.2 Description of the California Current Large Marine Ecosystem (CCLME)

The California Current (CC) (Figure 1) is formed by the bifurcation of the North Pacific Current. At approximately Vancouver Island, Canada, the southern branch of the North Pacific Current becomes the California Current, and flows southward along the West Coast to mid-Baja, Mexico. The California Current flows southward year-round off shore from the shelf break to ~200 miles. Coastal currents over the continental shelf flow southward during the summer upwelling season, but northward during the winter downwelling season. The California Undercurrent flows northward year-round, at depths of ~ 200-400 m over the continental slope.

The California Current also defines the outer boundary of the California Current Large Marine Ecosystem (CCLME) that is delineated by bathymetry, productivity and trophic interactions. The LME is an organizational unit to facilitate management of an entire ecosystem and recognizes the complex dynamics between the biological and physical components. NOAA's ecosystem-based management approach uses the LME concept to define ecosystem boundaries.

The CCLME is characterized as often having very high biological productivity (>250 mg $C/m^2/day$) that is stimulated by the addition of nutrients that is either upwelled along the shelf break or advected in surface currents from the Gulf of Alaska into the northern region or beginning of the California Current (Ware and Thomson 2005, Hickey and Banas 2008). The biological productivity is reflected in the extensive nearshore kelp beds, large schools of CPS (e.g., sardine, anchovy, squid, etc.) and groundfish (Pacific hake) that, in turn, support large populations of marine mammals, sea birds and highly migratory species (e.g., tuna, sharks, billfish).

The CCLME is heavily influenced by climate at intraannual and interannual time scales. Each year, the coastal winds and currents shift from poleward in the winter to equatorward in the summer. These equatorward winds force the surface waters offshore which are replaced by the upwelling of cool nutrient rich water from depth. This upwelling of nutrient rich water, concurrent with increased solar radiation in the spring, leads to a dramatic increase in productivity. This transition from winter downwelling to summer upwelling is called the Spring Transition. The timing of the Spring Transition and the difference from the long-term mean are determined by the NMFS' Newport, OR laboratory for 45°N 125°. They define the spring transition as the date on which deep water colder than 8°C was observed at the mid shelf (Station NH 05). Anomalies are calculated as the difference between the observed date and the long-term average from 1969 to present which is 13 April (Figure 2).

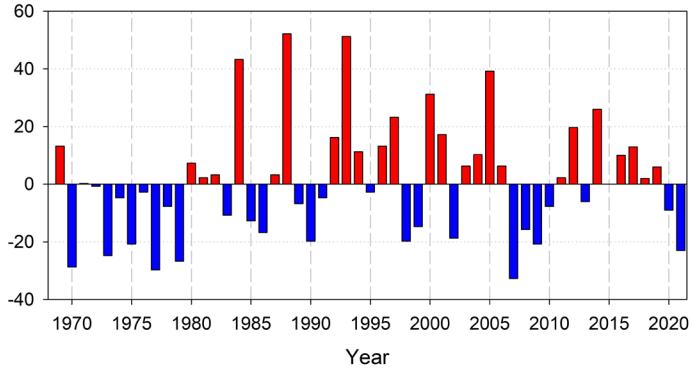

Figure 2. Anomaly of the date of the spring transition off Oregon. Peterson Zooplankton Lab, NOAA, NMFS, NWFSC.

The connection between the Spring Transition and CPS is presently not known but it is suspected to affect recruitment of Pacific herring, smelt, Northern anchovy and other coastal pelagic species.

On interannual time scales, the CCLME and the entire Pacific Ocean is affected by basin scale processes such as El Niño/La Niña (Figure 3) and those causing phase changes of the Pacific Decadal Oscillation Index (PDO; Figure 4). During El Niño events, the pycnocline deepens and warm fresh surface waters inhabit the shelf increasing water column stratification which in turn reduces primary productivity (Fisher et al. 2015). During La Niña conditions the productivity of the California Current is usually enhanced by the addition of cool, nutrient rich waters from the north, and increased effective upwelling. During El Niño events, CPS landings in CA often fluctuate widely, with decreased catches of market squid, anchovy and Pacific herring, while the landings for sardine and mackerel often remain relatively constant.

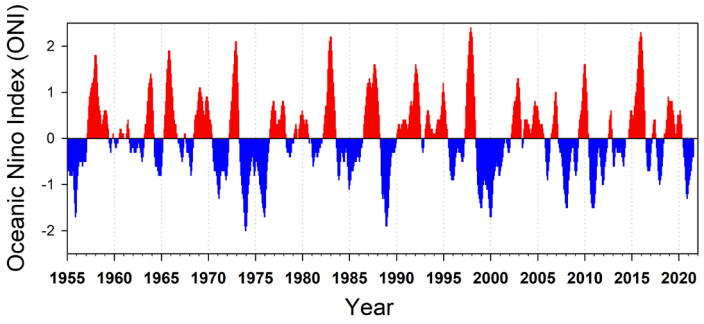

Figure 3. Oceanic Niño Index anomalies. Red indicates warm or El Niño conditions and blue cool La Niña conditions.

Changes in the strength of the Aleutian Low pressure system in winter drives the Pacific Decadal Oscillation (PDO) (Mantua et al. 1997; Figure 4). During negative phase of the PDO, the intensity of the Aleutian Low decreases and the North Pacific High increases, leading to increased southward wind stress and increased equatorward flow in the California Current (Bi et al. 2011, Keister et al. 2011). Conversely, when the PDO is positive, the strength of the Aleutian Low increases resulting in increased poleward and onshore flow. The PDO was mostly negative (warm in the central North Pacific Ocean and cool near the west coast of the Americas) from 1946-1976 and mostly positive from 1977-1998. Since 1998, the

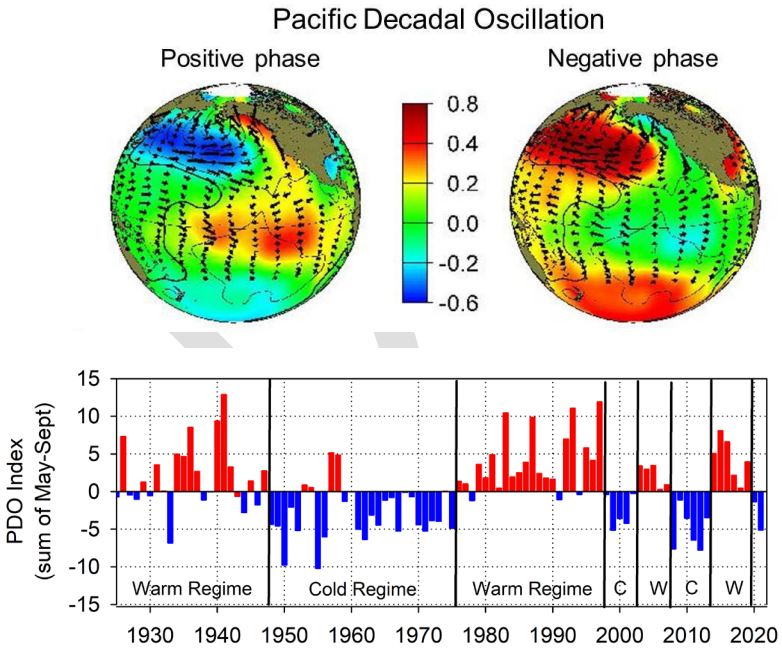

Figure 4. Time series of shifts in sign of the Pacific Decadal Oscillation Index (PDO) 1925 to 2021. Values are averaged over the months of May through September. Red bars indicate positive (warm) years; blue bars negative (cool) years.

PDO has fluctuated between positive and negative phases every five to six years, perhaps indicating an unusual climatic period for the CCLME.

The effects of the PDO on fisheries are mixed. In general, the warm phase of the PDO is associated with warm ocean temperatures off the West Coast and reduced landings of coho and Chinook salmon while the cool phase is associated with higher salmon landings (Mantua et. 1997). For sardine, positive PDO indices seem to correlate with high landings along the CCLME, while anchovy landings have been generally reduced under positive PDO (Figure 5) (Takasura et al. 2008). Work by Zwolinski and Demer (2013) indicate that sardine recruitment is strongly linked to adult condition and the PDO prior to spawning. Others have found that environmental conditions during spawning, such as sea surface temperatures (Lindegren and Checkley 2013) and wind stress curl-driven upwelling (Rykaczewski and Checkley 2008) are important for larval sardine survival and recruitment. Until a good understanding of the oceanographic/ecological mechanisms that affect the productivity of sardine and anchovy stocks is achieved, this correlation, which is essentially based on one cycle of the PDO, must be viewed with caution. Zwolinski and Demer (2012) highlighted the similarity between recent oceanographic conditions and past conditions (1930's) when the CCLME sardine population crashed after a change in the PDO. However, MacCall et al. (2012) noted that management/harvest rates were much different in the 1930's. It is also worth noting that both the physical and the ecological meanings of climate indices that have been utilized for the North Pacific may be changing and correlations found in the past may be breaking down as the relationships are non-stationary (Litzow et al. 2020).

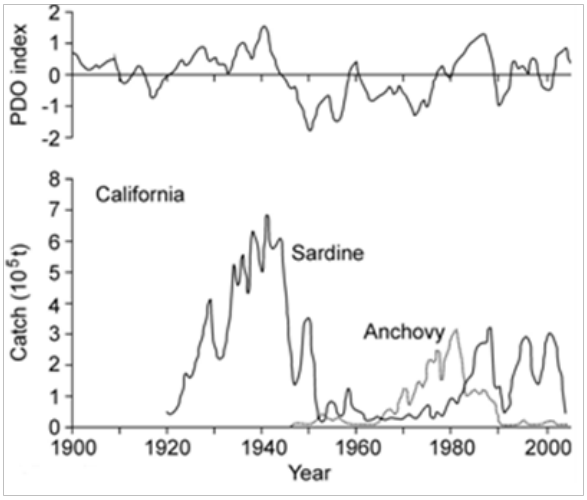

Figure 5. The relationships between Pacific sardine and Northern anchovy landings in California and the PDO. FromTakasura et al. 2008.

Like all marine ecosystems, the CCLME is very complex, and despite 65 years of research from the California Cooperative Fisheries Investigation (CalCOFI) surveys, understanding and predicting recruitment success for any fishery including CPS remains elusive. In light of the complexity, ecological indicators are used as surrogates of ecosystem health and status of fisheries. Preliminary physical indicators and sentinel species are being used to provide information as part of an ongoing Integrated Ecosystem Assessment of the CCLME and to forecast salmon returns in the northern California Current.

Finally, climate change is a significant threat to the CCLME. While ocean temperatures had been relatively cool from 2007 to 2013, reduced ocean mixing from winter storms led to anomalously warm conditions in the NE Pacific beginning in the fall of 2013 (Bond et al. 2015). These warm ocean conditions, termed "the Blob", combined with a strong El Niño that developed at the equator in 2015 and led to unprecedented and persistent warming from 2013 – 2016 greatly altering the pelagic ecosystem of the California Current (Auth et al. 2017, Peterson et al. 2017). Furthermore, ocean acidification appears to already be having an effect on certain plankton and perhaps forage fish feeding and recruitment in the CCLME. For example, Bednarsek et al. (2014) revealed that

ocean acidification in some areas of the CCLME is now great enough to dissolve the shells of the pelagic snail (*Limacina helicina*), an important prey for forage fish and pink salmon in some years.

7.3 Current Climate and Oceanographic Conditions

7.3.1 Spring Transition off Oregon and El Niño/Southern Oscillation

In 2020 the onset of upwelling, or the Spring Transition, was earlier than the long term average (13 April). In 2021 the spring transition off Oregon again occurred earlier than the long term average (Figure 2). The Oceanic Niño Index (ONI) was strongly positive throughout 2015, signaling one of the strongest El Niño events in recent history. Following this strong event, the ONI was negative in 2016; the ONI had been close to neutral until the fall of 2020 when La Niña conditions finally returned. By mid-summer of 2021 the ONI was again neutral (Figure 3).

7.3.2 Pacific Decadal Oscillation

The PDO was negative for much of 2020 (Figure 6) and through the summer of 2021. A positive PDO has been considered favorable for sardine and unfavorable for anchovy (Chavez et al. 2003) as well as for juvenile Pacific salmon and juvenile anchovy populations (Peterson et al. 2014, Auth et al. 2017). As noted above, however, there is much discussion on this topic.

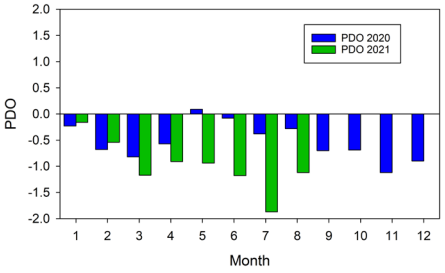

Figure 6. Monthly Pacific Decadal Oscillation index values in 2020-2021. http://jisao.washington.edu/pdo/

7.3.3 Columbia River Flows

The Columbia River provides the largest source of freshwater entering the California Current. As such, it has a large effect on the oceanography and biological resources on the region (Hickey et al. 2009; Litz et al. 2013). The mouth of the Columbia River has often been the center of the sardine fishing off the Pacific Northwest, as sardines and other CPS actively congregate and feed in the biological rich plume habitat (Peterson and Peterson, 2009). In July 2021 flows were well below a 24 year average of 209,500 cubic feet/second (Figure 7).

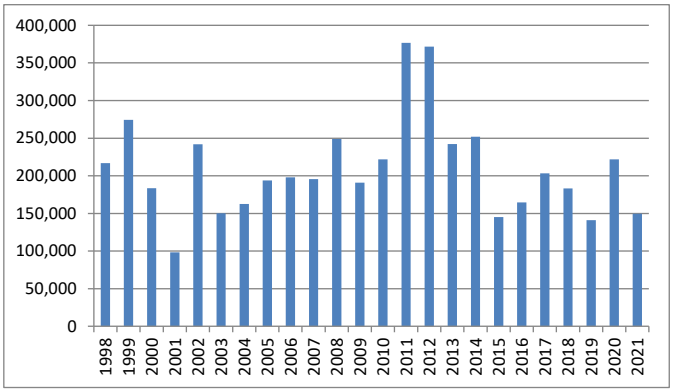

Figure 7. Average Columbia River flows (cubic feet/second) in July.

7.4 Trends in Ecosystem Indicators

7.4.1 Sea Surface Temperatures

Sea surface temperatures (SST) have been reported to affect the abundance/productivity of sardine, anchovy and other CPS (Chavez et al. 2003; Jacobson et al. 2001, 2005). Throughout most of

2021, SST in the northern regions of CCLME was cooler than normal (Figure 8, blues) despite the formation of another marine heatwave offshore in the NE Pacific (Figure 8, orange-red). However, warmer waters persisted off southern California for most of 2021. In nearshore upwelling regions, waters were able to remain cool throughout the first half of 2021. More on marine heatwaves in the NE Pacific can be found at https://www.integratedecosystemassessment.noaa.gov/regions/california-current/cc-projects-blobtracker.

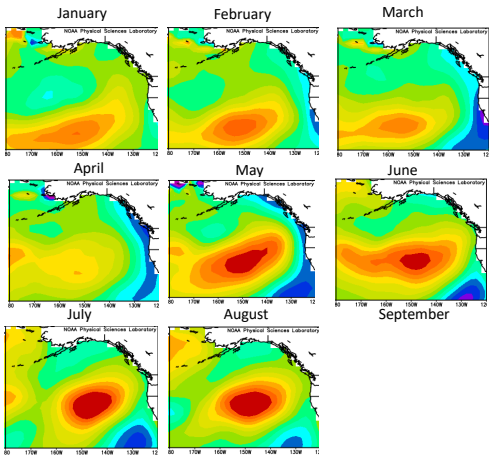

Figure 8. Monthly sea surface temperature anomalies in 2021. NOAA OISST V2 data provided by the NOAA/OAR/ESRL PSD, Boulder, CO, USA, http://www.esrl.noaa.gov/psd/.

7.4.2 Copepods

Copepod species biomass, measured by NMFS, NWFSC off Newport, OR, reflects the biological response and lag to local and large scale physical forcing and is highly correlated to the PDO (http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/ea-copepod-biodiversity.cfm). During a positive phase of the PDO, northward transport delivers subtropical water to the northern California Current system and the biomass of southern copepod species increases. During negative phases of the PDO, equatorward transport delivers subarctic water and boreal copepod species to the NCC, increasing their biomass. "The Blob" intruded the Oregon shelf in September 2014, drastically changing the pelagic ecosystem and the copepod community, which was dominated by subtropical species. In summer of 2018 and 2019 equatorward transport finally delivered northern copepod species to the Oregon shelf and in the summers of 2020 and 2021 the biomass anomaly was back to levels observed before the marine heat wave with a high abundance of northern lipid-rich copepods, a good sign for the prey base of coastal pelagics in the northern region of the California Current (Figure 9).

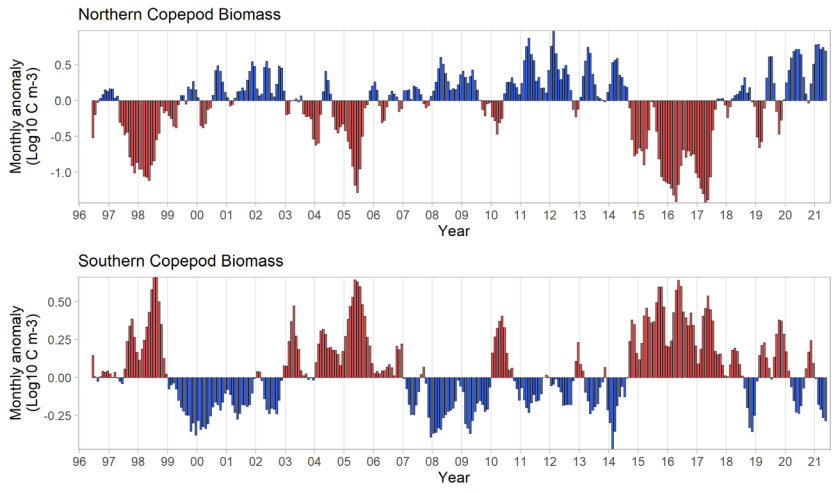

Figure 9. Three-month running mean of anomalies of biomass of northern and southern copepod taxa recorded off Newport, OR at NH05: Peterson Zooplankton Lab, NOAA, NMFS, Newport, OR.

7.4.3 Coastal pelagic fishes and invertebrates

The Fisheries Ecology Division of the SWFSC has conducted a late spring midwater trawl survey for pelagic juvenile (young-of-the-year, YOY) rockfish (*Sebastes spp.*) and other groundfish off Central California (approximately 36 to 38°N) since 1983, and has enumerated most other epipelagic micronekton encountered in this survey since 1990 (Ralston et al. 2015, Sakuma et al. 2016). The survey expanded the spatial coverage to include waters from the U.S./Mexico border north to Cape Mendocino in 2004.

Due to the Covid 19 epidemic, NOAA research ships were not operational for this survey in 2020, and instead the survey was conducted for a more limited spatial and temporal extent with a contracted commercial trawler. More details on adjusted analyses and results on non-CPS are included in the forthcoming State of the California Current to be published by Weber et al. in *Frontiers in Marine Science.*

Through a combination of bad weather and gear damage, only 15 hauls were conducted in 2020, all in the historical "core" area, compared to an average of 140 per year between 2004 and 2019. Thus, sampling for the core area was approximately 25% of the (recent) historical average. Additionally, survey effort did not begin until June 8, considerably later in the season than typical survey effort. Moreover, the small vessel size and poor weather conditions offshore constrained effort largely to shelf waters, and the more northerly stations in the core area survey grid were not sampled. Consequently, relative abundance indices were developed using a delta-generalized linear model (glm) approach (also referred to as a hurdle model), which can account for unbalanced spatial and temporal sampling by including covariates that model the effect (Dick 2004). A jackknife routine was used to estimate the relative error of the year effects and provided an indication of the greater uncertainty associated with 2020 abundance indices, as the coefficient of variation (CV) was either double (krill, yoy sanddabs, myctophids, Chrysaora fuscescens, salps) or triple (yoy rockfish, yoy hake) the long term mean. However, the CV was comparable to the long term mean for market squid, and slightly lower than the long-term mean cv for anchovies, due to the relatively high fraction of positive tows among those conducted in 2020.

Catches of juvenile rockfish remained on a declining trajectory since observed record high abundance levels in the 2015-16 surveys, with the 2020 relative abundance estimate second only to the 2005-2006 years with respect to being the lowest relative abundance estimated since 1990. Other pelagic young-of-the-year groundfish, namely Pacific hake and sanddab ((*Citharichthys spp*.), were also at near record low levels, consistent with 2019 survey results. Total krill catches were very low in 2019 and increased very slightly (albeit with much greater uncertainty) in 2020, although the two years were still well below any values observed since the early 2000s. Market squid, which had been at above average levels in every year except 2016 from 2012 through 2019, fell to just below long-term average levels. Northern anchovies, which had been increasing in recent years and were at record high levels in 2019 remained at very high levels, and were estimated at the second highest (to 2019) abundance level since 1990 in this survey and region, being present in all but one haul. The abundance of pelagic yoy anchovies was slightly higher than the long term average. As no Pacific sardine (adult or yoy) were encountered in 2020, no estimate of relative sardine abundance for the region is possible for 2020. However, as the fraction of positive tows for adults has been near 5% over the past decade, and that for yoy lower still, little should be inferred from this observation.

7.4.4 Central California Forage Indicators

Catches of juvenile groundfish and epipelagic micronekton have been enumerated from central California in late Spring (typically May through mid-June) since 1983 from the Rockfish Recruitment and Ecosystem Assessment Survey (RREAS), which was expanded to survey most waters offshore of CA starting in 2004 (Sakuma et al. 2016). Here we report relative abundance trends for several key forage taxa, including pelagic young-of-the-year (YOY) rockfish and Pacific hake, adult stages of two coastal pelagic species (northern anchovy and Pacific sardine), krill, market squid and pelagic octopus for the 1990-2021 period. These taxa are among the most frequently encountered forage species in this survey, and all are among the most important forage taxa in a meta-analysis developed by Szoboszlai et al. (2015), including four of the top five prey items for California Current predators (juvenile rockfish, northern anchovy, krill and market squid). Catches were standardized by using a delta-GLM to estimate year effects while accounting for spatial and temporal covariates, the relative abundance indices are shown with their approximate 95% confidence limits (see Santora et al. 2021). Although data were very limited in 2020 due to the Covid 19 pandemic, effort was closer to the longer term average (typically on the order of 60 trawls in the core area, 150 or so coastwide) in 2021. Due to the lack of 2020 data outside the core area, and time constraints for this document, only the core area abundance indices are reported here (Figure 10).

Catches of adult anchovy remained at the very high levels estimated in recent years, however no adult Pacific sardine were encountered in the core area in either 2020 or 2021, consistent with the observed decline in their abundance seen in other surveys. As the model could not estimate a variance when no fish were encountered, years with no confidence limits represent years in which none of a given taxa were encountered on the graphs (e.g,. most recent years for sardines, 2012 and 2016 for northern anchovy). Note that due to relatively infrequent catches, the uncertainty estimates around Paciifc sardine catches are considerably greater than those for other taxa (such as the YOY rockfish that the survey is designed to enumerate). Catches of YOY anchovy (not shown) were much lower than observed in recent years in the core area, but were considerably higher in the southern survey area (data have been provided to the Northern Anchovy stock assessment team for consideration in the upcoming stock assessment). Catches of YOY rockfish and YOY Pacific hake increased from the very low levels observed in 2019 and 2020, suggesting a return to more subarctic ocean conditions in the spring that tend to be related to improved rockfish recruitment (Ralston et al. 2013, Schroeder et al. 2019). Survey results suggest that the relative abundance of krill in this region also increased, but remained slightly below long-term average levels, a similar trend was observed for myctophids (lanternfishes). The abundance of market squid increased quite substantially between 2020 and 2021, although it should be noted that the uncertainty was also very high in the 2020 index due to sparse sampling. However, pelagic juvenile octopus catches, which often covary strongly with YOY groundfish and market squid (Sakuma et al. 2016), remained low in 2021.

Indices of abundance for key taxa of gelatinous zooplankton (thalacians and scyphozoan cnidarians) were not available in time for this report but catches of pyrosomes remained at high levels in 2021, catches of salps were close to long-term average levels and catches of large jellyfish (the scyphozoans *Chyrsaora fuscescens* and *Aurelia spp.*) were at fairly high levels in 2021. The cumulative results of these trends indicate a fairly productive ecosystem with abundant forage that

is dominated by the current high abundance of northern anchovy. Additional details will be included in the upcoming CCIEA report.

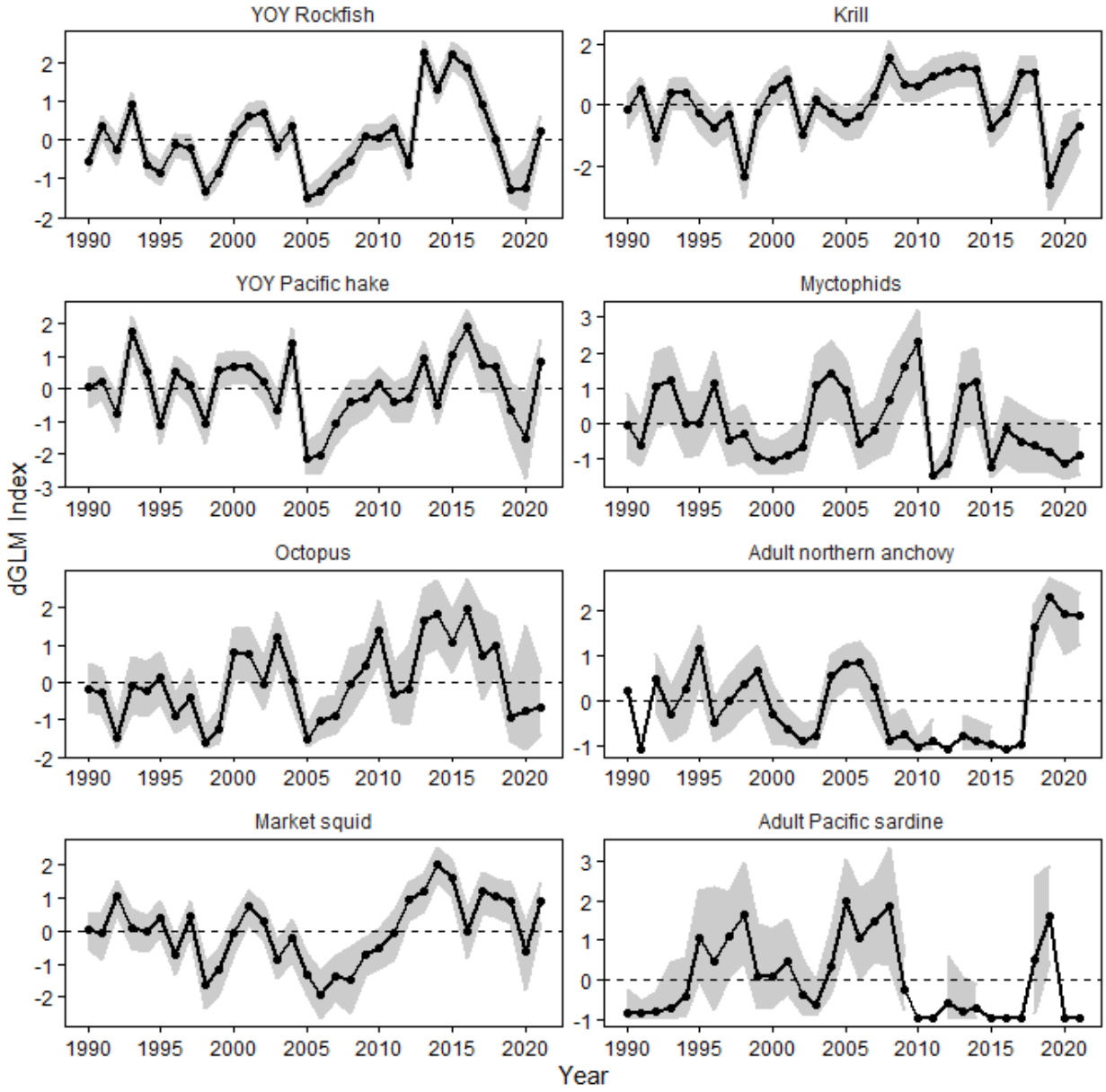

Figure 10: Standardized anomalies of log-scale abundance indices for key forage taxa sampled by the Rockfish Recruitment and Ecosystem Assessment Survey in the "core" (Central California) survey region.

Note- historically we have used 0.5 the lowest observed catch or index value for years in which a given taxa were not encountered- we've done so here as well, but it may well be better practice to not report anything for those years. For these taxa, this only is relevant to Pacific sardine and Northern Anchovy- former not encountered in the core area in 2010-2011, 2015-2017 or 2020,*

latter (anchovy) not encountered in core area in 1991, 2012, 2016. It may be more appropriate to report no data for those years, it's a bit of a judgment call.

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Climate Indicators:

El Niño Southern Oscillation (ENSO):
Source: Bill Peterson, NOAA, NWFSC
Source: https://www.esrl.noaa.gov/psd/enso/mei/index.html
Pacific Decadal Oscillation (PDO):
Source: http://jisao.washington.edu/pdo/, http://jisao.washington.edu/pdo/PDO.latest

California Current Ecosystem Indicators:
Copepods:
Source: Peterson Zooplankton Lab, NOAA, NWFSC

8 Stock Assessment Models, Stock Status, and Management Recommendations

The CPS FMP distinguishes between "actively managed," "monitored," "ecosystem component, and "prohibited harvest" species management categories. Actively managed species (Pacific sardine and Pacific mackerel) are formally assessed through Council proceedings annually or biennially. Over the years, seasonal closures and allocations, harvest guidelines, incidental landing allowances, and other management controls have been used for these stocks. Other CPS species (northern anchovy, jack mackerel, and market squid) are monitored to ensure their stocks are stable, but annual stock assessments and Federal fishery controls are not used on an annual basis. Both actively managed and monitored stocks are management unit species, however. Ecosystem component species (Pacific herring and jacksmelt) are not considered part of the CPS fishery but are categorized in the FMP as EC species. EC species do not require specification of reference points, but incidental catch of EC species should be monitored for indications of change in status of their vulnerability to the fishery. Krill (consisting primarily of two species of euphausiids) are listed under the prohibited harvest species category, and there is no directed take allowed.

On a systematic basis, the CPSMT makes recommendations to the Council and related agencies regarding appropriate management categories for each stock, both short- and long-term. Changes to the appropriate management category for each species can be made annually by the Council, based on all available data, including ABC levels and MSY control rules, and goals as outlined in the CPS FMP (PFMC 2010).

In June 2013, the CPSMT recommended moving Pacific mackerel from actively managed to monitored status starting in the 2014-2015 season, based on very low catches, limited additional sample information, and indications that the population's sustainability is not presently being compromised by fishing pressure. The CPSAS advised keeping mackerel actively managed, and the Council concurred, keeping Pacific mackerel as an actively managed species.

Based on biomass estimates, landings, conservation, socio-economics, and other information, the CPSMT recommends that Pacific sardine and Pacific mackerel remain as an actively managed species, while jack mackerel, northern anchovy, and market squid remain as Monitored stocks.

Finally, while this document focuses on U.S. fisheries, many CPS stocks are characterized by expansive ranges depending on oceanographic conditions and thus, catch information from both Mexico and Canada are of interest. See Table 8-4 for Pacific sardine harvest statistics from commercial fisheries operating in the U.S., Mexico, and Canada (2011-2020).

8.1 Actively Managed Species

8.1.1 Pacific sardine

Kuriyama *et al.* (2020) summarized the status of the Pacific sardine northern subpopulation off the U.S. Pacific Coast, British Columbia, and northern Baja California (Ensenada), Mexico. International Pacific sardine landings (Ensenada to British Columbia, northern and southern subpopulations) totaled 157,655 mt in calendar year 2020, up from 96,024 mt in 2019 (Table 8-4). The majority of sardine was landed in Ensenada and was primarily comprised of fish from the southern subpopulation. The U.S. directed sardine fishery was under a continued moratorium during the 2020-21 management year. During 2020-21, incidental and live bait sardine landings in

California totaled 2,493 mt, Oregon landed 3 mt, and Washington landed less than 1 mt (Table 8-3). U.S. landings totaled 2,497 mt during the 2020-21 fishing year.

The U.S. sardine fishery is regulated using a quota-based management approach. From 2000 to 2007, landings were typically lower than the recommended harvest limits. Due to a series of lower quotas, the U.S. fishery was subjected to in-season closures during 2008 to 2011, 2013, and 2014-15. In 2016-17 and 2017-18, the ACT (for incidental, Tribal, and live bait) was 8,000 mt, and the HG (directed fishery) was set to zero mt. In 2018-19, the ACT was lowered to 7,000 mt and the HG remained at zero. In 2019-20 and 2020-21, the ACT was lowered to 4,000 mt. The ACT was set at 3,000 mt for the 2021-22 management season.

Harvest of Pacific sardine by the Ensenada (Mexico) fishery is not yet regulated through a quota system, but there is a minimum legal size requirement of 150 mm standard length and measures are in place to control fleet capacity. The Ensenada fleet landed a record 155,130 mt of sardine in calendar year 2020 (Table 8-4). Sardine landed in Ensenada represent a mixture of fish from the southern and northern subpopulations. Due to prevailing warm oceanic conditions, the vast majority of sardine landed during 2015 to 2020 were likely from the southern subpopulation (Kuriyama et al. 2020). Canadian sardine landings increased substantially after 2007 (1,522 mt), peaking at 22,223 mt in 2010. However, the Canadian fishery has found no sardine since 2013 and the fishery has been under a continued moratorium (Table 8-4).

The 2020 benchmark stock assessment update (Kuriyama *et al.* 2020) provided a stock biomass (age 1+) estimate of 28,276 mt on July 2020 (Table 8-2), reflecting a continuing trend of low productivity in the northern subpopulation. The NSP of Pacific sardine is now below the minimum stock-size threshold (50,000 mt) and was declared 'overfished' in June 2019. A rebuilding plan was developed by the CPSMT in 2020 and adopted by the PFMC in September 2020. The 2021 catch-only assessment update was not ultimately adopted by the PFMC due to unresolved issues associated with low biomass but high catches in the Ensenada fishery. Therefore, the PFMC's 2021-22 management measures for sardine, described below, were based on biomass from the 2020 benchmark assessment with downward adjustments to ABC's and the ACT.

8.1.1.1 Pacific Sardine Harvest Control Rules for 2021-2022

The OFL and ABC for 2021-22 were based on an E_{MSY} for the three-year running average of CalCOFI SST for 2017-19 (15.9965 °C; E_{MSY}=0.2246). Harvest control rule formulas for the 2021-22 management year were calculated as follows:

OFL = BIOMASS * E_{MSY} * DISTRIBUTION,

ABC = BIOMASS * $BUFFER_{P\text{-}star}$ * E_{MSY} * DISTRIBUTION,

HG = (BIOMASS – CUTOFF) * E_{MSY} * DISTRIBUTION,

Where: BIOMASS = 28,276 mt; E_{MSY} = 0.2246 for OFL and ABC, and E_{MSY} = 0.20 for HG; DISTRIBUTION = 0.87; $BUFFER_{P\text{-star 0.4 (Tier 3)}}$ = 0.6025; and CUTOFF = 150,000 mt.

In April 2021, the Council used the most recent benchmark sardine stock assessment (Kuriyama *et al.* 2020) to set harvest specifications for the 2021-22 management year beginning July 1, 2021. Stock biomass from that assessment (28,276 mt, Kuriyama *et al.* 2020) was used to calculate all harvest control rules above. Because the biomass estimates from 2015 to 2020 fell below the 150,000 mt CUTOFF value, the HG (ACT) was calculated to be zero, hence no directed commercial fishery has been allowed since July 2015.

Using the control rules for 2021-22, the Council adopted an OFL of 5,525 mt, an ABC/ACL of 3,329 mt, and an ACT of 3,000 mt (Table 8-3). The ACT was established to allow for incidental catch, directed tribal harvest, live bait, research, and other minor sources of mortality. The Council also adopted the following management accountability measures regarding catch:

- Incidental sardine landing limit in other CPS fisheries of 20 percent;
- If landings in the live bait fishery attain 1,800 mt of sardine, a per-landing limit of one mt of Pacific sardine per trip will apply to the live bait fishery;
- If the ACT of 3,000 mt is attained, a per-trip limit of 1 mt of Pacific sardine applies to all CPS fisheries;
- An incidental per-landing allowance of 2 mt of Pacific sardine in non-CPS fisheries until the ACL is reached;
- Up to 830 mt of sardine to support exempted fishing permit research.

8.1.2 Pacific Mackerel

In June 2019, the Council adopted the most recent catch-only assessment update (Crone et al. 2019) for specifying management measures during the 2019-20 and 2020-21 fishing seasons, which run July 1-June 30 each season. Stock biomass (age-1+ biomass) steadily declined from the mid-1980s to the early 2000s, at which time the population began to increase moderately in size. However, in historical terms, the population remains at a relatively low abundance level, due primarily to oceanographic conditions, given limited fishing pressure over the last decade has likely not compromised this species' biology (i.e., their role in the larger CPS assemblage off the Pacific coast). Recent estimates of stock size are related to assumptions regarding the dynamics of the fish (biology, recruitment, etc.) and fishery (operations) over the last several years, which generally confound long-term abundance forecasts for this species (Crone et al. 2019). It is important to note that exploitation of this stock has changed considerably over the last two decades, i.e., during the 1990s, the directed fisheries off California had average annual landings of roughly 18,000 mt, whereas since 2002, average yearly landings have decreased substantially (Table 8-7). This pattern of declining yields in recent years generally characterized all of the Pacific mackerel fishery sectors, including U.S. commercial and recreational sectors, as well as the commercial fishery of Mexico. U.S. commercial landings in the 2020-21 fishing year were 605 mt, still well below the ACT and ABC (Table 8-7).

8.1.2.1 Pacific Mackerel Harvest Specifications for 2021-22 and 2022-23

The Council adopted the 2019 benchmark assessment (Crone et al. 2019) to establish an overfishing limit (OFL) and other annual specifications for both the 2019-20 and the 2020-21 fishing years. In 2021, a catch-only update assessment (Hill and Zwolinski 2021) was conducted, reviewed, and adopted for management measures during 2021-22 and 2022-23. Should the directed fishery realize the Annual Catch Target (ACT), the directed fishery will close and shift to an incidental-only fishery for the remainder of the fishing year, with a 45 percent incidental landing allowance when Pacific mackerel are landed with other coastal pelagic species (CPS). Up to 3 mt of Pacific mackerel per landing could be landed in non-CPS fisheries.

Harvest control rule formulas for the 2021-22 and 2022-23 management years were calculated as follows:

OFL = BIOMASS * F_{MSY} * DISTRIBUTION,

ABC = BIOMASS * $BUFFER_{P\text{-}star}$ * F_{MSY} * DISTRIBUTION,

HG = (BIOMASS – CUTOFF) * FRACTION* DISTRIBUTION,

Where: F_{MSY} = 0.30; DISTRIBUTION = 0.70; $BUFFER_{P\text{-star }0.45\text{ (Tier 3)}}$; and CUTOFF = 18,200 mt.

Fishing year:	2021-22 (mt)	2022-23 (mt)
Biomass	57,832	45,925
OFL	12,145	9,644
$ABC0.45_{(Tier\ 3)}$	9,446	7,501
ACL (=ABC)	9,446	7,501
HG	8,323	5,822
ACT	7,323	4,822
Incidental	1,000	1,000

8.2 Monitored Species

The Monitored species category of the CPS FMP includes the northern subpopulation of northern anchovy, the central subpopulation of northern anchovy, jack mackerel, and market squid. This management category is intended for those species or stocks that do not require intensive harvest management and where monitoring of landings and available abundance indices are considered sufficient to manage the stock. The default control rules and overfishing specifications are used for Monitored stocks unless otherwise specified. OFL, ABC, and ACLs can be revised based on the best available science as recommended by the SSC and as adopted through the annual harvest specification process and will be reported in the CPS SAFE.

Under the default harvest control rule, the ABC is set to 25 percent of the OFL until the SSC recommends an alternate value based on best available science. ACLs are set for multiple years until new information becomes available, or until the stock is moved to active management. Stocks may be moved between active and Monitored categories on short notice, under the point-of-concern framework.

8.2.1 Northern Anchovy

The most recent complete assessment for northern anchovy was described in Jacobson *et al.* (1995). California landings of northern anchovy began to increase in 1964, peaking in 1975 at 143,799 mt. After 1975, landings declined. From 1983 to 1999, landings did not exceed 6,000 mt per year. There were no reported landings of northern anchovy in Oregon from 1981 through 1999.

Washington landings of anchovy were sporadically reported before 1967. Landings peaked in the 1970s at 286 mt in 1975 and thereafter declined, not exceeding 100 mt between 1978 and 1995. From 2000 to 2019, northern anchovy landings averaged 191 mt for Washington and 427 mt for Oregon, and 8,841 mt for California. The greatest northern anchovy landings in California occurred in 2001 (19,277 mt). In Washington, the peak occurred in 2009 (810 mt). In Oregon, the peak in northern anchovy landings occurred in 2016 with 6,313 mt landed. In late summer/fall of 2016, a substantial effort occurred inside the Columbia River, resulting in the anomalously large 2016 catch. Oregon anchovy landings have been typically much less.

Anchovy (mt)	**WA**	**OR**	**CA**
	Northern subpopulation		Central subpopulation
2009	810	39	2,668
2010	108	138	1,026
2011	191	21	2,601
2012	218	0	2,488
2013	116	13	6,019
2014	112	0	10,512
2015	144	335	17,286
2016	164.5	6,313	8,369
2017	163.3	0.002	5,502
2018	123.2	0	17,402
2019	88	0	10,165
2020		0	5,636

Through the 1970s and early 1980s, Mexican landings increased, peaking at 258,745 mt in 1981 (Table 8-1). Mexican landings decreased to less than 2,324 mt per year during the early 1990s, with a spike of 17,772 mt in 1995, primarily during the months of September through November. Catches in Ensenada decreased to 4,168 mt in 1996; and remained at less than 5,000 mt through 2014. Landings in 2015 peaked in recent years to 46,850 mt.

Stock	OFL	ABC	ACL	ACT
Northern anchovy, northern subpopulation	39,000 mt	9,750 mt	Equal to ABC	1,500 mt
Northern anchovy, central subpopulation	94,290 mt	23,573 mt	Equal to ABC	N/A

CDFW began commercial sampling of anchovy in 2014; however, there remains little biological data for this species in recent decades, from either fishery or survey data collection efforts. WDFW began conducting northern anchovy sampling beginning in 2015.

The SWFSC plans to complete a stock assessment for the central subpopulation of northern anchovy in late 2021 that will be brought to the Council in 2022. The Council reviewed a newly proposed framework for managing the central subpopulation of northern anchovy that would include periodic assessments as well as periodic checks of biomass estimated from survey work. The management framework is pictured in the Figure 8-2 below, which includes the proposed parameter values that would define the long-term biomass as the arithmetic 10-year average based on the most recent assessment and the short-term biomass as the arithmetic 3-year average based on the most recent survey estimates. The basics of the framework are that assessments would be conducted every 8 years, and that both the catch levels and the survey estimates would be evaluated every 2 years to determine if adjustments to harvest parameters should be made or if the assessment schedule should be adjusted. Assessments would also determine the E_{msy} for the stock. Thus, the stock would remain on a long-term management with more frequent checks on stock status and harvest parameters. The framework and flowchart were incorporated into Council Operating Procedure (COP) 9 Schedule 3 in November 2021.

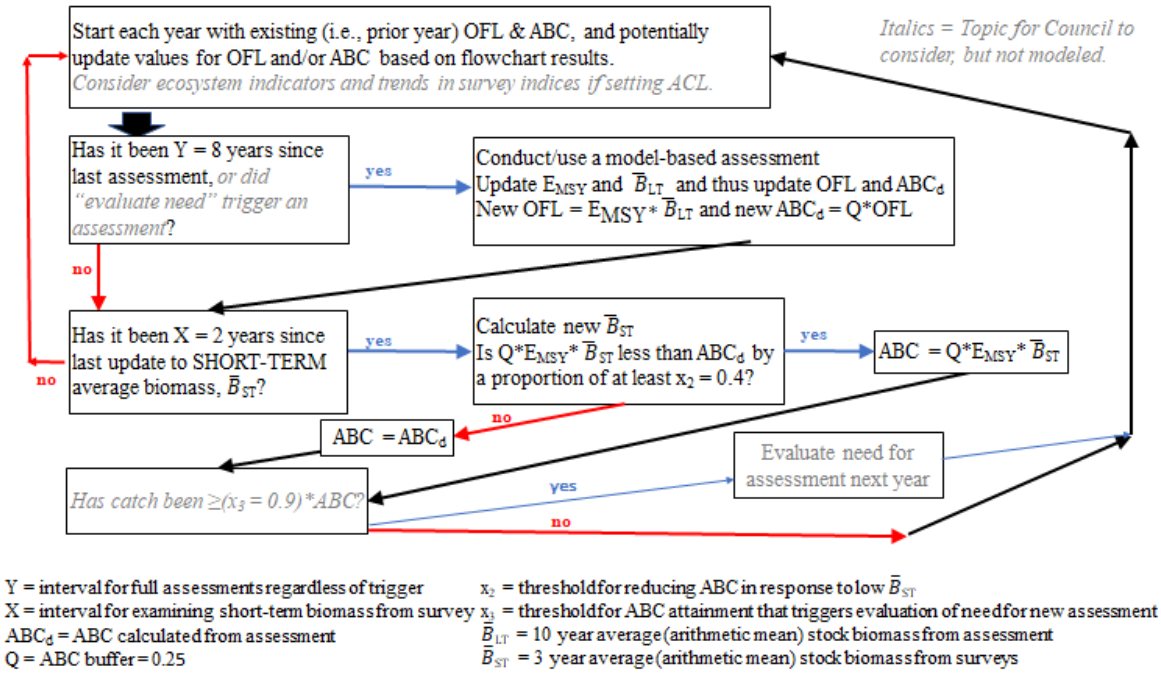

Figure 8-2. Flowchart depicting the proposed framework for managing the central subpopulation of northern anchovy with the parameter values proposed to be utilized.

8.2.2 Jack Mackerel

Jack mackerel have not been significantly targeted on the West Coast and most landings are caught incidentally to other fisheries. Regular stock assessments or efforts to collect biological information on jack mackerel have not been a priority. The SWFSC Acoustic-Trawl survey, which began in 2006, could potentially be used to provide abundance estimates in the future, but to date the demand for this exercise has not been great. Management efforts to collect fishery-dependent age composition data, such as the CDFW Port Sampling Program, are in place for the two actively managed CPS (Pacific sardine and Pacific mackerel), but not for jack mackerel, aside from samples taken prior to 1995.

Jack Mackerel are managed on a calendar year basis. Landings of jack mackerel reached a maximum of 25,984 mt in 1982 to a low of 94 mt in 2011. Since the Pacific sardine directed fishery closed in 2015, most landings of jack mackerel in Oregon and all landings in Washington are currently incidental to non-CPS fisheries, whereas California landings are typically incidental catch from CPS fisheries.

Jack mackerel landings – metric tons				
Year	**WA**	**OR**	**CA**	**Coast-wide**
2011	-	14	80	94
2012	14	96	145	338
2013	22	123	892	1,037
2014	176	800	793	1,769
2015	>1	117	1285	1538
2016	-	116	207	373
2017	-	303	101	453
2018	45	97	64	206
2019	88	458	9	555
2020	74	364	33	471

In 2010, in accordance with the reauthorized MSA, the Council adopted new management benchmarks for jack mackerel. The overfishing limit (OFL) value is based on past studies and the ABC value accounts for a 75 percent uncertainty buffer in the OFL. The ACL was set equal to the ABC:

Stock	OFL	ABC	ACL

Jack mackerel	126,000 mt	31,000 mt	Equal to ABC

8.2.3 Market Squid

Market squid is under Federal management, which adopts California's annual landings cap of 118,000 short tons. Market squid lifecycle is less than one year and therefore exempt from the requirement to apply an ACL but is still required to adopt OFL and ABC values or proxies. The bulk of market squid landings occur in California, although sporadic landings also occur in Oregon. The Egg Escapement Method has been used as an assessment tool, to evaluate population dynamics and biological reference points (MSY related) regarding this species (Section 4.3.4 and Dorval et al. 2008, 2013). The CDFW manages the market squid fishery in California through a state-based management plan including the annual landings cap and various spatial/temporal constraints such as weekend closures, area and time closures to address seabird issues, and harvest replenishment areas within MPAs (CDFG 2005). The fishery control rules currently in place under the California MSFMP, are thought to preclude the need for active Federal management. However, if fishery operations change substantially in the future (for example, spatially expands, harvests high amounts of immature squid), additional management measures could be considered.

In 2010, the Council approved benchmarks for market squid, which remain in place until changed by the Council:

Stock	OFL	ABC	ACL
Market squid	Fmsy proxy resulting in egg escapement ≥ 30%	Fmsy proxy resulting in egg escapement ≥ 30%	Exempt

8.2.3.1 California's Market Squid Fishery

In 2001, legislation transferred the authority for management of the market squid fishery to the California Fish and Game Commission (CFGC). Legislation required that the CFGC adopt a Market Squid Fishery Management Plan (MSFMP) and regulations to protect and manage the squid resource. In August and December of 2004, the CFGC adopted the MSFMP, the environmental documentation, and the implementing regulations, which went into effect on March 28, 2005, just prior to the April 1 start of the 2005/2006 fishing season.

In 2020, the market squid fishery was California's largest fishery, with landings estimated at 20,445 mt. This is a 66 percent increase from 2019 (12,336 mt). The total ex-vessel value decreased from $35.8 million in 2018 to $13.5 million in 2019. The median ex-vessel price per metric ton of market squid in 2019 was $1,100, a small increase from $1,100.81 in 2017. The Median ex-vessel price per metric ton of market squid in 2020 was $1,152.00. The fishing permit season for market squid extends from April 1 through March 31 of the following year. During the 2018-2019 season (as opposed to the 2019 calendar year), 13,801 mt were landed, a 78 percent decrease from the 2017-2018 season (61,609 mt). During the 2019-2020 market squid season, 18,841 mt were landed which was a 37 percent increase from the previous season (13,801 mt).

8.3 Prohibited Harvest Species

Amendment 12 to the CPS FMP was approved by the Secretary of Commerce in 2009. Amendment 12 prohibits the directed harvest of krill species. The Amendment described EFH for krill and set an ACL equal to zero.

8.4 Ecosystem Component and Shared Ecosystem Component Species

In June 2010, the Council added Pacific herring (*Clupea pallassi*) and jacksmelt (*Atherinopsis californiensis*), two species not under Federal management, to the Ecosystem Component category of the CPS FMP. Several criteria should be met for a species to be included in the EC category (MSA Section 660.310(d)(5)(i)). These are 1) be a non-target stock/species; 2) not be subject to overfishing, approaching overfished, or overfished and not likely to become subject to overfishing or overfished in the absence of conservation and management measures; and 3) not generally retained for sale or personal use within the CPS fishery, although "occasional" retention is not by itself a reason for excluding a species from the EC category. Identifying and including EC species in an FMP is not mandatory but may be done for a variety of purposes, including data collection, for ecosystem considerations related to specification of OY for the associated fishery, as considerations in the development of conservation and management measures for the associated fishery, and/or to address other ecosystem issues.

A 2010 review of bycatch species in CPS fisheries confirmed that incidental catch and bycatch in CPS fisheries is dominated by other CPS and that bycatch/incidental catch of non-CPS is extremely low. However, jacksmelt and Pacific herring are infrequently caught with CPS gear and were therefore added to the FMP under Amendment 13 to ensure continued monitoring of incidental catch and bycatch of these species through sampling and logbook programs. This information will continue to be reported in the SAFE report. The Council intends to continue and expand its consideration of ecological factors when developing status determination criteria (SDCs) and management measures for CPS management unit species. These considerations will evolve as improved information and modeling of ecological processes become available and will likely include predator/prey relationships and the overall status and role of forage species including these two EC species.

In 2015, the Council took final action to protect unfished and unmanaged forage fish species through Comprehensive Ecosystem-Based Amendment 1(CEBA 1), an initiative of the Council's Fishery Ecosystem Plan (FEP). These "Shared Ecosystem Component Species" were incorporated into each of the Pacific Council's FMPs. A directed fishery may not proceed for any of these stocks, until and unless the Council has had an adequate opportunity to both assess the scientific information relating to any proposed directed fishery and consider potential impacts to existing fisheries, fishing communities, and the greater marine ecosystem.

Shared Ecosystem Component Species:

Common Name	Scientific Name

Round herring	*Etrumeus teres*
Thread herring	*Opisthonema libertate, O. medirastre*
Mesopelagic fishes	Families: *Myctophidae, Bathylagidae, Paralepididae, and Gonostomatidae*
Pacific sand lance	*Ammodytes hexapterus*
Pacific saury	*Cololabis saira*
Silversides*	*Atherinopsidae*
Smelts	*Osmeridae*
Pelagic squids	Families: *Cranchiidae, Gonatidae, Histioteuthidae, Octopoteuthidae, Ommastrephidae* except Humboldt squid (*Dosidicus gigas*), *Onychoteuthidae, and Thysanoteuthidae*

8.5 References

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9 Emerging Issues

This section describes current and potential issues that may need to be addressed relative to FMP species and management in general.

9.1 Pacific Sardine

In June 2019 NMFS declared the northern subpopulation of Pacific sardine to be overfished, due to the stock biomass having fallen below the 50,000 mt MSST. The Council and NMFS are required to develop a rebuilding plan for overfished stocks. At its September 2020 meeting the Council adopted a rebuilding plan, which was transmitted to NMFS and approved on June 14, 2021.

9.2 Offshore Wind Energy Development

In 2020 the Biden Administration issued Executive Order 14008, "Tackling the Climate Crisis at Home and Abroad." As part of a national policy to develop renewable energy, offshore wind energy development has been prioritized, under the Bureau of Ocean Energy Management (BOEM). The planning process includes identifying areas in the U.S. EEZ that are suitable for wind energy development. It is likely these wind energy areas will coincide with fishing grounds, transit corridors, and potentially will impact benthic habitat and coastal communities. The Council established an Ad Hoc Marine Planning Committee to advise the Council and its Advisory Bodies on pending comment opportunities, development plans, and other information that may impact fisheries, habitat, and coastal communities.

10 Research and Data Needs

Robust assessment procedures are needed to meet the requirements of the FMP, especially for actively managed stocks such as Pacific sardine. Reliable CPS biomass estimates are used in the Council's annual determination of allowable coastal pelagic harvests, as well as appropriate management responses.

The Council's comprehensive Research and Data Needs Document last revised in September 2018 is the Council's primary statement of priority research and data needs. The document includes numerous research and data recommendations for CPS including but not limited to:

- Establishing a long term record of abundance for the CPS assemblage
- Researching the stock structure of Pacific sardine
- Improving the accuracy and spatial coverage of stock surveys
- Continuing international data and information sharing
- Reducing ageing error and bias
- Refining EFH and distribution for all CPS stocks
- Investigating the role of CPS in the ecosystem, including predator-prey interactions

For detailed information on the Council's research and data needs relative to CPS, see Chapter 6 of the Research and Data Needs document.

The 2014 Pacific sardine stock assessment, for the first time, differentiated the northern and southern subpopulations. This is a departure from past stock assessments, which assumed that all landings from Ensenada, Mexico, north were of the northern stock.

Priority research and data needs for CPS are:

- Develop methods for differentiating southern from northern subpopulation of Pacific sardines and develop an appropriate management approach.
- Develop a coastwide (Mexico to British Columbia) synoptic survey of sardine and Pacific mackerel biomass, i.e., coordinate a coastwide sampling effort (during a specified time period) to reduce "double-counting" caused by migration.
- Evaluate and incorporate nearshore biomass estimation methods for CPS to complement Acoustic-trawl surveys, especially for Pacific sardine and northern anchovy.
- Increase fishery sampling for age structure (Pacific sardine and Pacific mackerel) in the northern and southern end of the range. Establish a program of port sample data exchange with Mexican and Canadian scientists.
- Evaluate the role of CPS resources in the ecosystem, the influence of climatic/oceanographic conditions on CPS, and define predator-prey relationships.
- Routinely, collect detailed cost-earnings data to facilitate analyses for long-term changes to the sardine allocation structure.

10.1 Pacific Sardine

Priority research and data needs for Pacific sardine include:

1) exploring environmental covariates (e.g., SST, wind stress) to inform the assessment model, and to address recent research that brings into question the temperature-recruitment relationship.
2) continuing to develop methods (e.g., otolith microchemistry, genetic, morphometric, temperature-at-catch analyses) to improve our knowledge of sardine stock structure that

can ultimately be applied toward more refined management of northern and southern subpopulations;

3) continuing to gain better information about Pacific sardine status through annual coastwide Acoustic trawl surveys;
4) standardizing fishery-dependent data collection among agencies, and improving exchange of raw data or monthly summaries for stock assessments;
5) obtaining more fishery-dependent and fishery-independent data from northern Baja California, México, and British Columbia, Canada; as well as from nearshore habitats;
6) further refining ageing methods and improved ageing error estimates through a workshop of all production readers from the respective agencies;

10.2 Pacific Mackerel

Given the transboundary status of Pacific mackerel, it is imperative to encourage collaborative research and data exchange between NMFS SWFSC and researchers from both Canada's and in particular, Mexico's academic and Federal fishery bodies. For example, such cooperation is critical to providing a synoptic assessment that considers available sample data across the entire range of this species in any given year.

Given the importance of age (and length) distribution time series to developing a sound understanding of Pacific mackerel population dynamics, it is critical that data collection programs at the Federal and state levels continue to be supported. In particular, CDFW/NOAA funding should be bolstered to ensure ongoing ageing-related laboratory work is not interrupted, and for related biological research. This applies to the Pacific Northwest fishery as well. For example, maturity-related time series currently relied upon in the assessment model are based on data collected over twenty years ago during a period of high spawning biomass that does not reflect current levels. Also, work is needed to obtain more timely error estimates from production ageing efforts in the laboratory; for example, accurate interpretation of age-distribution data used in the ongoing assessment requires a reliable ageing error time series. Finally, examinations of sex-specific age distributions will allow hypotheses regarding natural mortality/selectivity (i.e., absence of older animals in sex-combined age distributions) to be more fully evaluated.

10.3 Market Squid

Currently, the basics of market squid population dynamics in California are understood, with market squid rapidly expanding in cool oceanographic conditions and productive ocean environments associated with La Niña events; and contracting in warm and unproductive regimes associated with El Niño events. However, the same relationship between ocean conditions and squid population dynamics may not hold true in waters off the Pacific Northwest. In light of the wide range (Baja California to Alaska) and short lifespan of market squid, a formal stock assessment has not been attempted, which limits the ability to quantify the abundance of this valuable marine resource. Although found primarily off California, fisheries occasionally develop off Oregon and Washington and thus, some amount of fishery-dependent data exist coast wide. General information concerning important stock- and fishery-related parameters suggests

maximum age is less than one year, and the average age of squid harvested is roughly six to seven months. Under the National Standard 1 Guidelines, market squid are exempt from ACLs due to their short lifespan. However, the CPSMT recommends that current monitoring programs continue for this species, including tracking fishery landings, collecting reproduction data from the fishery, and obtaining logbook information.

Although some coastwide squid distribution and abundance has been extracted from fishery-independent midwater and bottom trawl surveys aimed at assessing other finfish species, there is currently no comprehensive measure of annual recruitment success beyond information obtained from the fishery. Since fishing activity generally occurs only on shallow-water spawning aggregations, it is unclear how fluctuations in landings are related to actual population abundance and/or availability to the fishery itself. Landings may be influenced by market conditions, as well as resource abundance.

The general consensus from the scientific and fishery management communities is that squid do inhabit, to some degree, greater depths than fished by the fleet; however, species' range suppositions are qualitative at this point in time. Better information on the extent and distribution of spawning grounds along the U.S. Pacific Coast is needed, particularly, in deep water and areas north of central California.

Since 2011, collaborative work between federal, state, and industry sponsored research has produced a relative paralarval abundance index in the two major fishing grounds in southern California and the Monterey Bay area, which has shown a high correlation between ENSO events and paralarval distribution and abundance along the California coast. This collaborative work is also focused on addressing basic life history information, such as trophic ecology and the effects of environmental forcing (ENSO events) on age and growth patterns.

Fecundity and egg survival research is needed from different spawning habitats in nearshore areas and oceanographic conditions associated with the population. Further data on mechanisms and patterns of dispersal of adults, as well as paralarvae, along the coast is necessary to clarify how local impacts might be mitigated by recruitment from other areas inhabited by this short-lived species. See Dorval 2008, Dorval et al 2013, and Van Noord & Dorval 2020 for additional information.

Although some fishery effort information is now being collected with a logbook program in the State of California, the continuation of this program is essential to provide estimates of relative abundance (e.g., CPUE time series) in the future. Annual collaborative surveys that target market squid paralarvae in shallow waters at the traditional spawning beds in southern and central California using obliquely towed bongo nets have been conducted since 2011. Continuation of this effort and/or the establishment and integration of additional surveys using midwater trawls, bottom trawls, remotely operated vehicles, and satellite and aerial surveys to target abundance data on adult squids would also provide useful information for developing alternative indices of abundance other than those derived from logbook data.

Potential impacts to EFH-related issues could arise in concert with fishing activity by the purse-seine fleet on spawning aggregations in shallow water if gear potentially makes contact with the sea floor. In this regard, there are two areas of potential concern that have not been quantified to date: (1) damage to substrate where eggs may be deposited; and (2) damage or mortality to egg masses from contact with the gear itself. One potential way to determine if nets are disturbing egg beds is to look for egg cases in market squid landings. When market squid egg cases are observed

at offloading sites, there are two potential reasons that egg cases may be in the load: 1) market squid released egg cases in the net after being captured, or 2) egg cases were taken from the ocean floor during fishing activity. If egg cases are more than one day old, then egg cases were likely taken from the bottom. The rate of development of embryos is greatly influenced by environmental conditions, such as temperature.

Currently, market squid fecundity estimates, based on the Egg Escapement Method (Dorval et al. 2008 and 2013), are used informally to assess the status of the stock through evaluations of alternative biological reference points related to productivity and MSY. The Egg Escapement Method is based on several assumptions: (1) immature squid are not harvested; (2) potential fecundity and standing stock of eggs are accurately measured; (3) life history parameters are accurately estimated (e.g., natural mortality, egg laying rate); and (4) instantaneous fishing mortality (F) translates into meaningful management units. Given the inherent uncertainty associated with these assumptions, each must receive more scrutiny in the future through continuation of rigorous sampling programs in the field that generate representative data for analysis purposes, as well as further histological evaluations in the laboratory and more detailed assessment-related work. For example, data collected through the CDFW port sampling program will provide information on maturity stages of harvested squid. Further, laboratory work concerning mantle condition, especially the rate of mantle "thinning," will benefit our understanding of squid life history and subsequently help improve the overall assessment of this species. Finally, other poorly-understood biological parameters that relate to spawning and senescence should be studied (for example, life history strategies concerning spawning frequency, the duration of time spent on spawning grounds, and the period of time from maturation to death).

10.4 Live Bait Fishery

The California live bait fishery supplies product for several recreational fisheries, primarily in southern California, but as far north as Eureka. Live bait catch is generally comprised of both Pacific sardine and northern anchovy. Sardine typically represents a larger portion of the live bait catch, ranging from about 42 percent to 95 percent between 1994 and 2018. Total live bait landings in those years vary between about 1,475 mt and 4,300 mt, with effort increasing in summer months. However, estimates to 2015 are based only on logbooks provided by a limited number of bait haulers, and are provided by the CPFV industry. Beginning in 2019, reporting of live bait catch in California has been mandatory, as part of the commercial fishery electronic ticket reporting system.

10.5 Socioeconomic Data

Economic analyses of management actions affecting coastal pelagic fisheries requires detailed, representative cost and earnings data for the harvesters and processors of sardine and other CPS making up each fishery sector. These data are used to evaluate the economic impacts of proposed management actions. Experience with the long-term allocation of the Pacific sardine HG emphasizes this need and underscores the necessity for routine data collection. Collecting such data on an irregular basis, or to address an issue at hand, often makes them suspect in terms of strategic bias and validity.

Under Ecosystem-based fishery conservation and management, economic analyses may examine changes in yields from a number of different species and finding a balance among the variety of ecosystem services CPS can provide. The tradeoffs of interest are between benefits CPS provide as directed harvests, food for higher trophic level commercial-harvested predators, food for recreationally important predators, and food for non-commercial but ecologically important predators. The economic data required to evaluate tradeoffs involving recreationally important versus non-commercial but ecologically important species will entail the development of non-market data acquisition and valuation techniques. While these methods may have been developed, it is not clear the extent of their application to CPS fishery socio-economics.

10.5.1 Commercial Fisheries

A CPS vessel logbook program for Washington, Oregon, and California vessels that included economic data would greatly contribute to economic analyses of the commercial CPS fishery. Such a program could provide vessel-trip-level fishery economic data (e.g., fuel cost and consumption, number of crew, cost of provisions) across all CPS fishery operations. A logbook program would also need to include other fishery operations in which vessels engage in order to fully evaluate their economic opportunities. To fully understand fleet economics, the at-sea data would need to be supplemented with annual expenditure data, and other data that are not trip-specific, such as interest payments.

A parallel effort should be taken with processors. To fully evaluate the economic impacts of proposed management actions detailed, representative cost and earnings data for west coast sardine processors should be reported on a routine basis. This would entail periodic surveys of CPS processors to collect representative economic data on their processing operations. With the closure of the Pacific sardine fishery since 2015, the impetus for such an initiative is less crucial.

10.5.2 Non-market Values

Economic analyses of conservation and management actions affecting the availability of sardines as forage for non-commercial predators will entail developing a framework and compiling the data to estimate the non-market values of recreationally and ecologically important sardine predators. These nonmarket values can then be used to impute the economic value (shadow prices) of Pacific sardine and other CPS as forage for these predators, compared to the economic value in the absence of fishing.

10.6 Northern Anchovy and Acoustic-Trawl Survey

Concerns about a declining biomass of the central subpopulation of northern anchovy (CSNA) led to several Council agenda items in 2015 and into 2016, as well as a workshop to consider optimal approaches to an anchovy stock assessment, and a general increased impetus to identify adequate survey methodologies. A methodology review panel evaluated the SWFSC's ATM survey for potential use in stock assessments for CPS finfish. The panel produced a report, subsequently endorsed by the SSC and adopted by the Council, which concluded that the ATM survey could be used for more species than previously, with certain caveats. The recommendations are summarized in the table below, from page 30 of the panel's report (PFMC 2018).

Evaluation of possible use of ATM results in assessments and management. Q denotes the catchability coefficient between the biomass estimate and biomass in the model. This table does not discuss option (c) of TOR 8 given the Panel did not support using the ATM estimates as measures of absolute abundance, but provides options for how biomass estimates from the survey could be used to directly inform management.

Species / stock	Inclusion in an integrated stock assessment		Use of biomass estimates from the survey to directly inform management (following an MSE)[4]	Ability to estimate abundance at age
	Relative abundance (Q estimated)[1]	Absolute abundance (Q=1)[2]		
Pacific Sardine	Yes	No	Yes	Yes, but there are concerns with aging
Pacific mackerel	Yes, summer surveys only	No	Yes, summer only	Yes, but there are concerns with aging
Jack mackerel	Yes, summer surveys only	No	Yes, summer only	In principle, but there is currently no ageing program
Northern sub-population of northern anchovy	Yes, summer surveys only, if inshore area is addressed[3]	No	Yes, summer surveys only, if inshore area is addressed	Yes – no current ageing program that is ready to be used
Central sub-population of northern anchovy	Yes, but only, if inshore areas is addressed[3]	No	Yes, but only, if inshore areas is addressed	Yes – no current ageing program that is ready to be used

1: option (a) in the TOR 8
2: option (b) in the TOR 8
3: Only available from 2015.
4. Only with MSE. Harvest control rules that use indices of biomass that are not considered absolute have been developed for other fisheries using Management Strategy Evaluation and generally involve examining changes in biomass indices.

10.7 References

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11 ESSENTIAL FISH HABITAT

Recognizing the importance of fish habitat to the productivity and sustainability of U.S. marine fisheries, in 1996 Congress added new habitat conservation provisions to the Magnuson Fishery Conservation and Management Act of 1976, the Federal law that governs U.S. marine fisheries management. The re-named Magnuson-Stevens Fishery Conservation and Management Act (MSA) mandated the identification of essential fish habitat (EFH) for managed species as well as measures to conserve and enhance the habitat necessary to fish to carry out their life cycles. The MSA requires cooperation among the NMFS, the Councils, fishing participants, Federal and state agencies, and others in achieving EFH protection, conservation, and enhancement. Congress defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). The EFH guidelines under 50 *CFR* 600.10 further interpret the EFH definition as follows:

> *"Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle."*

The Councils and NMFS are expected to periodically review the EFH components of FMPs. Each FMP should include a procedure to review and update EFH provisions if newly-available information warrants revision of EFH. The schedule for this review should be based on an assessment of the quality of both the existing data and expectations when new data will be available. Such a review of information should be conducted at least once every five years (50 *CFR* 600.815).

11.1 Process for periodic review of CPS EFH

EFH reviews conducted by the Pacific Council are typically divided into two phases. The first phase is focused on new information related to species biology, migration, prey, habitat needs, distribution, and human activities that may adversely affect EFH. If the Council concludes that revisions to the existing EFH provisions are not warranted, the review is concluded. However, should the Council determine that new information warrants changes to the current EFH provisions, the Council may embark on a second phase, during which specific changes to EFH provisions are developed for Council, Advisory Body, and public consideration.

Objectives

The overarching objectives for all EFH reviews are to ensure that the EFH provisions in the Council's FMPs are consistent with the best scientific information available, and to ensure a transparent and efficient science-based process for review of new information and consideration of any potential changes to EFH provisions.

The specific objectives of Phase 1 of the CPS EFH review are 1) to evaluate published and unpublished scientific literature and reports, information from interested parties, and previously unavailable or inaccessible data, and 2) to make a recommendation to the Council as to whether the body of new information warrants consideration of changes to EFH provisions. As part of Phase 1, the Council may issue a call for information to support the review. Phase 2 objectives would be identified only if the Council moves forward after considering the Phase 1 report.

Current Status

A new review was initiated in late 2020 and a literature review was completed in late winter 2021. At the April 2021 council meeting Council voted to proceed to Phase 2 following recommendations by the CPSMT. Information below will be updated following completion of Phase 2 of the ongoing CPS EFH review.

11.2 Description of Existing EFH

The CPS fishery includes four finfish species, market squid, and krill:

- Pacific sardine (*Sardinops sagax*)
- Pacific (chub) mackerel (*Scomber japonicus*)
- Northern anchovy (two stocks) (*Engraulis mordax*)
- Jack mackerel (*Trachurus symmetricus*)
- Market squid (*Doryteuthis opalescens*)
- Krill (*Euphasiid spp*.)

CPS finfish inhabit the water column, are not typically associated with bottom substrate, and generally occur above the thermocline in the upper mixed layer. For the purposes of EFH, the four CPS finfish species are treated as a single species complex, because of similarities in their life histories and similarities in the habitat requirements. Market squid inhabit the water column, but are also associated with bottom substrate during spawning events and egg development. Squid are treated in the same complex as CPS finfish because they are similarly fished above spawning aggregations (PFMC 1998).

Unless the Council and NMFS conclude that there are reasons to substantiate a change to the definition of CPS EFH at this time, the description of EFH will remain the same as that identified in Amendment 8 to the FMP (PFMC, 1998). A detailed description of existing EFH for CPS can be found in Appendix D of that document. In determining EFH for CPS, the estuarine and marine habitats necessary to provide sufficient production to support maximum sustainable yield and a healthy ecosystem were considered.

Using presence/absence data, EFH is "based on a thermal range bordered within the geographic area where a managed species occurs at any life stage, where the species has occurred historically during periods of similar environmental conditions, or where environmental conditions do not preclude colonization by the species" (PFMC 1998). The specific description and identification of EFH for CPS finfish accommodates the fact that the geographic range of all species varies widely over time in response to the temperature of the upper mixed layer of the ocean, particularly in the area north of 39° N latitude. For example, an increase in sea surface temperature since the

1970s has led to a northerly expansion of the Pacific sardine resource. With an environment favorable to Pacific sardine, this species can now be found in significant quantities from Mexico to Canada. Adult CPS finfish are generally not found at temperatures colder than 10° C or warmer than 26° C. Preferred temperatures (including minimum spawning temperatures) are generally above 13° C. Spawning is most common at 14° C to 16° C (PFMC 1998).

Essential fish habitat for west coast CPS species was established in December, 1998, with the issuance of Appendix D to Amendment 8 of the Northern Anchovy Fishery Management Plan. Appendix D contains the identification and description of CPS EFH; information on life history and habitat needs; fishing and non-fishing effects on CPS EFH; and potential conservation and enhancement measures. CPS EFH is linked to ocean temperatures, which shift temporally and spatially, providing a dynamic description of CPS EFH.

This description is as follows:

> *The east-west geographic boundary of EFH for each individual CPS finfish and market squid is defined to be all marine and estuarine waters from the shoreline along the coasts of California, Oregon, and Washington offshore to the limits of the exclusive economic zone (EEZ) and above the thermocline where sea surface temperatures range between 10^0C to 26^0C. The southern boundary of the geographic range of all CPS finfish is consistently south of the US-Mexico border, indicating a consistency in SSTs below 26^0C, the upper thermal tolerance of CPS finfish. Therefore, the southern extent of EFH for CPS finfish is the US-Mexico maritime boundary. The northern boundary of the range of CPS finfish is more dynamic and variable due to the seasonal cooling of the SST. The northern EFH boundary is, therefore, the position of the 10^0C isotherm which varies both seasonally and annually.*

Krill species were added to the CPS FMP in 2006, and EFH for krill was issued in 2008. The two most prevalent species of krill are *Euphausia pacifica* and *Thysanoessa spinifera,* although six other krill species are also included in the FMP. All are prohibited from harvest on the U.S. West Coast. The two species (*E. pacifica* and *T. spinifera*) form large aggregations of moderate density, while the other species are typically more dispersed. EFH is identified individually for *E. pacifica* and *T. spinifera*, and then collectively for the other krill species. The following descriptions are taken from Amendment 12 to the CPS FMP (PFMC 2006).

Euphausia pacifica EFH
Larvae, juveniles and adults: From the baseline from which the shoreline is measured seaward to the 1000 fm (1,829 m) isobath, from the U.S.-Mexico north to the U.S.-Canada border, from the surface to 400 m deep, from the U.S.- Mexico north to the U.S.-Canada border. Highest concentrations occur within the inner third of the EEZ, but can be advected into offshore waters in phytoplankton-rich upwelling jets that are known to occur seaward to the outer boundary of the EEZ and beyond.

Thysanoessa spinifera EFH
Larvae, juveniles and adults: From the baseline from which the shoreline is measured to the 500 fm (914 m) isobath, from the U.S.- Mexico north to the U.S.-Canada border, from the surface to 100 m

deep. Largest concentrations in waters less than 200 m deep, although individuals, especially larvae and juveniles, can be found far seaward of the shelf, probably advected there by upwelling jets.

Other krill species EFH
Larvae, juveniles and adults: From the baseline from which the shoreline is measured seaward to the 1000 fm (1,829 m) isobath, from the U.S.- Mexico north to the U.S.-Canada border, from the surface to 400 m deep, from the U.S.- Mexico north to the U.S.-Canada border. Amendment 12 concluded that no biological, social or economic impacts are expected beyond administrative costs of reviewing federally regulated projects for potential impacts on this habitat, where krill and krill predators concentrate.

11.3 New Information

Existing EFH descriptions for CPS are based largely on presence/absence data and upon a thermal range within the broader geographic area in which CPS stocks occur. The 1998 EFH identification and descriptions also base EFH on historical presence or "where environmental conditions do not preclude colonization by the CPS" (PFMC 1998). Although temperature associations among individual species and life stages within the CPS complex exhibit some variation, the temperature range that describes existing EFH is sufficiently representative of habitat associations. This temperature range is between 10°-26° C, although CPS can be found at temperatures outside that range. The CPSMT considered information contained in several recent publications relevant to CPS. The new information continues to support the strong linkage between CPS distribution and sea surface temperature, which varies spatially and temporally, and thus does not present any significant change in existing documented habitat associations. All the new information considered during this process is included in the References section below.

When krill EFH was established (under Amendment 12, finalized in 2008), the CPSMT did not invest significant effort in reviewing information on which EFH designations for krill are based. However, the periodic review offers an opportunity to synchronize the timing of krill with the other CPS stocks for future EFH reviews.

Amendment 8 cited several research needs related to market squid habitat and potential adverse effects to EFH. More specifically, these research needs centered on spawning distribution, depth, and location; as well as egg and paralarvae production and survival. Dispersal of larvae was also cited as key information that could help to understand how local impacts could be mitigated by recruitment from other areas. At the last review there remained a relatively meager volume of literature on market squid habitat. The current review, however, will add new literature to the identification and description of CPS EFH.

A comparison of new and newly-available literature since the last EFH review in 2010, and from when CPS EFH was originally established in 1998, shows that the California Current (CC) and CPS EFH continues to have significant annual and decadal variations in its oceanographic conditions; this includes upwelling, currents, primary and secondary productivity, and plankton and nekton species abundance and distributions. A recent review of oceanographic conditions can be found in the Ecosystem Considerations of this document.

Zwoliniski et al. (2011) found that they could identify the pelagic habitat of Pacific sardine using satellite-derived SST and Chlorophyll information. Their information clearly shows the movement of this preferred habitat from southern California in winter/early spring to off the

Pacific Northwest in summer. The pelagic habitat off northern Washington appears to have particularly high phytoplankton concentrations during summer (Hickey and Banas 2008; Hickey et al. 2009) and is probably why sardines track this particular habitat.

These colder temperatures appear to have had a negative effect on sardine recruitment (Chavez et al. 2005; Jacobson and MacCall 1995; Jacobson et al. 2001, 2005; Takasuka et al. 2008) and may have had a positive effect on squid (Vidal et al 2002; Zeidberg et al. 2006).

Climate change has the potential to alter CPS EFH significantly. However, there are still many unknowns regarding how climate change will affect the CCE. At this time it is still uncertain if the CC will actually get colder or warmer in the future. Increasing land temperatures could lead to larger air pressure differentials and cause more upwelling. However, these upwelled waters could be much less productive if ocean acidification affects primary and secondary production (Fabry et al. 2008; Juranek et al. 2009).

11.4 Habitat Areas of Particular Concern (HAPCs)

The implementing regulations for the EFH provisions of the MSA (50 CFR part 600) encourage the FMCs to identify specific types or areas of habitat within EFH as "habitat areas of particular concern" (HAPC), based on one or more of the following considerations: (1) the importance of the ecological function provided by the habitat; (2) the extent to which the habitat is sensitive to human-induced environmental degradation; (3) whether, and to what extent, development activities are, or will be, stressing the habitat type; and (4) the rarity of the habitat type. The intended goal of identifying such habitats as HAPCs is to provide additional focus for conservation efforts. While the HAPC designation does not add any specific regulatory process, it highlights certain habitat types as ecologically very important. This designation is manifested in EFH consultations where federally permitted projects with potential adverse impacts to HAPC are more carefully scrutinized during the consultation process.

HAPC were not considered in Appendix D of Amendment 8, for CPS. HAPCs for krill species were considered under Amendment 12 but were not adopted. CPS finfish and market squid are highly mobile, and generally associated with a range of thermal conditions rather than fixed physical habitat. In addition, CPS are somewhat unpredictable and not particularly dependent on any single habitat type or spatially discrete location. Their strong association with a dynamic habitat feature creates a challenge in proposing HAPCs, especially in open ocean waters where CPS stocks are found. This association, combined with the large range of habitats suitable for many CPS, makes it infeasible to provide appropriate justification for designating HAPCs at this time.

For the reasons described above, it was determined that the available information was insufficient to recommend designating HAPCs as part of this review.

11.5 Fishing Gear Effects

The MSA requires each FMP to identify fishing activities that may adversely affect EFH and to minimize adverse effects of those activities to the extent practicable. Fishing activities should include those regulated under the CPS FMP that affect EFH identified under any FMPs, as well as

those fishing activities regulated under other FMPs that affect EFH designated under the CPS FMP.

Appendix D to Amendment 8 of the CPS FMP describes CPS fishing activities and gear that have the potential to adversely affect EFH, and notes that direct interactions with habitat are unlikely because CPS fisheries typically occur in waters deeper than the height of the net. However, it is important to clarify that while CPS fishing gear does interact with the water (which is EFH), a fishing net passing through the water column is not expected to adversely affect the functioning of that habitat. Direct interactions between gear and CPS EFH may occur when derelict gear comes into contact with the benthos, which could potentially harm squid eggs embedded in the benthos. Even so, Appendix D concludes that habitat impacts resulting from net interactions are rare, minimal, and transitory.

Although some sector shifts and species harvest has changed since Appendix D was written, the gear type, harvest levels, and methods have remained essentially the same over time. In the 1990s, the industry was dominated by roundhaul and lampara gear, which still was true in 2020 (PFMC 2020).

The most recent review concluded that based on fishery information and statistics, compared over time, there was no substantial change in gear or activities. Therefore, the description, adverse impacts, and mitigation measures contained in Appendix D are still relevant and valid, and did not suggest that any new evaluation is warranted.

11.6 Emerging Threats

11.6.1 Climate Change

Fluctuating oceanographic conditions are known to have significant effects on the abundance of CPS in the Pacific Ocean and worldwide. Ocean temperatures, which are known to have direct effects on CPS recruitment, distribution, and abundance, have increased worldwide (Domingues et al. 2008). The California Current, the dominant large-scale oceanographic feature along the US west coast, is known to fluctuate significantly at annual and longer time scales. At short time scales the El Niño/Southern Oscillation (ENSO) (http://www.esrl.noaa.gov/psd/people/klaus.wolter/MEI/mei.html) is a short-term cooling or warming of the ocean at the equator caused by altering wind patterns. El Niño periods can produce considerable warming and reductions in primary and secondary production in the CC and reduce some CPS abundances. Many CPS and other fishes show significant alterations in their coastal distributions during strong El Niño or warm ocean periods (Phillips et al. 2007). For example, jellyfish blooms appear to be having significant effects on fisheries all over the world. Brodeur et al. (2008) indicated that that jellyfish may compete directly with CPS in the CC. The Integrated Ocean Observing System and its regional affiliates tracks many oceanographic (physical and biological) indices. The California Current Integrated Ecosystem Assessment team has been reporting annually since 2013 on oceanographic fluctuations and effects on marine resources, including some CPS. Climate change is expected to alter ENSO frequencies and duration but the levels are still impossible to predict.

Recent research has also shown that the entire North Pacific Ocean oscillates (Pacific Decadal Oscillation, or PDO) between warm and cold states at decadal scales, with significant effects on

living marine resources (both benthic and pelagic) (Mantua et al. 1997; Hare et al. 1999; Beamish et al. 2000; Hare and Mantua 2000; Hollowed et al. 2001; Kar et al. 2001; and Brinton and Townsend 2003). Sardines appear to become abundant during warm PDO periods and anchovy during cool PDO periods. However, the time series is short and the mechanisms involved are still uncertain.

The "source water" for the CC appears to fluctuate depending on the status of the PDO and ENSO (DFO. 2010). This has significant effects on CPS and other species in the CC When the southern split is strong, much nutrient rich North Pacific waters enter the CC and appear to enhance primary and secondary productivity (DFO 2010).

The most significant local feature along the west coast is wind induced upwelling (Bakun 1996). Upwelling is responsible for bringing nutrient rich waters from depth to the surface, thus enhancing primary production. Future climate change scenarios indicate much uncertainty as to whether winds and ocean conditions will be more conducive to upwelling or not, but Bakun (1990) thought that upwelling related winds would intensify because of higher pressure differentials between ocean and land. There is also concern that the phenology (i.e., timing of upwelling relative to the evolved life histories of various species) might be affected by alterations or changes in the seasonality and timing of upwelling periods along the west coast (Bograd et al. 2008).

One of the most significant impacts of climate change comes directly from the increased concentrations of carbon dioxide dissolving into the oceans and leading to decreased pH or ocean acidification. Lower ocean pH levels may have significant consequences on some calcifying organisms, many of which are prey for sardines and other CPS (Feely et al. 2004; 2008; Kerr 2010).

Recently, periods of hypoxia, or very low levels of oxygen, were observed on the continental shelf off Washington and Oregon and are expected to occur more often in the future (Grantham et al. 2004; Chan et al. 2008). Hypoxia could be related to changes in wind and currents directly tied to climate change.

Finally, harmful algal blooms (HABs) have been observed more frequently in recently years and are expected to be more common in the future. The effects of various HAB on CPS are unknown at this time, but related increases in domoic acid can be harmful to marine species, and were responsible for recent closures of west coast the Dungeness crab fishery.

11.6.2 Ocean Energy Development

Alternative energy development such as wave and wind energy have become increasingly prevalent in U.S. West Coast waters, as renewable energy sources are supported as means to combat climate change. Construction of a grid-connected wave energy pilot project off the central Oregon Coast began in 2021. The PacWave South project was developed in partnership with U.S. Department of Energy, the State of Oregon, and local stakeholders. Oregon State University was granted a lease from the Bureau of Ocean Energy Management (BOEM) in February 2021.

The first offshore wind (OSW) energy development project (Vineyard Wind, off the Massachusetts Coast) was awarded a lease from BOEM in 2021, the first commercial scale offshore wind energy project authorized in the U.S. Executive Order 14008 (Tackling the Climate Crisis at Home and Abroad) established ambitious goals for developing renewable energy, including continued development of OSW. Wind Energy Areas have been established off the California Coast, and planning for OSW is well underway off the Oregon coast as of late 2021.

11.7 Conclusions

After review of recently-published literature, discussion, and presentation at several Council-related meetings, and based on the opportunity provided for public comment, the CPSMT made the following conclusions as part of the most recent review:

- New information still supports the strong linkage between CPS habitat utilization and sea surface temperature, which along with other oceanographic conditions like upwelling and primary productivity, is both spatially and temporally variable. Therefore, although this information is likely to help inform EFH consultations, and provides additional background on CPS habitat, it does not warrant changes to the existing description of CPS EFH.
- The fishing impacts and non-fishing impacts sections of Appendix D to Amendment 8 sufficiently describe those adverse impacts as well as conservation measures to mitigate those impacts.
- New information on climate change and ocean energy development should be added to the body of information on potential impacts to CPS EFH. This should be published in the annual SAFE documents, to remain available for use in EFH consultations and for future EFH reviews.

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