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

STOCK ASSESSMENT AND FISHERY EVALUATION 2019

INCLUDING INFORMATION THROUGH JUNE 2019

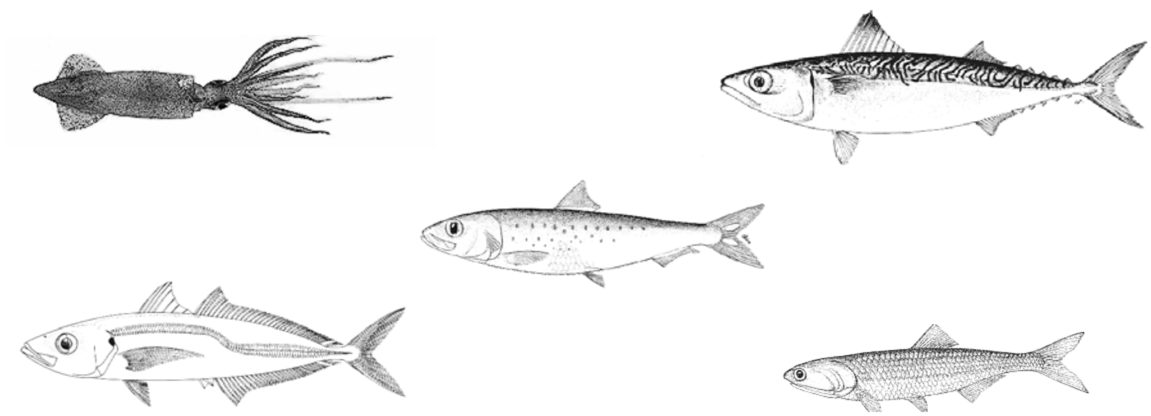

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TABLE OF CONTENTS

Page

Appendix A: 2019 SAFE Tables

Appendix B: 2019 Pacific Sardine Stock Assessment

Appendix C: 2019 Pacific Mackerel Stock Projection Estimate

LIST OF ACRONYMS AND ABBREVIATIONS

ABC	acceptable biological catch
ACL	annual catch limit
ACT	annual catch target
ADEPT	a population analysis model
APA	Administrative Procedures Act
ASAP	Age-structured Assessment Program
BO	Biological Opinion
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CANSAR-TAM	Catch-at-age Analysis for Sardine - Two Area Model
CC	California Current
CCLME	California Current Large Marine Ecosystem
CDFW	California Department of Fish and Wildlife
CESA	California Endangered Species Act
CFGC	California Fish and Game Commission
CONAPESCA	National Commission of Aquaculture and Fisheries (Mexico)
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
INP	Instituto Nacional de la Pesca (Mexico)
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
NOI	notice of intent
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
RIR	regulatory impact review
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)
TF	transformation frontier
USFWS	U.S. Fish and Wildlife Service
VPA	virtual population analysis
WCR	NMFS West Coast Region
WDFW	Washington Department of Fish and Wildlife

1.0 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 2018, although some sections include more recent information. 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 and Pacific mackerel are typically published in briefing book materials in April and June, respectively. In addition, they may be 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 managed fisheries (i.e., Pacific mackerel and Pacific sardine).

2.0 THE CPS FISHERY

2.1 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 9-1, 9-2); 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.

2.3 CPS Fisheries – History and Description

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. 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.).

Since 1999, a fishery for Pacific sardine has operated off Oregon and Washington. This fishery targets the larger sardines prevalent in the Pacific Northwest, which are typically sold as bait for Asian longline tuna fisheries. 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.

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 72 years, with an average age of 34 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 10.6 GT to 182.5 GT, with an average of 86.2 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 5,105.4 GT, well within the bounds of the capacity goal.

2.3.2 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 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 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 Nino 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).

2.3.3 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).

The live bait boats also fish for a variety of species other than anchovy, such as squid, sardine, mackerel, white croaker and queenfish. Anchovies, however, comprise approximately 85 percent of the live bait catch. 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 (May 2017 SAFE, Table 4-12). Other anchovy landings averaged about 1,973 mt per year from 1965 to 1991.

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 boats 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.

2.3.3 *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. 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 Oregon Limited Entry fleet does not have capacity restrictions.

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.

In 2013, the Pacific Fishery Management Council approved shifting the sardine fishery year from a January 1 – December 31 schedule to a July 1 – June 30 schedule, beginning on January 1, 2014. To transition from the calendar year schedule to the new schedule, a 2014 Interim Fishery was specified for January 1 – June 30, 2014. The 2014-2015 sardine fishery began on July 1, 2014.

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 thru June 2019.

2.3.4 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.

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.

2018

No anchovy were landed by CPS fisheries in Oregon in 2018 and incidental landings in other fisheries totaled 0.03 mt, all of which was landed by non-CPS midwater trawl fisheries.

2.3.5 Washington State Limited Entry Sardine Fishery

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 moratorium, no directed sardine purse seine landings were made into Washington during the 2018 - 2019 fishing year. Landings from other fisheries included 2.05 mt by the Pacific Whiting fishery.

2.3.6 Washington State Trial (Open Access) Pacific Mackerel Fishery

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 2018 - 2019 fishing year. However, one trial license – which are valid for a calendar year - was issued each year in 2018 and 2019.

2.3.7 Washington State Anchovy Fisheries

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 2.3.11 Washington State Live Bait Fishery

2.3.8 Market Squid Fishery

2.3.8.1 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 MLMA 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 2018, 73 vessel permits, 33 light boat permits, and 45 brail (netted scoop) permits were issued. Of the 73 vessel permits issued, 66 vessels made commercial landings in 2018. Fifty-two vessels made 95 percent of the landings (by tonnage) in 2018. Of the 45 brail permits issued, 12 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.

With recent El Niño warm waters, overall California landings decreased significantly beginning with the 2015-2016 fishing season (running April 1, 2015 – March 31, 2016). The warm blob beginning in 2014, coupled with early El Niño signals, also had an effect of pushing the squid fishery north, as reflected in the geographic distribution of 2014 landings. El Niño persisted through 2016 and as a result, squid landings were lower for the 2016-2017 season (running April 1, 2016 – March 31, 2017). Following the weak La Nina from 2017-2018, a weak El Nino occurred in 2018-2019. Landings for the 2018-2019 squid season were modest (34,235 mt), and the fishery stayed open till the end of the season on March 31, 2019. A weak El Nino event occurred during 2018-2019 and this led to lower squid landings in California.

2.3.8.2 Oregon Market Squid Fishery

In Oregon, market squid fishing dates back to the 1980s with most fishery activity associated with strong *El Nino* 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.

<u>2016</u>

The fishery off Oregon landed 1,260 mt of market squid in 83 vessel-days during May to June. Fifteen purse seine vessels operated near Cape Perpetua and landed to seven processors in Newport, Winchester Bay, and Charleston, Oregon. Ex-vessel revenue for this fishery exceeded $1.1 million.

In June 2016, permanent rules were adopted for purse seine fishing for market squid and other coastal pelagic species. These rules prohibit a reduction fishery, allow pumping of catch from another vessel's seine, require dipnetting of salmon and groundfish from the seine before pumping, and add mackerels to the list of prohibited species in the Cape Perpetua Seabird Protection Area. Also by temporary rule during June 3 to November 29, 2016, incidental allowances not to exceed 10 percent in the aggregate, were established for purse seiners fishing for market squid to take and land Pacific herring, Pacific sardine, anchovy, smelt, and mackerels from the Cape Perpetua Seabird Protection area and osmerid smelts (e.g., eulachon) in the ocean. Sale of these species were prohibited.

Based on fish receiving tickets, a variety of species were landed incidentally, and most were in trace amounts. Those species or species groups with landings of at least 0.05 mt are shown below:

Species	**Total Landed (mt)**
Pacific mackerel	3.92
Pacific sardine	0.48
Smelts	0.26
Jack mackerel	0.21
Dungeness crab	0.17
Flathead sole	0.05

Biological samples from the landings showed that mean size (mantle length) was 123 mm, ranging from 95-145 mm. Sex ratio was 55 percent males and 45 percent female. These size and sex compositions were similar to squid sampled during the only other significant squid fishery off Oregon, which occurred in the same area during 1983-85.

<u>2017</u>

No directed fishing nor commercial landings of market squid occurred in Oregon during 2017.

2018

The highest CPS fishery landings of market squid recorded in Oregon were in 2018 with 3,203 mt landed by 11 boats. The ex-vessel value was approximately $3.1 million. Incidental landings of market squid in non-CPS fisheries totaled 0.06 mt.

2.3.8.3 Washington Market Squid Fishery

Squid species in Washington have historically not been commercially targeted or incidentally landed by CPS fisheries. The abundance of market squid has not been sufficient to support a commercial directed fishery. However, in 2019, two purse seine squid licenses with endorsements (permits) to fish state waters as well as federal waters were issued. The interest in the license was primarily to provide the flexibility to deliver, into Washington, squid harvested off Oregon.

2.3.9 Treaty Tribe Fisheries

The CPS FMP recognizes the rights of treaty Indian tribes to harvest Pacific sardine and provides a framework for the development of a tribal allocation. An allocation or a regulation specific to the tribes is initiated by a written request from a Pacific Coast treaty Indian tribe to the NMFS West Coast Regional Administrator at least 120 days prior to the start of the fishing season.

The Makah Tribe sent a letter to NMFS expressing their intent to attain an allocation and to enter the Pacific sardine fishery in 2006. However, no formal request was subsequently submitted.

The Quinault Indian Nation (QIN) sent letters to the NMFS WCR Regional Administrator stating intent to harvest a part of the sardine resource, starting in 2011, to fish on the subsequent year's sardine harvest guideline:

Fishing year	QIN intent to harvest up to	Actual harvest
2012	9,000 mt	1,294 mt
2013	9,000 mt	586 mt
2014 (Jan 1 – June 30)	1,000 mt	0
2014-2015	4,000 mt	584 mt
2015-2016	1,000 mt	66 mt
2016-2017	800 mt	85 mt
2017-2018	800 mt	0
2018-2019	800 mt	0

Agreements were reached with NMFS to re-allocate unharvested sardines to the coast-wide fishery in 2012, 2013, in the six-month season January 1 – June 30, 2014, and also in the 2014 – 2015 fishing year.

The Quinault Indian Nation has also requested northern anchovies from the northern subpopulation beginning in 2016:

Fishing year	QIN intent to harvest up to	Actual harvest
2016	2,000 mt	112 mt
2017	2,000 mt	0
2018	2,000 mt	0

2.3.10 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).

2.3.10.1 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.

2.3.10.2 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 2009 to 2018, 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 7 percent anchovy to 93 percent sardine in 2018 (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.

2.3.10.3 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 are 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 can include juvenile barracuda (*Sphyraena argentea*), Osmerids, Atherinids, and market squid (Table 4-11). Estimates of ancillary catch data has 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 will no longer be used for catch records.

2.3.11 Oregon Live Bait Fishery

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 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 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.

In recent years, small amounts (<1 mt annually) of live bait have been landed in Oregon. There were no landings of live bait reported in 2018.

2.3.12 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 2018, the Washington non-treaty fishery for anchovy largely experienced a typical year in terms of total landings, effort and catch area. 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 30 licenses for lampara gear (used by albacore tuna fishers to catch bait for personal use in the albacore tuna fishery) similar to recent years. Actual landings were reported by three purse-seine gear vessels and 14 lampara gear license holders.

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 2018, directed fishing by purse seine vessels based at Westport was limited to Grays Harbor; abundance in the estuary precluded the need to fish offshore. Albacore tuna vessels reported fishing in Grays Harbor for personal-use bait.

At 123.2 mt, Washington total landings for 2018, including purse seine and lampara gears, were down approximately 25% compared to 2017 (163.3 mt). Purse seine landings spanned early-May through early-October, with the majority - 90%- landed in July, August and September. Total 2018 direct value of anchovy landed in the purse seine gear fishery was approximately $50,500, a decline of 17% from $60,500 in 2017.

2.3.13 References

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3.0 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.

In July 2019, NMFS notified the Council that the northern subpopulation of Pacific sardine had been declared overfished. The Council and NMFS will be required to develop a rebuilding plan by July 2021.

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.

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.

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.:

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

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.

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 has been closed 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. These new mantle and gonad data will be used to update the egg escapement model and provide estimates of proportional egg escapement and fishing mortality rates from 1999 to 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:

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4.0 Bycatch and Discard Mortality

Fishery management plans prepared by a fishery management council or by the Secretary must, among other things, establish a standardized reporting methodology 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 12007 - 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.

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 though 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 2013 and 2017. 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 2018 were Pacific herring, jacksmelt, Pacific sandab, bat ray, butterfish (Pacific pompano), California halibut, unspecified flatfish, Dungeness crab, salps, jellyfish, market squid egg cases, eelgrass, kelp, feather boa kelp, and surfgrass. A total of 378 incidental species were observed. Since the closure of the directed 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 2018, incidental catch consisted of 52 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 and jellyfish were also observed frequently. During the 2018-2019 season, market squid egg cases were identified in 5.8 percent of observed landings.

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. 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 target Pacific sardine. 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 of these two species are required to be reported in the SAFE document.

<u>2018-2019</u>

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).

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.

<u>2018-2019</u>

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).

4.4 Section References

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.

5.0 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, and other minor sources of mortality, the commercial fishery was essentially shut down again for the 2018 – 2019 season.

The U.S. Coast Guard reported in April 2018 on U.S. West Coast safety incidents from the previous year: https://www.pcouncil.org/wp-content/uploads/2018/03/I1a_USCG_Rpt1_Dist11and13_2017AnnualRpt_Apr2018BB.pdf. There was one fatality reported in the CPS fishery during 2017, and seven total among all West Coast commercial fisheries. This marked a decline from the 13 fatalities reported in 2016. The 10-year average is 6.2 fatalities per year. The CPS casualty is described in the following excerpt from the USCG report:

> On October 19th, the 54' squid purse seine vessel PAMELA ROSE was operating eight miles north of Point Piedras, CA, with five people on board, when her mast collapsed. The vessel had recently had structural modifications completed in Mexico. The mast fell on to the deck, fatally crushing one crewmember and seriously injuring another. The cause of the mast collapse was determined to be multiple structural weak points not addressed during the modification.

2016 boarding statistics in all West Coast commercial fisheries indicate approximately 29% of commercial fishing vessels boarded had some type of discrepancy involving safety gear carriage requirements or other federal safety regulations (up from 26% in 2016). The rate of vessels with fishing vessel safety discrepancies when boarded subsequent to search and rescue cases, per standard USCG protocol, was 31% (up from 25% in 2015). Approximately 4.6% of commercial fishing vessels boarded either 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. 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. The USCG very carefully considers all circumstances related to the potential termination of a vessel's voyage and issuance of a Captain of the Port Order. The final decision will only be made by the cognizant District Commander or a senior officer to whom the authority has been delegated. Following the termination of a vessel's voyage and issuance of a Captain of the Port Order, the vessel's operator must correct the discrepancies noted and receive permission from the USCG Captain of the Port prior to getting underway again.

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

Introduction

This section summarizes landings and revenues data for the five coastal pelagic species: Pacific sardine, Pacific mackerel, jack mackerel, northern anchovy, and market squid for the fisheries of the Pacific west coast, comprised of the states of California, Oregon, and Washington. This section is organized as follows. The next paragraph provides information regarding units, inflation adjustments, data sources, and confidentiality. The following paragraphs are organized to correspond with Figures 6.1 through 6.6 and Tables 6.1 through 6.5 below.

In the text and above-mentioned figures and tables, landings are reported in metric tons (mt) and revenues are reported in real 2018 US dollars (2018$US). Real dollar values, reported in the primary text, are adjusted to eliminate the effects of inflation relative to a base year, enabling comparison of quantities as if prices had not changed. This section reports real dollars in the 2018 base year. The source data for all calculations were obtained from PacFIN (https://pacfin.psmfc.org). Data on the 1981 through 2008 time period data was extracted Oct. 22, 2013; 2009 through 2018 data was extracted on October 10, 2019. The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act sets forth information confidentiality requirements that stipulated that the government cannot make public any data that can be linked to individual people or businesses. In this document, this is achieved through applying the "Rule of Three" at the vessel-id level; data that can only be attributed to two or fewer are aggregated to a higher level or are excluded. Application of confidentiality safeguards are denoted in the text and tables only, but follow through to figures; "Conf" denotes that the statistic is not reported due to 2 or fewer vessels; * denotes that the reported statistic is underreported due to confidentiality safeguards being imposed at a lower level of aggregation.

Overview and Species-level breakout

Total coastal pelagic species landings for California, Oregon, and Washington totaled 57,034 mt in 2018, a 20% decrease from the 2017 landings of 71,241 mt. Total coastal pelagic species exvessel revenues totaled $41,980,524 in 2018, a 42% decrease from the 2017 exvessel revenues of $72,051,440 (2018$US). Relative to the 2013-2017 five (5) year average of 104,564 mt in landings and $67,691,964 in revenues, 2018 landings and exvessel revenues (2018$US) decreased by 45% for landings and decreased by 38% for revenues.

Figure 6.1 presents total CPS west coast landings and revenues from 1981 to 2018. Table 1 reports annual west coast CPS landings, in mt, and exvessel revenues, in 2018 US$, by species. Figure 6.2 presents annual CPS landing by species from 1981 to 2018. Figure 6.3a presents annual CPS revenues from 1981 to 2018, while Figure 6.3b provides a more detailed view of CPS finfish revenues and excludes market squid revenues. Figure 6.4 presents the percentage contribution of west coast CPS finfish and market squid to total west coast exvessel revenues from 1981 to 2018.

Pacific sardine landings for California, Oregon, and Washington totaled 338 mt in 2018, a 22% decrease from the 2017 landings of 433 mt. The directed fishery for Pacific sardine remains closed, with the directed fishery having closed in 2016. Pacific sardine exvessel revenues totaled $80,603 in 2018, a 28% increase from the 2017 exvessel revenues of $63,208 (2018$US).

Relative to the 2013-2017 five (5) year average of 18,412 mt in landings and $5,388,109 in revenues, 2018 landings and exvessel revenues (2018$US) decreased by 98% for landings and decreased by 99% for revenues. As a percentage of CPS totals, Pacific sardine landings accounted for 1% of landings and 0% revenues in 2018; a change from the five year 2013-2017 average of 18% for landings and 8% for revenues. Relative to the pre-closure 2011-2015 period, the Pacific sardine fishery has decreased by over 99% in terms of landings and revenues; annual average landings for the 2011-2015 period was 47,881 mt with annual average revenues (2018$US) of $12.2 million.

Pacific mackerel landings for California, Oregon, and Washington totaled 2,591 mt in 2018, a 13% increase from the 2017 landings of 2,299 mt. Pacific mackerel exvessel revenues totaled $1,001,639 in 2018, a 48% increase from the 2017 exvessel revenues of $675,211 (2018$US). Relative to the 2013-2017 five (5) year average of 5,144 mt in landings and $1,217,487 in revenues, 2018 landings and exvessel revenues (2018$US) decreased by 50% for landings and decreased by 18% for revenues. As a percentage of CPS totals, Pacific mackerel landings accounted for 5% of landings and 2% revenues in 2018; these values are consistent with the five-year 2013-2017 average landing and revenue shares.

Jack mackerel landings for California, Oregon, and Washington totaled 205 mt in 2018, a 58% decrease from the 2017 landings of 484 mt. Jack mackerel exvessel revenues totaled $29,087 in 2018, a 50% decrease from the 2017 exvessel revenues of $58,578 (2018$US). Relative to the 2013-2017 five (5) year average of 1,066 mt in landings and $199,045 in revenues, 2018 landings and exvessel revenues (2018$US) decreased by 81% for landings and decreased by 85% for revenues. As a percentage of CPS totals, jack mackerel landings accounted for below 1% of landings and revenues in 2018; with no change in the share of revenues and a change from the five-year 2013-2017 average of 1% for landings.

Northern anchovy landings for California, Oregon, and Washington totaled 17,525 mt in 2018, a 212% increase from the 2017 landings of 5,613 mt. Northern anchovy ex-vessel revenues totaled $2,028,074 in 2018, a 131% increase from the 2017 ex-vessel revenues of $878,111 (2018 $US). Relative to the 2013-2017 five (5) year average of 10,729 mt in landings and $1,710,826 in revenues, 2018 landings and exvessel revenues (2018 $US) increased by 63% for landings and increased by 19% for revenues. As a percentage of CPS totals, northern anchovy landings accounted for 31% of landings and 5% revenues in 2018; a change from the five year 2013-2017 average of 10% for landings and 3% for revenues.

Market squid landings for California, Oregon, and Washington totaled 36,375 mt in 2018, a 42% decrease from the 2017 landings of 62,412 mt. Market squid ex-vessel revenues totaled $38,841,122 in 2018, a 45% decrease from the 2017 ex-vessel revenues of $70,376,336 (2018 $US). Relative to the 2013-2017 five (5) year average of 69,213 mt in landings and $59,176,497 in revenues, 2018 landings and ex-vessel revenues (2018 $US) decreased by 47% for landings and decreased by 34% for revenues. As a percentage of CPS totals, market squid landings accounted for 64% of landings and 93% revenues in 2018; a change from the five year 2013-2017 average of 66% for landings and 87% for revenues.

Regional-level breakout

Table 2 reports annual west coast CPS landings in metric tons (mt) and exvessel revenues in 2018 US dollars by species and regional fishery sector for southern California, northern California, and Pacific Northwest fisheries. Fisheries are defined by port-id codes as follows: southern California includes port codes from San Diego in the south to Morro Bay in the north, northern California includes port codes from Monterey in the south to Crescent City in the north, and Pacific Northwest includes port codes from Oregon and Washington. Reports in previous years categorized unidentified port codes into an “other” sector. A major effort has been made to identify the location of previously unidentified records by utilizing both port codes and processor codes. Thus, the other sector has been eliminated from Table 2. In total the fishery had CPS landings of 57,034 mt and revenues of $41,980,524 (2018$US) in 2018. 2017 landings and revenues were 71,241 mt and $72,051,440, respectively.

The west coast fishery can be described by multiple sectors: southern California, northern California, and the Pacific Northwest.

The southern California sector had CPS landings of 22,230 mt and revenues of $22,113,835 (2018$US) in 2018. 2017 landings and revenues were 56,706 mt and $61,570,509, respectively. This accounted for a 39% share in west coast landings, and a 53% share of west coast revenues; this marked a change from 2017 landings shares of 80% and a from 2017 revenue shares of 85%.

By species, the southern California sector accounted for 77% of Pacific sardine, 97% of Pacific mackerel, 31% of jack mackerel, 0% of northern anchovy, and 53% of market squid west coast landings in 2018. For revenues, the southern California sector accounted for 88% of Pacific sardine, 998,730 of Pacific mackerel, 89% of jack mackerel, 0% of northern anchovy, and 54% of market squid revenues in 2018.

The northern California sector had CPS landings of 31,255 mt and revenues of $16,734,379 (2018$US) in 2018. 2017 landings and revenues were 13,967 mt and $10,391,048, respectively. This accounted for a 55% share in west coast landings, and a 40% share of west coast revenues; this marked a change from 2017 landings shares of 20% and a from 2017 revenue shares of 14%.

By species, the northern California sector accounted for 20% of Pacific sardine, 0% of Pacific mackerel, 0% of jack mackerel, 99% of northern anchovy, and 38% of market squid west coast landings in 2018. For revenues, the northern California sector accounted for 8% of Pacific sardine, 643 of Pacific mackerel, 1% of jack mackerel, 97% of northern anchovy, and 38% of market squid revenues in 2018.

The Pacific Northwest sector had CPS landings of 3,549 mt and revenues of $3,132,312 (2018$US) in 2018. 2017 landings and revenues were 569 mt and $89,886, respectively. This accounted for a 6% share in west coast landings, and a 7% share of west coast revenues; this marked a change from 2017 landings shares of 1% and from 2017 revenue shares of 0%.

By species, the Pacific Northwest sector accounted for 3% of Pacific sardine, 3% of Pacific mackerel, 69% of jack mackerel, 1% of northern anchovy, and 9% of market squid west coast landings in 2018. For revenues, the Pacific Northwest sector accounted for 4% of Pacific sardine, 2,266 of Pacific mackerel, 10% of jack mackerel, 2% of northern anchovy, and 8% of market squid revenues in 2018.

Exvessel Prices

Table 3 reports the average annual real exvesssel prices in 2018 US$ for Pacific Sardine, Pacific mackerel, jack mackerel, northern anchovy, and market squid from 2009 to 2018. Figures 6.5 and 6.6 present landings and exvessel prices between 1981 and 2018 for west coast CPS finfish and market squid, respectively.

The landings price for Pacific sardine was $0.11 (2018$US) per pound in 2018. This marked a 57% increase from the 2017 price of $0.07, and an 8% decrease from the 2013-2017 five-year arithmetic average of $0.12.

The landings price for Pacific mackerel was $0.18 (2018$US) per pound in 2018. This marked a 38% increase from the 2017 price of $0.13, and a 58% decrease from the 2013-2017 five-year arithmetic average of $0.11.

The landings price for jack mackerel was $0.06 (2018$US) per pound in 2018. This marked a 20% increase from the 2017 price of $0.05, and a 23% decrease from the 2013-2017 five-year arithmetic average of $0.08.

The landings price for northern anchovy was $0.05 (2018$US) per pound in 2018. This marked a 29% decrease from the 2017 price of $0.07, and a 34% decrease from the 2013-2017 five-year arithmetic average of $0.08.

The landings price for market squid was $0.48 (2018$US) per pound in 2018. This marked a 6% decrease from the 2017 price of $0.51, and a 19% increase from the 2013-2017 five-year arithmetic average of $0.40.

State-level breakout

Table 4 reports annual west coast CPS landings in metric tons (mt) and exvessel revenues in 2018 US dollars by species and state for California, Oregon, and Washington for the years 2009 through 2018.

The state of California CPS landings totaled 53,485 mt generating $38,848,212 (2018$US) of revenues in 2018. For California landings, this was a 24% decrease from 70,673 mt in 2017, and a 39% decrease from 87,272 mt during the five-year period from 2013 to 2017. For California revenues, this was a 46% decrease from $71,961,560 in 2017, and a 38% decrease from $62,403,247 (2018$US) during the five year period from 2013 to 2017.

The state of Oregon CPS landings totaled 3,372 mt generating $3,079,510 (2018$US) of revenues in 2018. For Oregon landings, this was a 864% increase from 350 mt in 2017, and a 63% decrease from 9,191 mt during the five year period from 2013 to 2017. For Oregon revenues, this was a 35524% increase from $8,645 in 2017, and a 6% decrease from $2,894,232 (2018$US) during the five-year period from 2013 to 2017.

The state of Washington CPS landings totaled 177 mt generating $52,802 (2018$US) of revenues in 2018. For Washington landings, this was a 20% decrease from 219 mt in 2017, and a 98% decrease from 8,100 mt during the five-year period from 2013 to 2017. For Washington revenues, this was a 35% decrease from $81,241 in 2017, and a 98% decrease from $2,393,686 (2018$US) during the five year period from 2013 to 2017.

Gear-level breakout

Table 5 reports annual west coast CPS landings in metric tons (mt) and exvessel revenues in 2018 US dollars by gear type for the years 2009 through 2018.

West coast CPS landings using roundhaul (lampara) gear totaled 56,039 mt, bringing in $41,191,588 in revenues (2018$US). This represents 98.3% and 98.1% of west coast CPS landings and revenues, respectively; roundhaul (lampara) gear ranks number 1 in terms of landings and number 1 in terms of revenues.

West coast CPS landings using dipnet gear totaled 698 mt, bringing in $717,733 in revenues (2018$US). This represents 1.2% and 1.7% of west coast CPS landings and revenues, respectively; dipnet gear ranks number 2 in terms of landings and number 2 in terms of revenues.

West coast CPS landings using trawl gear totaled 224 mt, bringing in $8,037 in revenues (2018$US). This represents 0.4% and 0.0% of west coast CPS landings and revenues, respectively; trawl gear ranks number 3 in terms of landings and number 4 in terms of revenues.

West coast CPS landings using gillnet gear totaled 1 mt, bringing in $1,560 in revenues (2018$US). This represents less than 1% of west coast CPS landings and revenues, respectively; gillnet gear ranks number 5 in terms of landings and number 5 in terms of revenues.

West coast CPS landings using hook and line gear totaled less than 1 mt, bringing in $1,473 in revenues (2018$US). This represents less than 1%of west coast CPS landings and revenues, respectively; hook and line gear ranks number 6 in terms of landings and number 6 in terms of revenues.

West coast CPS landings using pot or trap gear totaled less than 1 mt, bringing in $1,430 in revenues (2018$US). This represents less than 1%of west coast CPS landings and revenues, respectively; pot or trap gear ranks number 7 in terms of landings and number 7 in terms of revenues.

West coast CPS landings using other gear totaled 73 mt, bringing in $58,704 in revenues (2018$US). This represents 0.1% and 0.1% of west coast CPS landings and revenues, respectively; other gear ranks number 4 in terms of landings and number 3 in terms of revenues.

Figures

Figure 6.1. Annual West Coast Landings and Exvessel Revenues (2018 $) for all CPS Species, 1981-2018

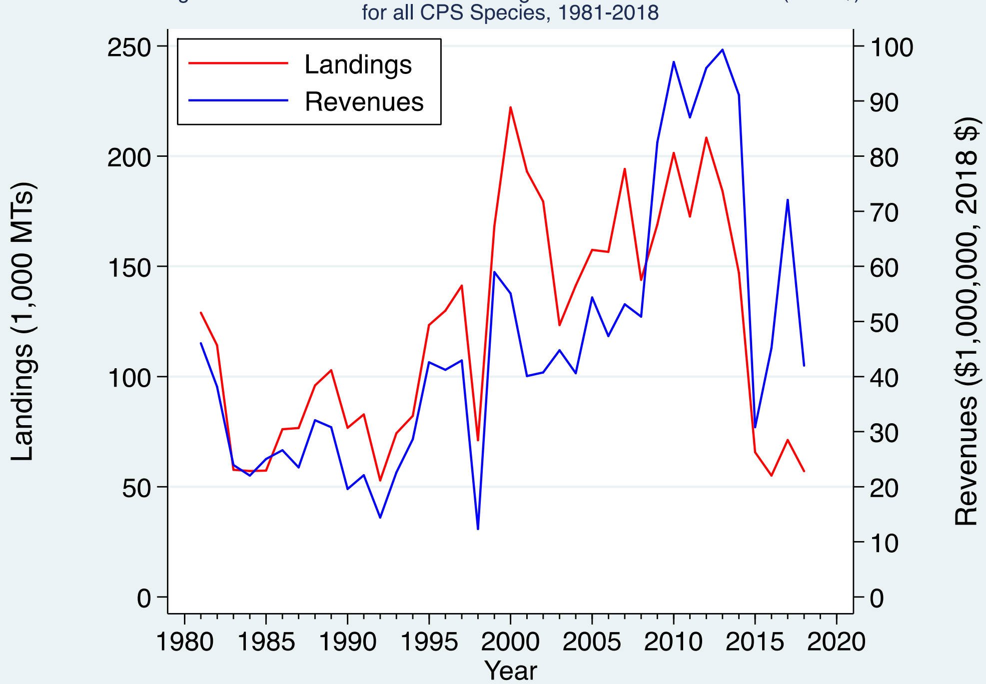
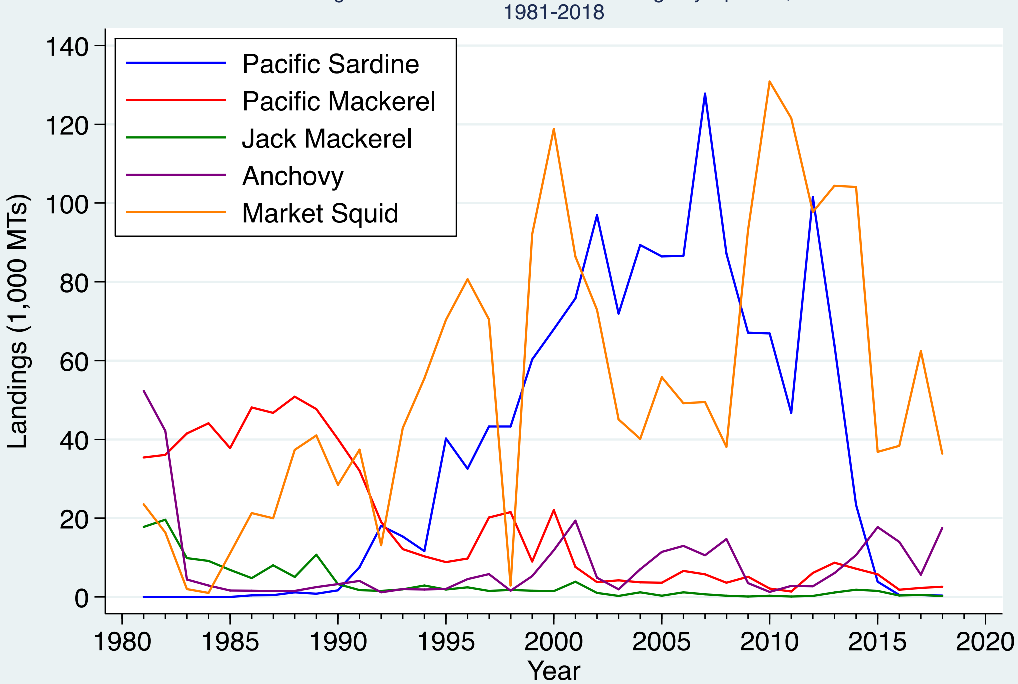


Figure 6.2. West Coast CPS Landings by Species, 1981-2018



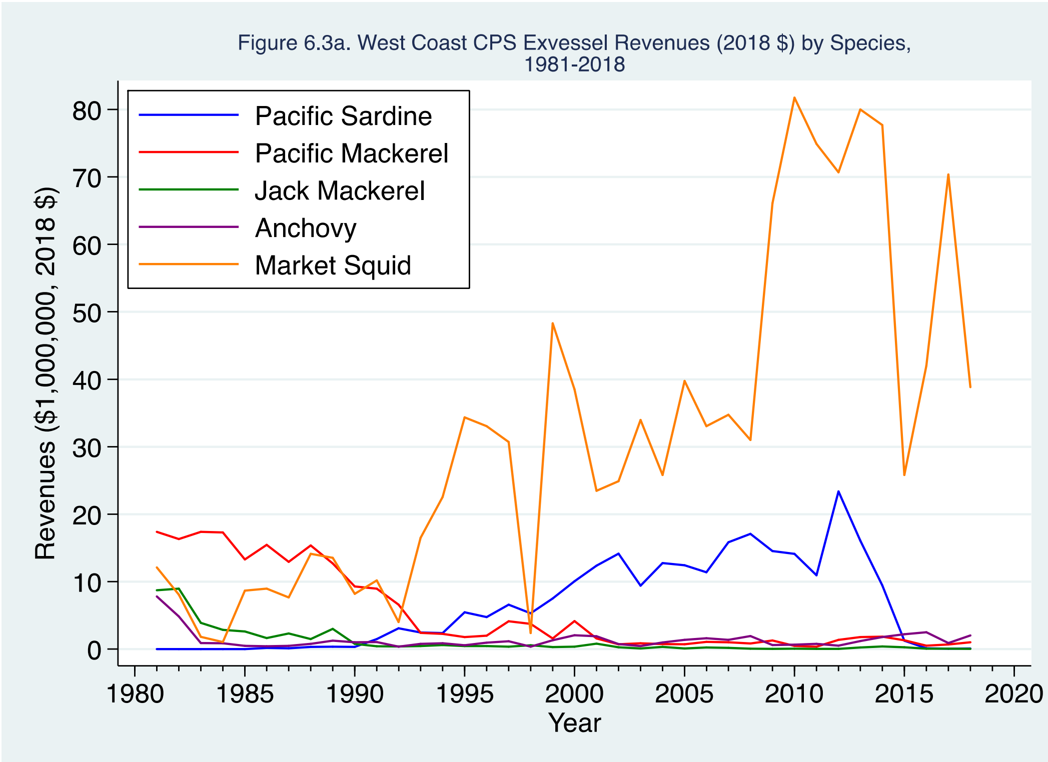


Figure 6.3a. West Coast CPS Exvessel Revenues (2018 $) by Species,
1981-2018
Revenues ($1,000,000, 2018 $)
80
70
60
50
40
30
20
10
0
Pacific Sardine
Pacific Mackerel
Jack Mackerel
Anchovy
Market Squid
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

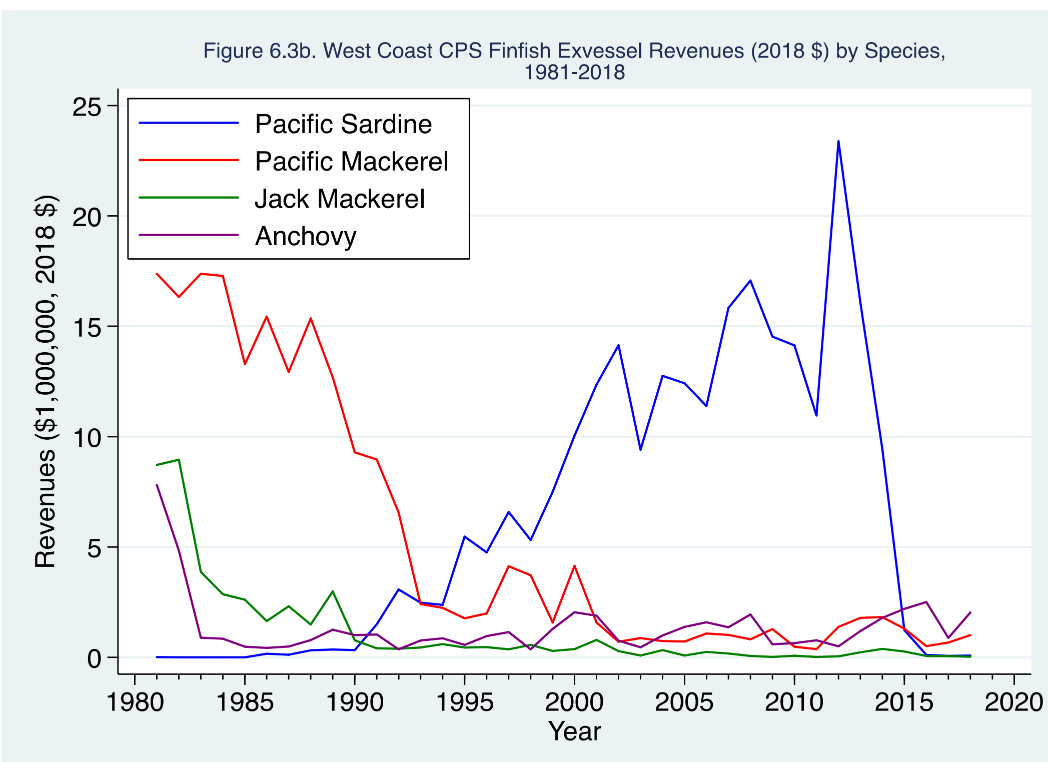


Figure 6.3b. West Coast CPS Finfish Exvessel Revenues (2018 $) by Species,
1981-2018
Revenues ($1,000,000, 2018 $)
25
20
15
10
5
0
Pacific Sardine
Pacific Mackerel
Jack Mackerel
Anchovy
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

Figure 6.4. Percentage Contribution of West Coast CPS Finfish and Market Squid to Total West Coast Exvessel Revenues, 1981-2018

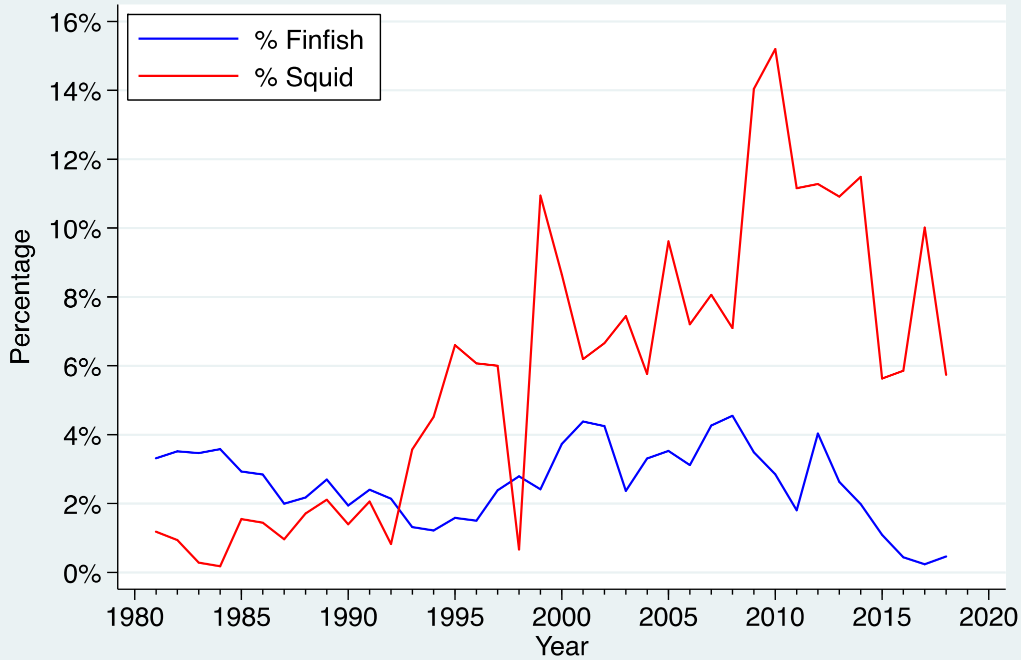


Figure 6.5. West Coast CPS Finfish Landings and Average Exvessel Price (2018 $), 1981-2018

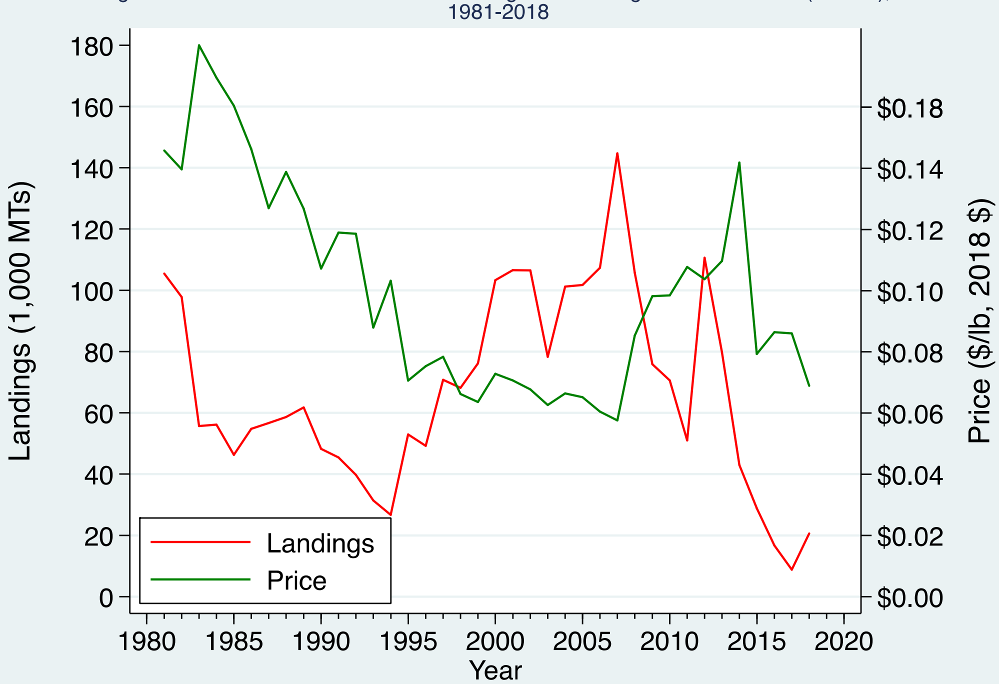
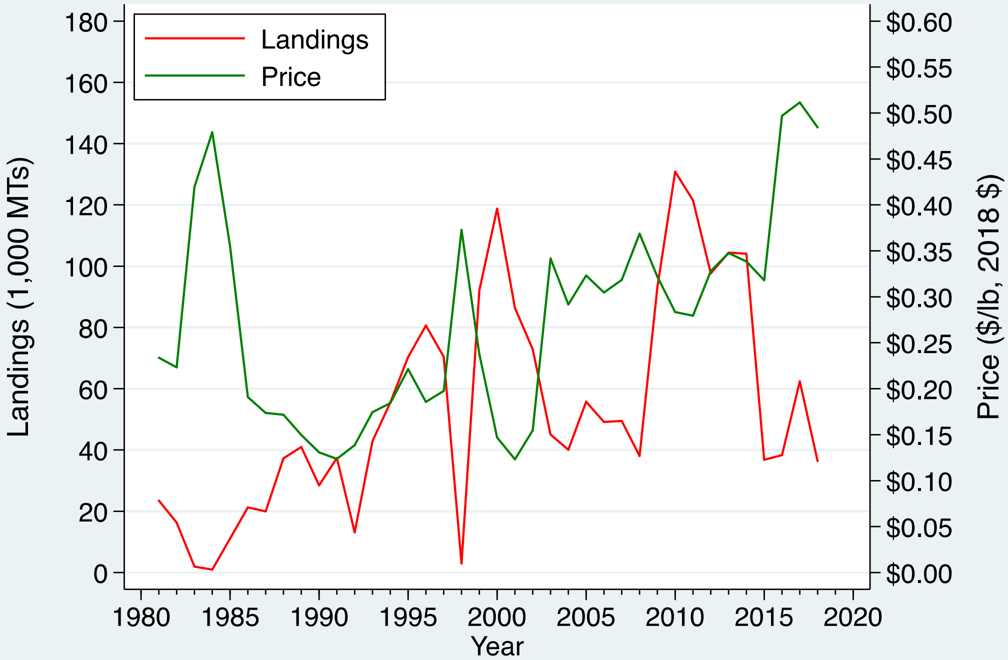


Figure 6.6. West Coast CPS Market Squid Landings and Average Exvessel Price (2018 $), 1981-2018



7.0 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 provided 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 improve our knowledge base and improved CPS management decisions.

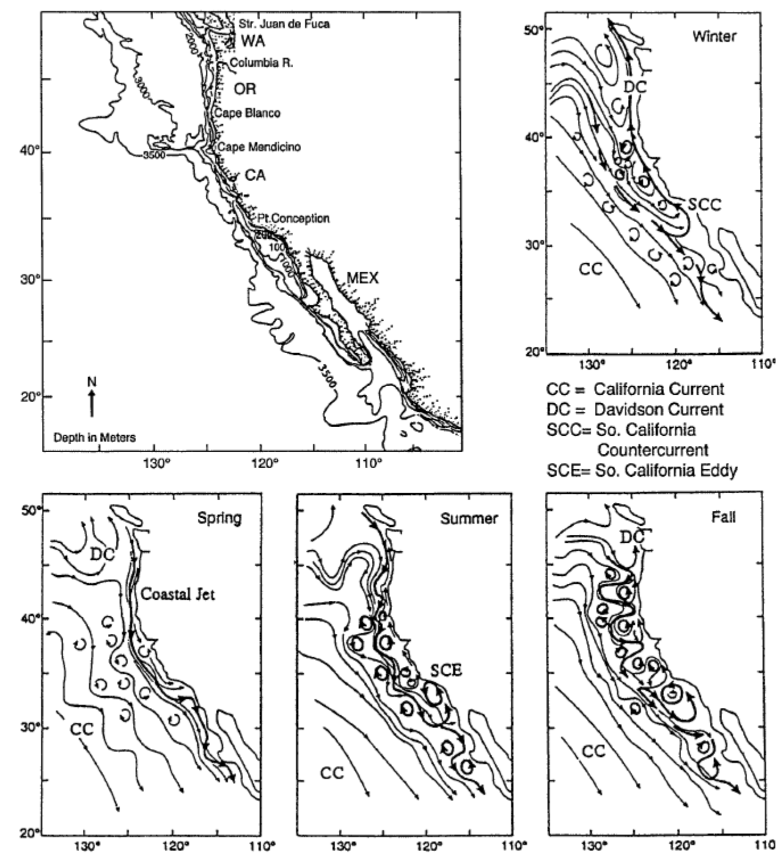


Figure 1. Seasonal variation of large-scale currents along the West Coast with bathymetry illustrating the dynamic conditions in the CCLME. The CC flows southward year round offshore from the shelf break to several hundred kilometers. Along the shelf break, several other currents are found, including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

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).

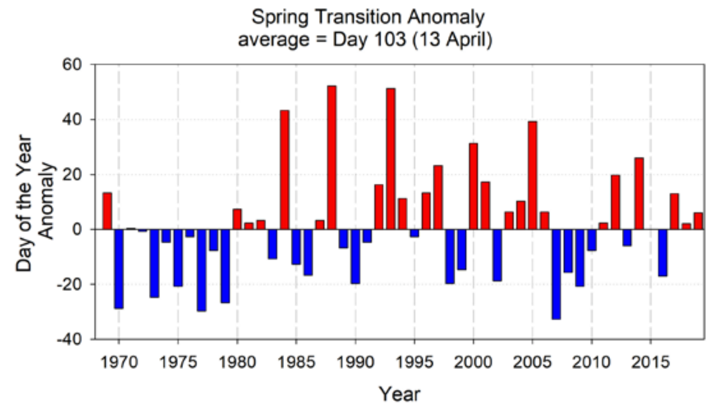


Figure 2. Anomaly of the date of the spring transition off Oregon. Peterson Zooplankton Lab, NOAA, NMFS, NWFSC.

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).

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 phase changes of the Pacific Decadal Oscillation (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.

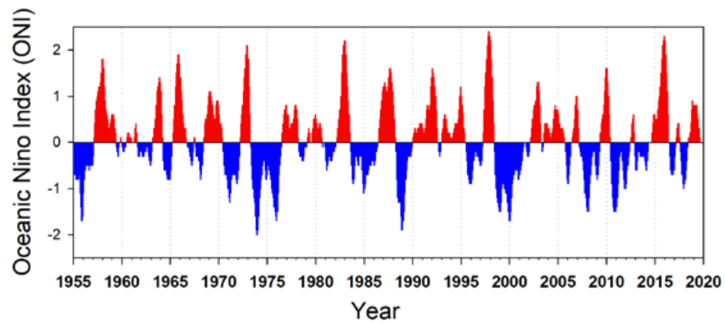


Figure 3. Oceanic Niño Index anomalies. Red indicates warm or El Niño conditions and blue cool La Niña conditions.

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

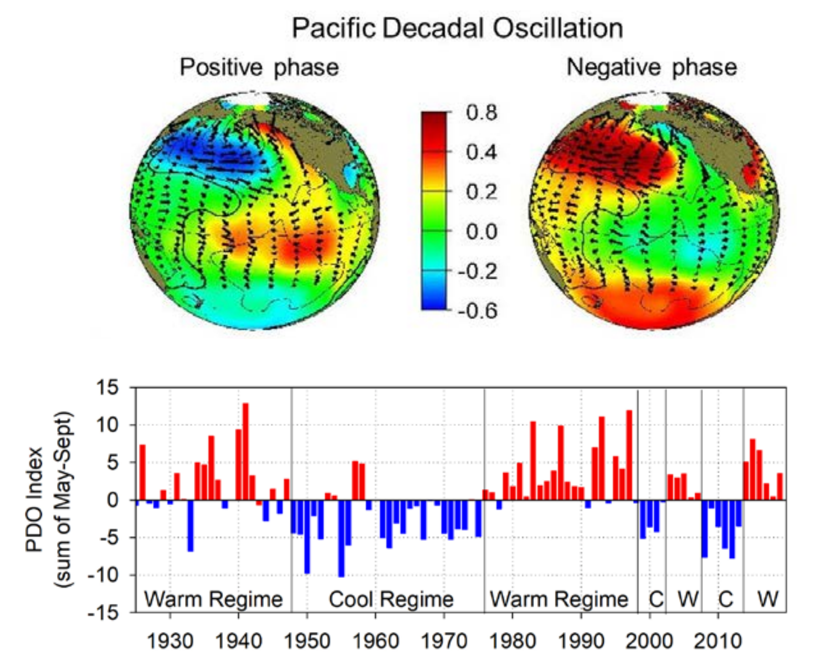


Figure 4. Time series of shifts in sign of the Pacific Decadal Oscillation (PDO) 1925 to 2019. Values are averaged over the months of May through September. Red bars indicate positive (warm) years; blue bars negative (cool) years. The PDO has been in a warm phase since 2014. http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/ca-pdo.cfm

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 are reduced under positive PDO (Figure 5) (Takasura et al. 2008). Recent 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)

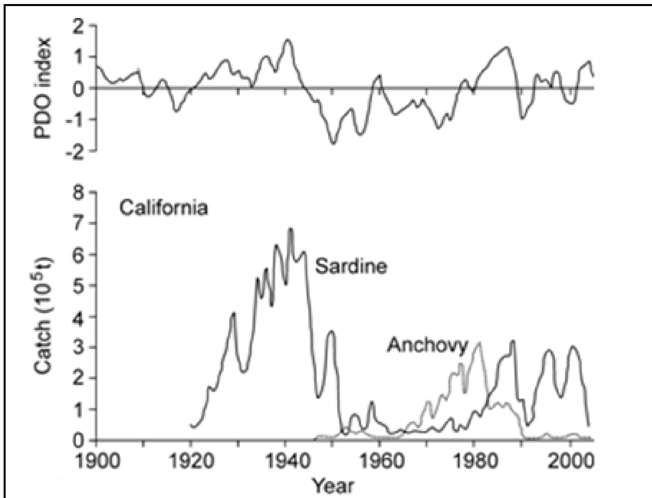


Figure 5. The relationships between Pacific sardine and Northern anchovy landings in California and the PDO. FromTakasura et al. 2008.

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.

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 2018 the timing of the onset of upwelling was close to the long term average (13 April, 2015), or the Spring Transition, in 2019 the onset of upwelling was only slightly later (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, signaling La Niña conditions in 2016; recently the ONI has been close to neutral (Figure 3).

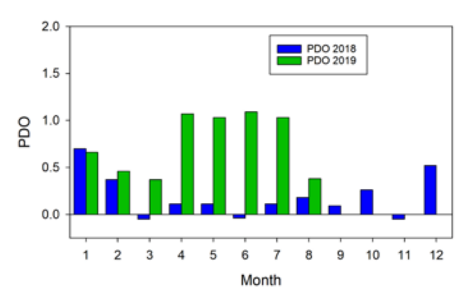


Figure 6. Monthly Pacific Decadal Oscillation index values in 2018-19. http://jisao.washington.edu/pdo/

7.3.2 Pacific Decadal Oscillation

The PDO was neutral in spring of 2018 through September 2018 but positive for much of 2019 (Figure 6). A positive PDO is 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).

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 2019 flows were just below a 20 year average (Figure 7).

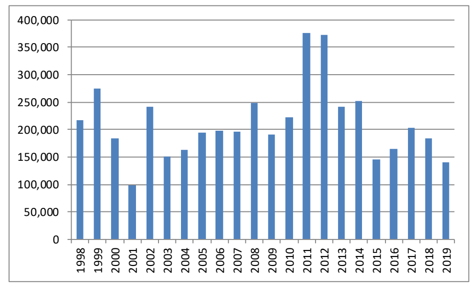


Figure 7. Average Columbia River flows (cubic feet/second) in July.

7.4 Trends in Ecosystem Indicators

7.4.1 Sea Surface Temperatures

Sea surface temperatures appear to affect the abundance/productivity of sardine, anchovy and other CPS (Chavez et al. 2003; Jacobson et al. 2001, 2005). In 2019, SST in the NE Pacific was cooler than normal and cool waters persisted in the CCLME (Figure 8, blues) until warmer waters that developed in northern NE Pacific reached the CCLME in mid-summer (Figure 8, orange-red).

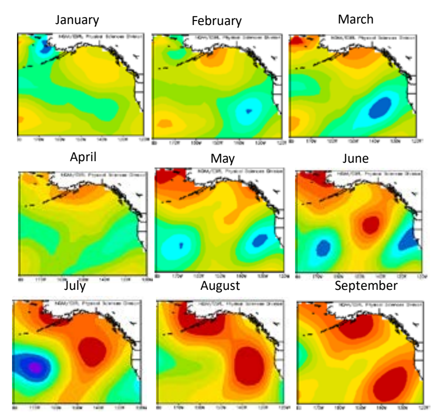


Figure 8. Monthly sea surface temperature anomalies in 2019. NOAA OISST V2 data provided by the NOAA/OAR/ESRL PSD, Boulder, CO, USA, http://www.esrl.noaa.gov/psd/.

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 again in 2019 equatorward transport finally delivered northern copepod species to the Oregon shelf (Figure 9).

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. The following results and summary provided by the SWFSC include a time series of anomalies of some of the key species or groups of interest in this region since 1990 (core area) or 2004 (expanded survey area). The data for the 2019 survey are preliminary.

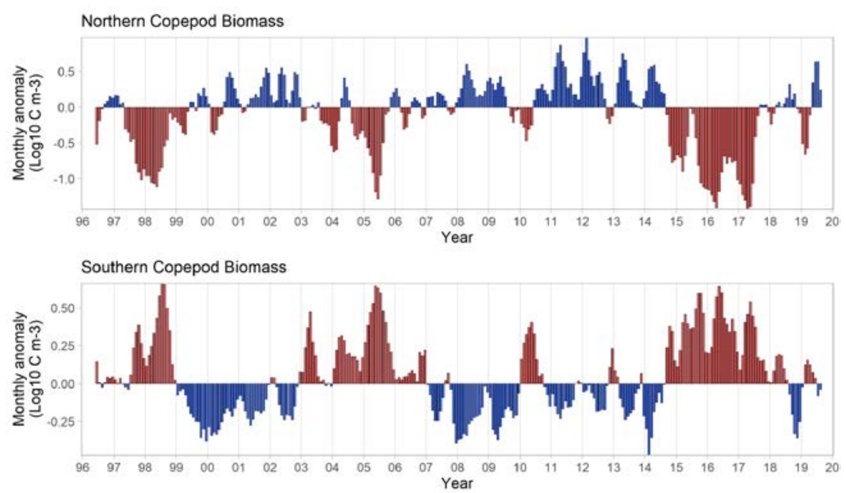


Figure 9. Three-month running mean of anomalies of biomass of northern and southern copepod taxa recorded off Newport, OR at NH05: Peterson Zooplankton Lab, NOAA, NMFS, Newport, OR.

The mean of the log transformed catches are shown by year for key forage groups (Figure 10), i.e. market squid (*Doryteuthis opalescens*), krill (primarily *Euphausia pacifica* and *Thysanoessa spinifera*), Pacific sardine and northern anchovy. The survey area is broken into five large regions (Sakuma et al. 2016), south (Point Conception south to the U.S./Mexico Border), south central (Point Sur to Point Conception), core (immediately north of Point Reyes through Monterey Bay), north central (Cape Mendocino to Fort Ross), and north (the Oregon border to Cape Mendocino). As the north region has only a limited amount of data (sampling began in 2013 and inclement weather reduced sampling effort in 2016), this region is excluded from this analysis. No sampling was conducted in the south region in 2011 and none in the north central region in 2012 due to weather and vessel constraints.

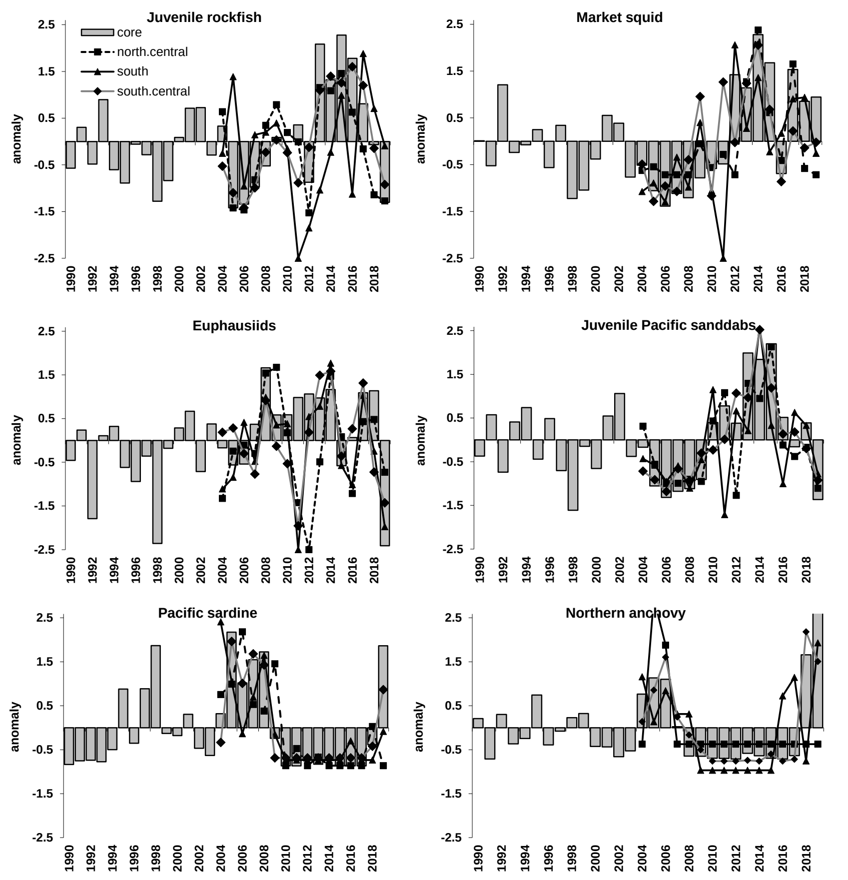


Figure 10. Standardized anomalies (of average (ln(catch+1)) catches) for key forage taxa sampled by the Rockfish Recruitment and Ecosystem Assessment Survey: from rockfish recruitment survey in the core (Central California) region (1990-2019) and the southern, south-central and north-central survey areas (2004-2019). John Field, NOAA, NMFS, SWFSC.

Catches of epipelagic micronekton from the SWFSC Rockfish Recruitment and Ecosystem Assessment Survey (RREAS) in late spring of 2019 indicated increasing catches of coastal pelagic species and declines in most YOY groundfishes. In particular, the high abundance of adult Northern Anchovy (*Engraulis mordax*) in the core and south central regions observed in recent years continued in 2019 (Figure 10). In fact, the relative abundance of adult anchovy in the core region was higher in 2019 than any previous year in the survey for the core region (extending back to 1983; see Sakuma et al. 2016). Adult Pacific Sardine (*Sardinops sagax*) were more abundant than in the last ten years but still at low abundance relative to the late 1990s and early 2000s.

However, relative to previous years, YOY northern anchovy and YOY Pacific sardine (not shown) were at low levels throughout the survey area, with the exception of northern anchovy in the Southern California Bight, which continued to be encountered at high levels.

There were substantial declines in krill, particularly in the core (central California) region where abundance was comparable to 1998 (the lowest value in the 1990-2019 time series), which extended throughout most California waters. However, Market Squid were at fairly high abundance levels in the core region, and closer to average or just below average levels for other regions. Pelagic Red Crab (*Pleuroncodes planipes*, not shown) also continued to be encountered in the southern California Bight, albeit with a slow decline since the 2015 peak. Declines were observed in catch rates of YOY groundfishes (particularly rockfishes, *Sebastes spp.*, and sanddabs, *Citharichthys spp.*), with strongly negative anomalies following near-average levels in 2018 and very high abundances from 2013-2017 (Figure 10). Abundance of YOY rockfishes was greatest again in the Southern California Bight, where catches were close to the long-term average. YOY Pacific Hake (*Merluccius productus*, not shown) were at low abundance in central California, although this species was fairly abundant in the Southern California Bight.

7.5 Section References

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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
Source:https://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/ea-copepod-biodiversity.cfm

Coastal Pelagic Fishes and Invertebrates:
Ecosystem indicators for the Central California Coast
Source: John Field, Fisheries Ecology Division, SWFSC

8.0 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 critical interest. See Table 8-4 for Pacific sardine harvest statistics from commercial fisheries operating in the U.S., Mexico, and Canada (2009-2018).

8.1 Actively Managed Species

8.1.1 Pacific sardine

Hill *et al.* (2019) 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 73,451 mt in calendar year 2018, down from 130,896 mt in 2017 (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 2018-19 management year. During 2018-19, incidental and live bait sardine landings in California totaled 1,114 mt, Oregon landed 11 mt, and Washington landed two mt (Table 8-3). U.S. landings totaled 1,126 mt during the 2018-19 fishing year.

The U.S. sardine fishery is regulated using a quota-based management approach (see Section 8.1.1.1). From 2000 to 2007, landings were typically lower than the recommended harvest limits (Table 8-3). Due to a series of lower quotas, the U.S. fishery was subjected to in-season closures during 2008 to 2011, 2013, 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, the ACT was lowered again to 4,000 mt.

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 130,463 mt of sardine in calendar year 2017 (Table 8-4) but catch dropped to 73,114 mt in 2018. 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 2018 were likely from the southern subpopulation (Hill et al. 2019). 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 moratorium (Table 8-4).

The 2019 stock assessment update (Hill *et al.* 2019) provided a stock biomass (age 1+) estimate of 27,547 mt on July 2019 (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 has been declared ‘overfished’.8.1.1.1 Pacific Sardine Harvest Control Rules for 2018-2019

In March 2014 the PFMC adopted the use of CalCOFI SST data for specifying environmentally-dependent E_{MSY} each year, beginning July 2014. The OFL and ABC for 2019-20 were based on an E_{MSY} for the three-year running average of CalCOFI SST for 2016-18 (16.1123 °C; E_{MSY}=0.243). Harvest control rule formulas for the 2019-20 management year were calculated as follows:

$$\text{OFL} = \text{BIOMASS} * E_{\mathrm{MSY}} * \text{DISTRIBUTION},$$

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

$$\text{HG} = (\text{BIOMASS} - \text{CUTOFF}) * E_{\mathrm{MSY}} * \text{DISTRIBUTION},$$

Where: BIOMASS = 27,547 mt; E_{MSY} = 0.243 for OFL and ABC, and E_{MSY} = 0.20 for HG; DISTRIBUTION = 0.87; $\text{BUFFER}_{\text{P-star 0.4 (Tier 2)}}$ = 0.7762; and CUTOFF = 150,000 mt.

In April 2019, the Council adopted the most recent sardine stock assessment (Hill et al. 2019) to set harvest specifications for the 2019-20 management year beginning July 1, 2019. Stock biomass from that assessment (27,547 mt, Hill *et al.* 2019) was used to calculate all harvest control rules above. Because the biomass estimates in 2015, 2016, 2017, 2018, and 2019 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 2019-20, the Council adopted an OFL of 5,816 mt, an ABC/ACL of 4,514 mt, and an ACT of 4,000 mt. 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 accountability measures regarding catch:

• A 20 percent incidental catch allowance applies to the primary directed commercial fishery.

• Directed take of sardines in the live bait fishery will be allowed. However, if Amendment 17 to the CPS Fishery Management Plan is not approved before the July 1, 2019 start date, the live bait fishery will be limited to 15 percent incidental take of sardines, until Amendment 17 is approved.

• A per-trip limit of 1 mt of sardines in the live bait fishery will apply if the live bait fishery attains 2,500 mt.

• A per-trip limit of 1 mt of incidentally-caught sardines would apply to both the live bait and primary directed CPS fisheries, if the annual catch target of 4,000 mt is attained.

• An incidental per-trip allowance of 2 mt of sardines applies to non-CPS fisheries.

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 2018-19 fishing year were 5,421 mt, still well below the ACT and ABC (Table 8-7).

8.1.2.1 Pacific Mackerel Harvest Specifications for 2019-20 and 2020-21

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 (see table below). The Council also adopted the following management measures: the directed fishery will close if it reaches the annual catch target 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) and no more than 3 mt of Pacific mackerel per landing in non-CPS fisheries.

Harvest control rule formulas for the 2019-20 and 2020-21 management years 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: $E_{MSY} = 0.30$; DISTRIBUTION = 0.70; $BUFFER_{\text{P-star 0.45 (Tier 2)}} = 0.874$; and CUTOFF = 18,200 mt.

Fishing year:	2019-20 (mt)	2020-21 (mt)
Biomass	71,099	56,058
OFL	14,931	11,772
$ABC_{0.45 \text{ (Tier 2)}}$	13,169	13,169
ACL (=ABC)	13,169	13,169
HG	11,109	11,109
ACT	10,109	6,950
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 2018, northern anchovy landings averaged 191 mt for Washington and 427 mt for Oregon, and 8,772 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
2000	79	<1	11,753
2001	68	0	19,277
2002	229	3	4,643
2003	214	39	1,676
2004	213	13	6,792
2005	164	68	11,182
2006	161	9	12,791
2007	153	5	10,390
2008	109	260	14,285

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

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

Beginning in 2013, California anchovy landings began increasing to levels previously seen several years ago. CDFW conducted commercial sampling of anchovy beginning 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.

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.

Landings of jack mackerel in the California pelagic wetfish fishery and other (especially mid-water trawl) fisheries through the decade of the 1990s reached a maximum of 5,878 mt in 1992 and averaged under 1,900 mt over 1990-2000. During the previous decade, California landings ranged from a high of 25,984 mt in 1982 to a low of 9,210 mt in 1985. Currently, most landings of jack mackerel are incidental to Pacific sardine and Pacific mackerel in California; however, pure landings do occur sporadically. From 2000 to 2015, jack mackerel landings averaged 33 mt in Washington CPS fisheries for years with reported landings, with a high of 176 mt in 2014; 109 mt for Oregon, with a high of 800 mt in 2014; and 730 mt for California, with a high of 3,624 mt in 2001. In California and Oregon, jack mackerel landings occurred each year; however, in Washington, jack mackerel were landed in 2001, 2002-2004, 2010, and 2012-2017.

Jack mackerel landings – metric tons				
Year	**WA**	**OR**	**CA**	**Coast-wide**
2000	-	161	1,269	1,430
2001	73.7	196	3,624	4,191
2002	12	8	1,005	1,263
2003	2	74	156	286
2004	<1	126	1,027	1,175
2005	-	70	199	293
2006	-	5	1,167	1,213
2007	-	14	630	680
2008	-	46	274	326
2009	-	2	119	125
2010	<1	3	310	313
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

Mason (2001) concluded that spawning biomass estimates of the past were inadequate.

Anecdotal evidence suggests that the spawning biomass may be large in California waters, but test fishing found the adult fish too scattered for economical harvest, since portions of the contemporary catch are sometimes found in small aggregations of young fish along rocky shores.

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, with an annual landings cap of 118,000 metric 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 and Washington. 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 start of the 2005/2006 fishing season, which started April 1.

In 2018, the market squid fishery was California's second largest fishery behind Dungeness crab, with landings estimated at 33,178 mt. This is a 47 percent decrease from 2017 (62,078 mt). The total ex-vessel value decreased from $68.3 million in 2017 to $35.8 million in 2018. The median ex-vessel price per metric ton of market squid in 2018 was $1,102.32, a small increase from $1,100.81 in 2017. The fishing permit season for market squid extends from April 1 through March 31 of the following year. During the 2017-2018 season (as opposed to the 2018 calendar year), 61,609 mt were landed, a 60 percent increase from the 2016-2017 season (38,510 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*

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9.0 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 2016, the Council considered action that would allow minor directed harvest on CPS finfish when the directed fishery is otherwise closed. This issue was prompted during the 2015 and 2016 closures of the Pacific sardine fishery, when the estimated biomass fell below the 150,000 mt CUTOFF value of 150,000 mt. Although live bait, tribal harvest, and incidental harvest are allowed to continue (up to the ACL) in that case, there are several small operations that harvest sardines as specialty dead bait or for the restaurant market. These small operations were shut down along with the primary directed harvest fishery. However, given the de minimis harvest level, the Council pursued a mechanism to allow for such operations to continue. This action was implemented as Amendment 16 of the CPS FMP, approved by NMFS in January 2018.

9.2 Live Bait Harvest

In 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 have been precluded, and harvest would have been 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 CPFV/private angler fleet and the commercial albacore fleets, 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.

In response to concerns that catch reporting is voluntary in the live bait fishery, CDFW stated its intent to increased monitoring of landings, including mandatory catch reporting.

10.0 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.

In addition to research and data needs presented in this section, refer to the Council's comprehensive research and data needs document last revised in March 2013. The document includes a chapter dedicated to CPS matters and can be obtained by contacting the Council office or by visiting the Council web page. Also, the most recent Pacific sardine and Pacific mackerel assessments and STAR Panel reports include detailed, species-specific, research and data needs.

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

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 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. 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, and not 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 2017 (in press) 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.

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.

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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11.0 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).

Process for periodic review of CPS EFH

The review process was initiated at a meeting of the CPSMT in January, 2010, in La Jolla, California, with a discussion of the existing EFH, habitat needs, and new information. The team subsequently compiled publications (see References) relevant to CPS habitat needs and associations. The CPSMT discussed CPS EFH at its April 27-30, 2010 meeting in Portland, Oregon; and during the June 13-14, 2010 Council meeting. In addition, the CPS Subcommittee of the SSC, the CPSMT, and some members of the Coastal Pelagic Species Advisory Subpanel (CPSAS) attended the sardine assessment meeting in October, 2010 in La Jolla, CA, which included discussion of CPS EFH.

The Council's Habitat Committee (HC), Scientific and Statistical Committee (SSC), and the CPSAS considered the issue during the June, 2010 Council meeting in Foster City, California.

The full Council also considered CPS EFH at that meeting, and added it to the November, 2010 Council meeting agenda in Costa Mesa, California, scheduled for final action.

In August, 2010, Council staff issued a request for comments on CPS EFH, via an email to the Council's HC, CPSMT, CPSAS, and the CPS subcommittee of the SSC. These advisory and management groups of the Council include representatives from the NMFS Northwest and Southwest Fisheries Science Centers; the NMFS Northwest and Southwest Regions; state agencies of California, Oregon, and Washington; commercial and recreational fishing interests; conservation interests; a port representative; and a tribal representative. No comments were received in response to that request.

The CPSMT considered new information, comments and discussion with Council advisory bodies, and best professional judgment to review CPS EFH in the context of three primary questions:

1. Does new information indicate that existing CPS EFH should be revised?
2. Does new information suggest establishing Habitat Areas of Particular Concern (HAPC)?
3. Are there emerging threats that could adversely affect CPS EFH?

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 (*Loligo 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.

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.

Because krill EFH was only recently 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, this 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. There remains a relatively meager volume of literature on market squid habitat. However, there are recent reports and research that are either published or in submission.

A comparison of new and newly-available literature since the last EFH review in 2005, 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 (e.g., Humboldt squid in 2009).

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.

From 2003-2005 California Current Ecosystem (CCE) ocean temperatures were warmer than average. From 2006 and on, SST were colder – especially in 2008. The PDO also went from positive to negative in 2006. 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). This may be why the stock size of sardines appears to be lower now.

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).

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.

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 2009 (PFMC 2010).

One notable change in fishing activities since 1998 has been a spatial shift in west coast CPS landings. In 1998, the Pacific Northwest sector harvested approximately 1-2% (by weight) of the total west coast CPS landings. More recently, the Pacific Northwest was responsible for harvesting approximately 28% of total CPS landings in 2009 (PFMC 2010). It is important to note that the increase in Pacific Northwest landings represents a shift in where landings are occurring, and not necessarily an overall increase in landings along the west coast. There is no reason to conclude any increase in effects, because methods and gear are essentially the same between California and the Pacific Northwest industry sectors.

This review concludes that based on fishery information and statistics, compared over time, there is 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 do not suggest that any new evaluation is warranted.

Emerging Threats

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. Recently, Brodeur et al. (2008) indicated that that jellyfish may compete directly with CPS in the CC. The CC moved from an El Niño condition to a La Niña or cold condition in the summer of 2010. The PACOOS program (http://www.pacoos.org/Default.htm) is presently tracking many oceanographic (physical and biological) indices that are revealing how oceanographic fluctuations affect 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. In 2008, the North Pacific Current was very strong, as was the amount of water that split south from this current to become 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; http://www.pac.dfo-mpo.gc.ca/science/oceans-eng.htm). In 2009 and spring 2010 North Pacific flows to the CC were reduced, which decreased overall productivity.

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.

The last few years and particularly in 2009, large numbers of Humboldt squid (*Dosidicus gigas*) were observed in the CC from Canada to Mexico (Field 2008). It is unknown if the unusual abundance of this species in the CC was related to climate change or some other oceanographic condition. However, their occurrence does appear to be related to the recent abundance of the hypoxic area off the west coast (Gilly et al. 2006). Humboldt squid are very efficient predators that have some of the highest growth rates of any species. They can consume significant numbers of CPS and other species and may affect their abundance.

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.

Ocean Energy Development

At this time, there is a lot of interest in developing renewable ocean energy projects in the CC. Possible energy projects include wave, wind, tidal, ocean currents, and thermal gradient. All of these will have structures that may affect benthic and pelagic environments. Unfortunately, the environmental effects of these projects needs study (Boehlert et al. 2008; Boehlert and Gill 2010). Some energy structures may act as fish aggregating devices (FADs) for CPS or their predators. Very few studies have been done to look at the effects of electromagnetic effects on migrations/movements of CPS. As these energy projects become initiated, it will be important to identify how they interact with CPS.

Presently, the nearshore areas that have the highest potential for wave energy development are also areas where many CPS and other fisheries (e.g., Dungeness crab, salmon) are focused. This nearshore habitat has also been identified as EFH for CPS and other fishes (Boehlert et al. 2008). From an ecosystem management position, these habitats (both pelagic and benthic) have not been well studied and their utilization by various species is not well mapped or documented in time or space.

Many coastal pelagic species undertake broad migrations in the coastal region. Wave energy devices may directly affect this migration by their physical structure or by emitting electromagnetic, acoustic, or chemical field that interfere with fish navigation/orientation systems.

Forecasting the effects of wave energy on pelagic species is presently difficult because we have limited information on the effects of large versus small projects and our time series of data from these habitats is also limited. Besides directly altering habitats, these structures could possibly alter food webs and may leach anti-fouling chemicals into the environment which may affect the health and marketability of CPS fishes caught in their vicinity.

Finally, large scale wave energy developments have the potential to conflict with existing or potential CPS fisheries. CPS fish often congregate in very specific areas depending on currents, time of year, predator abundance, etc. If CPS fish are highly congregated in areas that are off-limits to fishing because of wave energy structures, they would significantly affect potential harvest.

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 makes the following conclusions:

- 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 body of information on potential impacts to CPS EFH. This should be published in the 2011 SAFE[1] document, to remain available for use in EFH consultations and for future EFH reviews.

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[1] The Federal EFH regulations call for publishing the results of periodic EFH reviews in the SAFE report.

- The timing of the periodic review of krill EFH should be synchronized with the future reviews of CPS EFH.

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