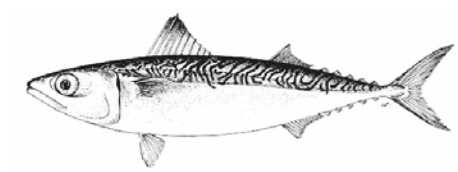
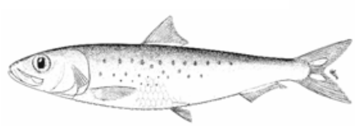
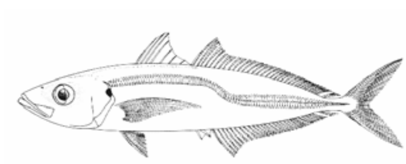
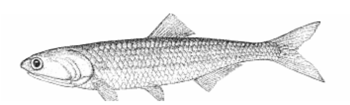
STATUS OF THE PACIFIC COAST COASTAL PELAGIC SPECIES FISHERY AND RECOMMENDED ACCEPTABLE BIOLOGICAL CATCHES

STOCK ASSESSMENT AND FISHERY EVALUATION 2005

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LIST OF ACRONYMS AND ABBREVIATIONS

ABC	acceptable biological catch
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CANSAR-TAM	Catch-at-age Analysis for Sardine - Two Area Model
CDFG	California Department of Fish and Game
CESA	California Endangered Species Act
Commission	California Fish and Game Commission
Council	Pacific Fishery Management Council
CPFV	commercial passenger fishing vessel
CPS	coastal pelagic species
CPSMT	Coastal Pelagic Species Management Team
CPSPDT	Coastal Pelagic Species Plan Development Team
CPUE	catch per unit effort
CUFES	Continuous Underway Fish Egg Sampler
CV	coefficient of variation
DEPM	daily egg production method
EEZ	exclusive economic zone
EFH	essential fish habitat
ENSO	El Niño southern oscillation
FMP	fishery management plan
GIS	Geographic Information System
GT	gross tonnage
HG	harvest guideline
LE	limited entry
LIDAR	light detection and ranging
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MAXCAT	maximum harvest level parameter
MSY	maximum sustainable yield
mt	metric ton
NMFS	National Marine Fisheries Service
ODFW	Oregon Department of Fish and Wildlife
OY	optimum yield
PacFIN	Pacific Coast Fisheries Information Network
PFAU	Pelagic Fisheries Assessment Unit
RecFIN	Recreational Fishery Information Network
RFA	Regulatory Flexibility Act
RIR	regulatory impact review
ROV	remotely operated vehicle
SAFE	stock assessment and fishery evaluation
Secretary	U.S. Secretary of Commerce
SSC	Scientific and Statistical Committee
SST	sea surface temperature
STAR	Stock Assessment Review (Panel)
STAT	Stock Assessment Team
SWFSC	Southwest Fisheries Science Center (NMFS)
VPA	virtual population analysis
WDFW	Washington Department of Fish and Wildlife

1.0 INTRODUCTION

The Guidelines for Fishery Management Plans (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 FMP. SAFE reports are intended to summarize the best available scientific information concerning the past, present, and possible future condition of the stocks, marine ecosystems, and fisheries being managed under federal regulation. Regional Fishery Management Councils use this information to determine annual harvest levels for each stock; document significant trends or changes in the resources, marine ecosystems, and fishery over time; and assess the relative success of existing state and federal fishery management programs.

This is the sixth *Status of the Pacific Coast Coastal Pelagic Species Fishery* SAFE document prepared for the Pacific Fishery Management Council (Council). Following NMFS guidelines, the purpose of this report is to briefly summarize aspects of the coastal pelagic species (CPS) FMP and to describe the history of the fishery and its management. Species managed under this FMP include: Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicus*), northern anchovy (*Engraulis mordax*), jack mackerel (*Trachurus symmetricus*), and market squid (*Loligo opalescens*).

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, Southwest Fisheries Science Center (SWFSC), California Department of Fish and Game (CDFG), 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 (including stock assessments for Pacific mackerel and Pacific sardine, Appendix 2 and Appendix 3), and acceptable biological catches (ABCs).

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).

Members of the CPSMT are: Dr. Sam Herrick, Chair (NMFS); Dr. Paul Crone, Vice Chair (NMFS); Mr. Brian Culver (WDFW); Dr. Kevin Hill (NMFS); Ms. Leeanne Laughlin (CDFG); Ms. Jean McCrae (ODFW); and Mr. Dale Sweetnam (CDFG). Ms. Tonya Wick (NMFS), Ms. Donna Dealy (NMFS) Mr. Mike Burner (Council staff), Ms. Heather Munro-Mann, and Ms. Diane Pleschner-Steele also provided information for this report.

2.0 THE CPS FISHERY

2.1 Management History

The CPS FMP is an outgrowth of 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 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 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 1 and 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 to amend the FMP for northern anchovy to conform to the recently revised Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) 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 the management unit species; CPS fishery management areas, consisting of a limited entry zone and two subareas; a procedure for setting annual specifications including harvest guidelines, quotas, and allocations; provisions for closing directed fisheries when the directed portion of a harvest guideline or quota is taken; fishing seasons for Pacific sardine and Pacific mackerel; catch restrictions in the limited entry zone and, when the directed fishery for a CPS is closed, limited harvest of that species to an incidental limit; a limited entry program; authorization for NMFS to issue exempted fishing permits for the harvest of CPS that otherwise would be prohibited; and 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 limited entry permits were effective immediately. Other provisions, such as harvest guidelines, were effective January 1, 2000.

2.2.2 Amendment 9

During 1999 and 2000, the CPSMT developed Amendment 9 to the CPS FMP. Originally, Amendment 9 addressed both disapproved provisions of the FMP – bycatch and market squid MSY. The amendment also included provisions to ensure 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

In April 2001, the Council adopted a capacity goal for the CPS limited entry 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 limited entry fishery, the amendment established a capacity goal, provided for limited entry permit transferability to achieve and maintain the capacity goal, and established a process for considering new limited entry permits. The purpose of this action was to ensure fishing capacity in the CPS limited entry 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 Magnuson-Stevens Act. The purpose of this action was to minimize the likelihood of overfishing the market squid resource. On December 30, 2002, the Secretary of Commerce 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, the 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% to both subareas, to 20% to Subarea A and 80% 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 harvest guideline is at least 90% of the 2003 harvest guideline.

2.2.4 Amendment 11

The Council is developing options for a new allocation framework for the coastwide Pacific sardine fishery. This revision to the sardine allocation framework will occur through Amendment 11 to the CPS FMP. The FMP amendment is 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 the 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 optimum yield.
- Implement a plan that balances maximizing value and historic dependence on sardine.
- Implement a plan that shares the pain equally at reduced harvest guideline (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 mt to 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 landing projections were based on 2004 landings and were inflated by 10% 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 the 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 Scientific and Statistical Committee as they proceed 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% 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 based on time, where sardine allocation would be reviewed after three, five, or seven years of implementation; the second 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.

The Council is scheduled to adopt a preferred alternative for a long-term sardine allocation framework at their June 2005 meeting in Foster City, California.

2.3 The CPS Fleet

During the 1940s and 1950s, approximately 200 vessels participated in the Pacific sardine fishery. 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 as relatively high volume/low value products (e.g., Pacific mackerel canned for pet food, Pacific sardine frozen and shipped to Australia to feed penned tuna, and northern anchovy reduced to meal and oil). In addition to fishing for CPS finfish, many of these vessels fish for market squid, Pacific bonito, bluefin tuna, and Pacific herring.

A fishery for Pacific sardine has operated off Oregon and Washington since 1999. This fishery targets larger sardine, which are typically sold as bait for Asian longline tuna fisheries.

Along the West Coast, other vessels target CPS finfish in small quantities, typically selling their catch to specialty markets for relatively high prices. In recent years, these included:

- Approximately 18 live bait vessels in southern California and two vessels in Oregon and Washington that landed about 2,000 mt per year of CPS finfish (mostly northern anchovy and Pacific sardine) for sale to recreational anglers. One vessel in Oregon landed 7.8 mt in 2003.

- Roundhaul vessels that take a maximum of 1,000 mt to 3,000 mt per year of northern anchovy that are sold as dead bait to recreational anglers.

- Roundhaul and other mostly small vessels that target CPS finfish (particularly Pacific mackerel and Pacific sardine) for sale in local fresh fish markets or canneries.

2.3.1 Limited Entry Fishery

The CPS limited entry (LE) fleet currently consists of 63 permits and 61 vessels (Table 3). The LE vessels range in age from 4 to 68 years, with an average age of 33 years (Table 4). Average vessel age has decreased by approximately four years since the initial fleet was established.

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 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 23.8 GT to 340.2 GT, with an average of 88.7 GT (Tables 3 and 4). Total fleet GT decreased from 5,462.9 GT to 5,408.4 GT during 2004. This decrease was due to the loss of the "Connie Marie" (permit 64; sank in 2002), which has yet to be replaced by the owner. 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%). The current limited entry fleet is 5,408.4 GT, well within the bounds of the capacity goal.

2.3.2 Northern Fisheries

2.3.2.1 Oregon

In Oregon, Pacific sardine is managed as a developmental fishery. In 2004, all 20 developmental fishery permits were issued. Permit stipulations include: permit is not transferable; logbook is required; observers are allowed on board; a grate must be placed over the hold to sort out larger fish; renewal of the permit is subject to meeting minimum annual landing requirements of five landings of sardines totaling 80,000 pounds, or landings of at least $25,000 exvessel price.

2.3.2.2 Washington

In Washington, sardines are managed under the Emerging Commercial Fishery provisions, which provide for the harvest of a newly classified species or harvest of a previously classified species in a new area or by new means. From 2000 through 2002, WDFW had trial purse seine fisheries for Pacific sardines, under which the number of participants, by law, cannot be limited. Since participation could not be limited, the Washington fishery was managed to a state HG of 15,000 mt. Following an extensive public process, which included establishing and meeting with a formal Sardine Advisory Board, the Director of WDFW decided to advance the sardine fishery from a trial to an experimental fishery in 2003. Experimental fisheries, under the Emerging Commercial Fisheries legislation, require participation to be limited. In collaboration with the Sardine Advisory Board, WDFW developed and implemented an effort limitation program in 2003. A total of 17 fishing permits were issued; of these, 10 vessels made landings during the season. Permit requirements require vessels to maintain logbooks and carry observers when requested and to reimburse the agency, in part, for observer costs.

In 2004, there were 17 fishers who met all of the criteria necessary to obtain a Washington sardine experimental fishery permit. The initial qualifying criteria included a cumulative total of 40 mt landed into Washington in the years 2000, 2001, and 2002 or landings in two of the three qualifying years. In addition to the minimum landing requirement, qualifying participants must have held a limited entry permit in 2003, paid any outstanding fees owed to WDFW for observer coverage in the 2000 through 2003 sardine fisheries, and renewed their fishing license by April 1. As the number of qualifying fishers was less than 20, the Director had the discretion to offer additional permits (up to a maximum of 25). A letter was sent to all fishers who had landed more than 40 mt of sardines into Washington (even those who did not hold permits in 2003) to solicit interest in the fishery. Four fishers indicated an interest in participating, which brought the number of permits issued in 2004 up to 21. Of these, 14 made landings during the season.

2.3.3 Treaty Tribe Fisheries

As of June 2005, no treaty tribe fisheries for CPS have occurred.

3.0 STOCK ASSESSMENT MODELS

3.1 Pacific Sardine

A Pacific sardine (*Sardinops sagax caerulea*) stock assessment is conducted annually in support of the Council process that, in part, establishes an annual HG (quota) for the U.S. sardine fishery. This process is centered on an environmentally-based control rule that establishes a U.S. coastwide HG for sardine on an annual cycle that begins on January 1st and ends on December 31st of each year (a 'calendar year' basis). The primary purpose of the assessment is to provide an estimate of current abundance (in biomass), which is used in a harvest control rule for calculation of annual-based HGs. A general overview of the harvest control rule is provided in Section 4.3.2 of this SAFE Report. For details regarding the harvest control rule, see Amendment 8 of the CPS FMP (PFMC 1998), Sections 4.2-4.2.5.3 and Table 4.2.5-1 (Option J).

In June 2004, the Council, in conjunction with NMFS, organized a stock assessment review (STAR) Panel in La Jolla, California to provide peer review of the methods used for assessment of Pacific sardine and Pacific mackerel (see Section 3.2 below). The STAR Panel Report for Pacific sardine included recommendations for improving the input data and modeling methods associated with this species' assessment (PFMC 2004a; Appendix 2). Several changes were made to the input data and modeling platform in 2004, including: (1) substantial revisions to the historical catch-at-age time series; (2) fewer indices of relative abundance were utilized; and (3) a new modeling approach was adopted. For details regarding the current assessment model, readers should consult Conser *et al.* (2004). The following is a summarization of the overall assessment conducted in 2004 concerning the status of the Pacific sardine resource off the U.S. Pacific Coast and Baja California, Mexico.

The stock assessment of Pacific sardine in 2004 was conducted using a likelihood-based, age-structured model (Age-structured Assessment Program-ASAP, see Legault and Restrepo 1998). The general estimation approach used in the ASAP model is a flexible, 'forward-simulation' that allows for the efficient and reliable estimation of a large number of parameters. The population dynamics and estimator theory that serves as the underpinnings of forward-estimation, age-structured models such as ASAP, is described in Fournier and Archibald (1982), Megrey (1989), and Methot (1990, 1998). Major changes to input data used by Conser *et al.* (2004) were as follows: (1) re-examination and development of historical catch-at-age time series, particularly, regarding assignment of age distributions to appropriate years associated with the temporal structure used in the model; (2) incorporating landing and biological data from 'northern' fisheries of the U.S. Pacific Coast (i.e., Oregon and Washington); (3) inclusion of additional biological data from the Mexico fishery, which improved the catch-at-age time series for this fishery; and (4) utilizing two indices of relative abundance, rather than four, as was the case in all previous assessments. See Conser *et al.* (2003) for descriptions of input data and modeling methods used in all previous assessments of sardine prior to 2004.

The final ASAP model (1983-2004) was based on fishery-dependent data from three fisheries (Ensenada, Mexico; U.S. California; and U.S. Oregon and Washington) and fishery-independent data from two research surveys (an index of spawning biomass based on the Daily Egg Production Method survey data, see Lo *et al.* (1996); and an index of pre-adult biomass from aerial spotter plane survey data, see Lo *et al.* 1992). Finally, an environmental index (i.e., a time series of sea-surface temperatures recorded at Scripps Pier, La Jolla, California) is used to develop a fishing mortality-based proxy for MSY, which is an additional parameter used in the harvest control rule for determination of annual HGs (see Section 9.1.1.1).

3.2 Pacific Mackerel

As is the case for Pacific sardine, a Pacific mackerel (*Scomber japonicus*) stock assessment is conducted annually in support of the Council process that ultimately establishes an HG (quota) for the U.S. mackerel fishery. The HG for mackerel applies to a fishing/management season that spans from July 1st and ends on June 30th of the subsequent year (i.e., a 'fishing year' basis). The primary purpose of the assessment is to provide an estimate of current abundance (in biomass), which is used in a harvest control rule for calculation of annual-based HGs. A general overview of the harvest control rule is provided in Section 4.3.3 of this SAFE Report. For details regarding this species' harvest control rule, see Amendment 8 of the CPS FMP, Section 4.0 (PFMC 1998).

Pacific mackerel, along with Pacific sardine were jointly reviewed in the STAR conducted in 2004 (see section 3.1 above and PFMC 2004b; Appendix 2 and 3). Two catch-at-age assessment models were developed and presented for critical review at this meeting: the ongoing 'backward simulation,' VPA-based analysis (using the ADEPT model); and an alternative 'forward simulation,' fully-integrated statistical analysis (using the ASAP model), see Hill and Crone (2004a) and Section 3.1 above. In general, the ASAP model differs from the classical VPA approach used to conduct previous assessments in the following: (1) calculations proceed from the initial conditions to the present and subsequently, forecasted into the future; (2) catch-at-age is estimated and not treated as 'known' without error; (3) differently operating fisheries can be treated in a strictly independent fashion; (4) a stock-recruitment relationship is required (to some degree); and finally, (5) some parameters can be evaluated in the context of time-varying hypotheses (e.g., catchability coefficients, q, associated with tuning indices and selectivity patterns associated with catch-at-age distributions).

The STAR concluded that future stock assessments of Pacific mackerel should be based on 'forward simulation' models, such as ASAP, given such modeling approaches provide more objective means for evaluating potential sources of uncertainty (e.g., recruitment and fishery-specific selectivity) in assessments than possible using VPA-based methods. For purposes of providing HG management in 2004-2005, results from the VPA-based assessment were used (see Hill and Crone 2004a, 2004b) and subsequently, the ASAP model was used to set a HG for the 2005-2006 management season (see Section 9.1.2.1 below and Hill and Crone 2005, Appendix 3). Finally, as was the case for Pacific sardine (see Section 3.1), in addition to changes in the assessment model for this species, the STAR Panel recommended two primary changes to the overall input data used in the analysis: (1) re-examination and development of historical catch-at-age time series, particularly, regarding assignment of age distributions to appropriate years associated with the temporal structure used in the model; and (2) reducing the number of indices of relative abundance from six to three, given concerns regarding potential biases associated with particular auxiliary sources of data. For details regarding changes to input data used in previous assessments (i.e., VPA-based analysis) and the current assessment (i.e., ASAP analysis), as well as further discussion of the overall ASAP model structure, readers should consult Hill and Crone (2005).

The final ASAP model (1929-2004) was based on fishery-dependent data from a single fishery (i.e., combined landings from California's commercial and recreational fisheries, and the Ensenada fishery of Mexico). Fishery-independent data used in the model consisted of relative abundance time series (indices) developed from three research surveys (Hill and Crone 2005): an index (proportion positive) of spawning abundance based on ichthyoplankton data collected through the ongoing CalCOFI survey; a standardized, catch per unit effort (CPUE) index from California-based commercial passenger fishing vessel (CPFV) logbooks; and an index of total abundance from aerial spotter plane survey data (Lo *et al.* 1992).

3.3 Section References:

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4.0 OPTIMUM YIELD, MAXIMUM SUSTAINABLE YIELD, AND MAXIMUM SUSTAINABLE YIELD CONTROL RULES

Information in this section is excerpted from: Amendment 8 (To the Northern Anchovy Fishery Management Plan) incorporating a name change to the Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council. Portland, Oregon. 1998.

4.1 Optimum Yield

The Magnuson-Stevens Act 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 maximum sustainable yield from the fishery, as reduced by any relevant social, economic, or ecological factor.
- In the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery [50 C*FR* §600.310(f)(1)(i)].

Optimum yield for a CPS stock is defined to be the level of harvest which is less than or equal to ABC estimated using a MSY control rule, consistent with the goals and objectives of this FMP, and used by the Council to manage the stock. The ABC is a prudent harvest level calculated based on an MSY control rule. In practice, OY will be determined with reference to ABC. In particular, OY will be set less than ABC to the degree required to prevent overfishing.

4.2 Maximum Sustainable Yield, MSY Control Rules, and Acceptable Biological Catch

For CPS, an MSY control rule is defined to be a harvest strategy that provides biomass levels at least as high as the FMSY approach while also providing relatively high and consistent levels of catch. According to federal regulations (50 CFR §600.310(b)(1)(ii)), an MSY control rule is "a harvest strategy which, if implemented, would be expected to result in a long-term average catch approximating MSY." Similarly, MSY stock size "means the long-term average size of the stock or stock complex, measured in terms of spawning biomass or other appropriate units that would be achieved under an MSY control rule in which the fishing mortality rate is constant." The definition of an MSY control rule for CPS is more general, because it includes the definition in National Standard 1. It is also more conservative, because the focus for CPS is oriented primarily towards stock biomass levels at least as high as the MSY stock size. The primary focus is on biomass, rather than catch, because most CPS (Pacific sardine, northern anchovy, and market squid) are very important to the ecosystem as forage.

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

The use of an MSY control rule for actively managed stocks provides 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 MSY control rules, a definition of overfishing, and a definition of an overfished stock. Definitions of overfishing and overfished are detailed below in Section 5.

The main use of an MSY control rule for a monitored stock is to help gauge the need for active management. MSY control rules and harvest policies for monitored CPS stocks may be more generic and simpler than those used for actively managed stocks. Under the FMP, any stock supporting catches approaching the ABC or MSY levels should be actively managed unless there is too little information or other practical problems.

4.3 MSY Control Rules for CPS

The Council may use the default MSY control rule for monitored species unless a better species-specific rule is available, e.g., the MSY-proxy approach adopted for market squid (see Section 4.3.4). The default MSY control rule can be modified under framework management procedures. The default MSY control rule sets ABC for the entire stock (U.S., Mexico, Canada, and international fisheries) equal to 25% of the best estimate of the MSY catch level. Overfishing occurs whenever total catch (U.S., Mexico, Canada, and international fisheries) exceeds ABC or whenever fishing occurs at a rate that is high enough to jeopardize the capacity of the stock to produce MSY. Overfishing of a monitored CPS stock is "approached" whenever projections or estimates indicate the overfishing will occur within two years.

In making decisions about active management, the Council may choose to consider ABC and catches in U.S. waters only. ABC in U.S. waters is the ABC for the entire stock prorated by an estimate of the fraction of the stock in U.S. waters. Active management may not be effective if U.S. catches are small, and overfishing is occurring in Mexico, Canada, or in international waters outside the jurisdiction of Federal authorities.

4.3.1 General MSY Control Rule for Actively Managed Species

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

H = (BIOMASS-CUTOFF) x FRACTION

H 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. BIOMASS is generally the estimated biomass of fish age 1+ at the beginning the 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. It may be useful to define any of the parameters in this general MSY control rule, so they depend on environmental conditions or stock biomass. Thus, the MSY 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 whole stock in the following year (H) although projections or estimates of BIOMASS, abundance index values or other data might be used instead. BIOMASS is an estimate only; it is never assumed that BIOMASS is a perfect measure of abundance. Efforts to develop a harvest formula must consider probable levels of measurement error in BIOMASS which typically have CVs of about 50% for CPS.

The general MSY control rule for CPS (depending on parameter values) is compatible with the Magnuson-Stevens Act and useful for CPS that are important as forage. If the CUTOFF is greater than zero, then the harvest rate (H/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 FRACTION. If FRACTION is approximately equal to FMSY, then the MSY control rule harvest rate will not exceed FMSY. In addition to the CUTOFF and FRACTION parameters, it may be advisable to define a maximum harvest level parameter (MAXCAT) so that total harvest specified by the harvest formula never exceeds MAXCAT. MAXCAT is used to guard 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. MAXCAT also prevents the catch from exceeding MSY at high stock levels and spreads the catch from strong year classes over 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 Magnuson-Stevens Act.

4.3.2 MSY Control Rule for Pacific Sardine

The MSY Control Rule for Pacific sardine sets ABC for the entire sardine stock based on an estimate of biomass for the whole sardine stock, a CUTOFF equal to 150,000 mt, a FRACTION between 5% and 15% (depending on oceanographic conditions as described below), and MAXCAT of 200,000 mt. The U.S. ABC is calculated from the target harvest for the whole stock by prorating the total ABC based on 87% proportion of total biomass in U.S. waters.

FRACTION in the MSY control rule for Pacific sardine is a proxy for FMSY (i.e., the fishing mortality rate for deterministic equilibrium MSY). FRACTION depends on recent ocean temperatures, because FMSY and sardine stock productivity are higher under ocean conditions associated with warm water temperatures. An estimate of the relationship between FMSY for sardine and ocean temperatures is:

$$\text{FMSY} = 0.248649805\, T^2 - 8.190043975\, T + 67.4558326$$

where T is the average three-season sea surface temperature (SST) at Scripps Pier (La Jolla, California) during the three preceding seasons. Thus, the MSY control rule for Pacific sardine sets the control rule parameter FRACTION equal to FMSY, except that FRACTION is never allowed to be higher than 15% or lower than 5%, which depends on recent average sea surface temperature.

Although FMSY may be greater or lesser, FRACTION can never be greater than 15% or less than 5% unless the MSY control rule for sardine is revised, because 5% and 15% are policy decisions based on social, economic, and biological criteria. In contrast, relationships between FRACTION, FMSY 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.

4.3.3 MSY Control Rule for Pacific Mackerel

The MSY control rule for Pacific mackerel sets the CUTOFF and the definition of an overfished stock at 18,200 mt and the FRACTION at 30%. Overfishing is defined as any fishing in excess of ABC calculated using the MSY control rule. No MAXCAT is defined because the U.S. fishery appears to be limited by markets and resource availability to about 40,000 mt per year. The target harvest level is defined for the entire stock in Mexico, Canada, and U.S. waters (not just the U.S. portion), and the U.S. target harvest level is prorated based on 70% relative abundance in U.S. waters.

4.3.4 MSY Control Rule for Market Squid

The MSY Control Rule for market squid is defined within the framework of the Egg Escapement method, which serves as the assessment-related tool for this species and was formally adopted by the Council in 2002. It is important to note that the main objective of a MSY Control Rule for a "monitored" stock (e.g., market squid) is to help gauge the need for "active" management. The MSY control rules and harvest policies for monitored CPS stocks may be based on broader concepts and constraints than those used for stocks with significant fisheries that fall under active management. Any fishery that supports catches approaching the ABC or MSY levels should come under active management, unless there is too little information available or other practical problems. Overfishing of a monitored CPS stock is "approached" whenever current estimates or projections indicate that a minimum stock threshold will be realized within two years.

The Egg Escapement method is founded on conventional spawning biomass "per recruit" model theory. In general, the proposed MSY Control Rule for market squid is based on evaluating (throughout a fishing season) levels of egg escapement associated with the exploited population(s). 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). The threshold proposed currently (i.e., 30%) necessarily represents a "baseline" statistic (i.e., preliminary, but intended to be precautionary), given that such biological reference points have not been definitively determined for coastal pelagic stocks specifically, as well as numerous fish stocks in general. Rather, the relationship between reproductive-related thresholds and sustainable population levels for this species will receive further scrutiny in the near future as much needed data accumulate and simulation modeling research gets underway (see section 9.2.3). Finally, further discussion concerning specific details involved in this assessment approach, as well as review-related discussion can be found in the Appendix 3 of the 2002 SAFE document.

5.0 OVERFISHING CONSIDERATIONS

Information in this section is excerpted from: Amendment 8 (To the Northern anchovy fishery management plan) incorporating a name change to: the Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council. Portland, Oregon. 1998.

5.1 Definition of Overfishing

By definition, overfishing occurs in a fishery whenever fishing occurs over a period of one year or more at a rate that is high enough to jeopardize the capacity of the stock to produce MSY on a continuing basis if applied in the long term. Overfishing in the CPS fishery is "approached" whenever projections indicate overfishing will occur within two years. The definition of overfishing is in terms of a fishing mortality or exploitation rate. Depending on the exploitation rate, overfishing can occur when CPS stocks are at either high or low abundance levels. The Council must take action to eliminate overfishing when it occurs and to avoid overfishing when exploitation rates approach the overfishing level.

In operational terms, overfishing occurs in the CPS fishery whenever catch exceeds ABC, and overfishing is approached whenever projections indicate that fishing mortality or exploitation rates will exceed the ABC level within two years. The definition of an overfished stock is an explicit part of the MSY control rule for CPS stocks.

5.2 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.

5.3 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 may be an integral part of the MSY control rule or may be developed or refined further in the event that biomass of a CPS stock reaches the overfished level.

6.0 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 that, to the extent practicable and in the following priority:

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

The Magnuson-Stevens Act 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 of approximately one-half mile in total length). These are encircling type nets, which are deployed around a school of fish or part of a school. When the school is surrounded, the bottom of the net may be closed, then the net drawn next to the boat. 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., brails). Roundhaul fishing results in little unintentionally caught fish, primarily because the fishers target a specific school, which usually consists of pure schools of one species. The tendency is for fish to school by size, so if another species is present in the school, it is typically similar in size. The most common incidental catch in the CPS fishery is another CPS 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 record 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.

To date, observer records from Washington, Oregon and California all indicate that marine mammals and marine turtles are not encountered (McCrae 2004; Culver and Henry 2004; NMFS/SWR/PRD, 2005). Historically the Pacific sardine fishery has been concentrated off of central to southern California but by the year 2000, the fishery expanded into Pacific Northwest off the Columbia River. The Pacific sardine fishery is currently managed by NMFS as a limited entry fishery in the Southern subarea (south of 39° N latitude or Point Arena, California), and an open access fishery in the northern subarea (north of 39° N latitude). The limited entry fishery in the Southern subarea has a dockside monitoring program administered by CDFG which collects fishery dependant data such as landings information, catch-at-age, and length-at-age data, and monitors bycatch at dock-side fish processing plants. There has been no documented bycatch of salmon species in the California contingent of the Pacific sardine fishery since the inception of CDFG’s dockside monitoring program back in the mid-1980s (Sweetnam and Laughlin, Pers. Comm., 2005). In order to confirm bycatch rates derived from the CDFG dock-side sampling, NMFS/SWR/SFD started a pilot observer program in the limited entry fishery for CPS off California in July of 2004. From July 20, 2004 to January 17, 2005, observers have been observed approximately 45 vessel trips ranging from San Diego, California, in the south to Moss Landing, California, in the north. The preliminary data suggest no salmon bycatch in the California sector (Southern subarea) of the Pacific sardine fishery.

The northern subarea of the Pacific sardine fishery operates as two separately managed fisheries by the individual states of Oregon and Washington. The Washington fishery operates in an area approximately 90 nm north and 30 nm south of the Columbia River—and extends to approximately 35 nm offshore (Culver, B., Pers. Comm, 2004). Washington fishers fish at depths ranging from 7 fathoms to 300 fathoms. The majority of the catch (about 54% for 2004) caught by Washington State permitted fishing vessels occurred in waters adjacent to the state of Washington (Culver and Henry, 2004). The Oregon fishery operates in an area approximately 45 nm north and 30 nm south of the Columbia River—and extends to approximately 25 nm offshore (McCrae, 2004). Oregon fishers fish at depths range from 7 fathoms to over 400 fathoms. The state of Washington has also had an observer program in place continuously since the year 2000. Observer coverage in the Washington Pacific sardine fishery has ranged between 24% to 27%. Additionally, Oregon Department of Fish and Wildlife (ODFW) placed observers on the vessels fishing for Pacific sardine in 2000, but after 2001 the observer program was halted due to a lack of funding. Observer coverage was between 4% and 7% for the state of Oregon. Both state observer programs shown salmon bycatch but the data on specific evolutionary significant units (ESU) is inconclusive because the data is recorded only to the species (i.e., Chinook and coho) level. Although there is no definitive conclusion on specific ESUs the NMFS-SWR-Protected Resources Division (PRD) conducted an ESA Section 7 consultation and produced a biological opinion (BO) dated April 25, 2005, on the implementation of the proposed 2005 HG for the Pacific sardine fishery under. The BO analyzed the effects of implementing the 2005 HG on three ESUs of Chinook salmon listed at threatened under the ESA: Lower Columbia River (LCR) Chinook salmon, Snake River fall (SRF) Chinook salmon, and Upper Willamette River (UWR) spring Chinook salmon. The BO The BO concluded that the proposed action will not jeopardize the continued existence of Lower Columbia River Chinook salmon, Snake River fall Chinook salmon or Upper Willamette River spring Chinook salmon. Below is an excerpt detailing the BO's analysis and conclusion:

> *"Based upon the FRAM output for the salmon recreational fishery off the mouth of the Columbia River, the following ESUs may be encountered in the sardine fishery off the coasts of Oregon and Washington: Lower Columbia River Chinook (LCR) salmon, Snake River fall (SRF) Chinook salmon, and Upper Willamette River (UWR) Chinook salmon. The Puget Sound (PS) Chinook salmon may be in the area. CWTs from salmon in this ESU did not appear in catch records for fish landed at the mouth of the Columbia River although they were present in landings at Westport, WA. The landings of PS Chinook salmon represent less than 0.2% of the recreational salmon fishery landings. Based upon the area and timing of the recreational salmon fishery, it is assumed that the proportion of PS Chinook salmon taken is similar to the proportion taken in the sardine fishery. That is, less than 0.2% of the total number of Chinook caught incidentally in the sardine fishery may be PS Chinook salmon. This low rate is consistent with evidence of distribution of PS Chinook salmon, which appear to travel and feed north of their natal streams, based on retrievals of PS Chinook salmon CWTs in Northern British Columbia and Southeast Alaska fisheries. Further, PS Chinook salmon return to fresh water spawning habitat via the Strait of Juan de Fuca (in northern Washington) and then enter the Puget Sound. Unlike all of the other ESUs considered in this BO, PS Chinook do not enter the Columbia River as part of their migration to fresh water to spawn. Therefore, NMFS believes that take of PS Chinook salmon in the sardine fishery is unlikely to occur and will not consider them further in this BO.*
>
> *Two coho salmon ESUs may also be encountered in the sardine purse seine fishery; Lower Columbia River (LCR) coho and Oregon Coast Natural (OCN) coho salmon. Both of these ESUs are proposed to be listed on the ESA as threatened. Neither of these ESUs is currently listed and will not be addressed in this Biological Opinion.*
>
> *There are currently 26 salmonid ESUs listed as either threatened or endangered under the ESA. The listings are currently under review and proposed listings have been published (69 FR 33102). A final rule implementing changes to the existing ESUs is expected in June 2005. For the purposes of this consultation, the existing definitions of the SRF (57 FR 34639; April 22, 1992),*

LCR (64 FR 14308; March 24, 1999) and UWR (64 FR 14308; March 24, 1999) will be used. The status of these ESUs has not been changed in the proposed rule (69 FR 33102); all are currently listed as threatened and remain threatened in the proposed rule."

Historically, market squid have been fished at night with the use of powerful lights, which cause squid to aggregate, which enables 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. California's market squid FMP established a management program for California's market squid resource with goals that are aimed at ensuring sustainability of the resource and reducing the potential for overfishing. The tools to accomplish these goals include:

- Establishing fishery control rules, including a seasonal catch limitation to prevent the fishery from over-expanding; continuing weekend closures, which provide for periods of uninterrupted spawning; continuing gear regulations regarding light shields and wattage used to attract squid, and maintaining monitoring programs designed to evaluate the impact of the fishery on the resource.

- Instituting a restricted access program, including provisions for initial entry into the fleet, types of permits, permit fees, and permit transferability.

- Establishing a general habitat closure area in northern California rarely used by the squid fishery to eliminate the potential of future negative interactions with seabirds, marine mammals, and important commercial and sport fishes; and adding limitations on using lights to attract squid around several of the Channel Islands, an effort intended to protect nesting seabirds.

In addition to the reasons discussed above, several circumstances in the fishery tend to reduce bycatch:

1. Most of what would be called bycatch under the Magnuson-Stevens Act is caught when roundhaul nets fish in shallow water over rocky bottom. Fishers try to avoid this to protect 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 fishers can be sold for reduction, which reduces discard.

4. The five tons or less allowable landing by vessels without limited entry permits under the FMP should reduce any regulatory discard, because those fish can be landed.

5. From 1996 to 2003, bycatch from the live bait logs was reported with an incidence of 10%. 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 Tables 13, 14, and 15.

6. CDFG has implemented a logbook program for the squid fishery. The data to be collected includes bycatch. See table 8a.

Generally, fisheries for CPS can be divided into two areas: north and south of Pigeon Point, California (approximately 37°10' N latitude). In recent history, virtually the entire commercial fishery for CPS finfish and market squid has taken place south of Pigeon Point. The potential for taking salmon exists in this area, but diminishes south of Monterey, California (37° N latitude). Starting in 1999, CPS fisheries (notably, targeting Pacific sardine) increased in waters off Oregon and Washington. Oregon and

Washington actively manage these northern fisheries, in part, because of the heightened potential for salmon bycatch. Section 6.1 describes the California fishery, section 6.2 provides information on Oregon and Washington fisheries.

See Amendment 9 to the CPS FMP (Environmental Assessment/Regulatory Impact Review, March 2001) for a complete description of bycatch-related issues and monitoring and reporting requirements. Amendment 9 is available from the Council office.

NMFS has proposed a pilot at-sea observer program for CPS purse seine vessels operating in California to determine the amounts and types of bycatch, and to confirm bycatch rates derived from CDFG dock-side sampling. Additionally, the pilot observer program would collect data on possible protected species interactions, information about fishing operations, and fishing economics. As of publication of this document funding had not yet been allocated for the observer program, NMFS intends to begin at-sea observations in the summer 2004 and continue through the fall 2004. The data will be analyzed by the CPSMT and management options will be assessed in conjunction with the fishing industry.

6.1 Fishery South of Pigeon Point

Information from at-sea observations of the CDFG and conversations with CPS fishers suggest that bycatch 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 are forage for virtually all predators, but there are no data to confirm significant bycatch of these species. CDFG port samples indicate minimal bycatch in the California fishery (Tables 5, 6, 7a, 7b, and 7c). The behavior of predators, which tend to dart through a school of prey rather than linger in it, and can more easily avoid encirclement with a purse seine, may help to minimize bycatch. Large predators such as blue sharks have been observed on occasion, but are by no means a common occurrence.

CDFG port samples collect information from CPS landings in Monterey and ports to the south. Biological samples are taken to monitor the fish stocks, and port samplers report incidentally caught fish. Reports of bycatch by CDFG port samplers confirm small and insignificant landings of bycatch at California off-loading sites (Tables 5, 6, 7a, and 7b). These data are likely representative of actual bycatch, because (as noted) fish are pumped from the sea directly into fish holds aboard the vessel. Fishers do not sort catch at sea that pass through the pump. Generally, whatever is caught is pumped into the hold and landed. Unloading of fish also occurs with pumps. The fish is 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 CDFG 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% occurrence. Up to 1999 reports of incidental catch were sparse, and prior to 1992 none was reported. Earlier incidents of bycatch may not have been noted, because the harvest of anchovy and sardine was small, and only in recent years has the harvest of sardine increased. The incidental catch reported are primarily those species that are marketable and do not meet the definition of bycatch in the Magnuson-Stevens Act. 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%, and northern anchovy at 12% incidence within samples (not by load composition). CDFG port sample information provides a useful database for determining the significance of bycatch in the CPS fishery off California (south of Pigeon Point).

In 2001, California wetfish port samplers were directed to tally bycatch observed during landings in greater detail. These observations are summarized for the Los Angeles area in Table 7a. for 2001 – 2004.

In 2004, kelp, California scorpionfish, squid, bat rays, white croaker, Pacific butterfish, California halibut, hornyhead turbot, northern anchovy, and unspecified dandabs were the ten most commonly occurring animal in wetfish landings.

In Monterey, bycatch was enumerated for the second year as summarized in Table 7b. In that port, much less bycatch was noted for 2004. Northern anchovy, white croaker, American shad, bat rays, and jellyfish were most commonly observed in wetlandings in this region.

Kelp (specifically holdfasts), crustaceans, flatfish, California scorpionfish, and elasmobranchs can serve as an indication of shallow set depth. Larger fish and animals are typically sorted either for market, personal consumption, or nutrient recycling in the harbor. As the collection of bycatch information in the CPS fishery is not a funded portion of the project, further study will require additional support from outside of CDFG. An additional concern may be that at some processors, the entire load is observable for bycatch because it goes by the sampler on conveyors; at others, only the surface layer of a bin can be observed. Some processors think they may be being scrutinized more closely than others.

6.1.1 Incidental Catch Associated with the Market Squid Fishery

Because squid frequently school with CPS finfish, mixed landings of market squid and incidentally caught CPS finfish occur occasionally. In 2002, about seven percent of round haul squid landings included "incidental" catch of CPS species; in 2003, there were nine percent; and in 2004, five percent (Table 8a). Squid also occurred as incidental catch in trawl fisheries for sea cucumber and ridgeback prawn, and in various other gears.

Another type of incidental catch is defined here as "bycatch" (i.e., species that are landed along with squid that are not recorded through landing receipt processes [i.e., not sold] as is typically done for incidentally-caught species). Although non-target catch in market squid landings is considered minimal, the presence of bycatch has been documented through CDFG's port sampling program. The port sampling program records bycatch observed (i.e., presence or absence evaluations), but actual amounts of bycatch have not been quantified to date. During 2004, bycatch was present in about forty-nine percent of squid landings observed (Table 8b). Similar to previous years, most of this catch was other pelagic species, including Pacific sardine, Pacific mackerel, northern anchovy, jack mackerel, and squid egg cases. However, jellyfish, kelp, jacksmelt, Pacific electric rays and eelgrass also occurred in the top ten in terms of incidence.

Finally, the extent that squid egg beds and bottom substrate are damaged by recent purse seine operations and subsequently, contribute to significant mortality of early life stages is not definitively known at this time. However, information regarding bycatch of squid eggs determined from squid landings port-side generally indicate that egg bed-related impacts have increased over the last several years. For example, from October 1998 through September 2001, bycatch of squid eggs had a 1.8% frequency of occurrence. In 2004, squid egg bycatch was 5.1% statewide, a 0.2% increase over 2003 (4.9%). If bycatch of squid eggs continues to increase, some gear regulations may need to be implemented in the future (e.g., restrictions to the depth at which nets could be set, spatio-temporal closures of some shallow water habitats). In this context, further investigations regarding potential damage to squid spawning beds from fishery-related operations would likely benefit status-based analyses concerning the overall squid population off California, given eggs-per-recruit theory underlies the recently adopted squid assessment method. Such investigations should involve collaborative research efforts between the CPSMT, CDFG, and NMFS-Southwest Fisheries Science Center.

6.2 Fishery North of Pigeon Point

Since 2000, limited fisheries for Pacific sardine occurred off the Pacific Northwest. Oregon and Washington closely monitor these fisheries and collect information about landings and the environmental effects of these fisheries. Information on salmon bycatch from Oregon and Washington (2000 through 2004) is summarized in Table 9.

In 2004, landings into Oregon began on June 8 and continued through mid-December; the latest that landings have occurred thus far in the fishery. Nineteen vessels landed a total of 36,111 mt, an increase from the 25,258 mt landed in 2003. There was a total of 939 landings with 99% of the catch delivered into Astoria. The average landing was over 38 mt per trip. Based on logbook data, 59% of the pounds landed were taken off Oregon and 41% off Washington.

Oregon's permit stipulations include allowing observers when requested and requiring a grate over the hold opening to sort out larger species of fish. As in the last three years, due to budget restriction, Oregon did not hire a seasonal employee in 2004 to ride along on sardine vessels and observe bycatch of nontarget species: permanent staff was able to observe three trips. Vessel skippers were also required to submit logbooks, which record all species caught. Logbooks submitted accounted for 97% of the landings.

Based on both observer and logbook data, bycatch continues to be low. Bycatch included salmon and sharks (Table 10). Salmon were the major species of concern. Based on logbooks, salmon catch averaged 0.9 salmon per trip, with 68% being released alive. The estimated total catch of salmon for the fishery, based on logbook data, was 823 salmon (0.027 salmon/mt) (Table 9).

Incidental catch recorded on fishtickets consisted of 161.5 mt of Pacific mackerel, 24.1 mt of jack mackerel, 10.3 mt of Pacific herring, 0.3 mt of thresher shark, in addition to some anchovy, shad, squid, and jellyfish for a total of 0.6% of the total catch.

The Washington fishery opened by rule on May 15, 2004, however, the first landing into Washington did not occur until June 24. Fourteen vessels participated in the fishery. There were two primary vessels that accounted for 58% of the total landings; both vessels fished out of Ilwaco. A total of 8,800 mt of sardines were landed into Washington. A total of 238 landings were made; 100 occurred within the month of August. A total of 375 sets were made with 89% (333) reported successful. Average catch per successful set was about 38 mt. The majority of the landings (61%) were made into Ilwaco, and the majority of the catch (about 54%) occurred in waters adjacent to Washington.

As part of the trial fishery and the experimental limited entry fishery regulations, WDFW has required fishers to carry at-sea observers, as well as provide financial support for the observer effort. Since the beginning of the Washington sardine fishery in 2000, bycatch information has been 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. Overall observer coverage in 2004 was 27% of the total catch and has averaged over 25% of both total landed catch and number of landings made during the five years of the program. Based on observer data, the bycatch of non-targeted species in the Washington sardine fishery has been relatively low. Bycatch and mortality estimates of incidentally captured salmon, by species, based upon observer information for the past five years is shown in Table 9. A complete list of non-targeted species and the amounts observed (numbers of individuals) compared with amounts reported in logbooks is contained in Table 11.

6.3 References

Culver, M., and C. Henry, 2004. Summary Report of the 2004 Experimental Purse Seine Fishery for Pacific Sardine (Sardinops sagax). Washington Department of Fish and Wildlife, Montesano, Washington. 11 pp.

Hill, K. T., and P. R. Crone. 2004. Stock assessment of Pacific mackerel (Scomber japonicus) in 2004. Paper can be obtained from Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 200, Portland, OR 97220. 44 p. and Appendices.

McCrae, J., 2004. Oregon's Sardine Fishery, 2003 Summary. Oregon Department of Fish and Wildlife. Newport, Oregon. 12pp.

NMFS. 2005. Endangered Species Act Section 7 Consultation Biological Opinion. Implementation of the 2005 Harvest Guideline for Pacific sardine fishery under the Coastal Pelagic Species Fishery Management Plan. 501 Ocean Blvd. Long Beach, CA 90802. 40 pp.

7.0 CALIFORNIA LIVE BAIT FISHERY

7.1 Introduction

Through much of the 20th century, CDFG 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 in this fishery, with a variety of other nearshore or CPS taken incidentally. An estimated 20% of this harvest is sold to private fishing vessels, with the remainder to the Commercial Passenger Fishing Vessel (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, Division of Fish and Game, can be found in Aplin (1942). The nature of 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 63 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 CDFG, 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).

7.2 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 CDFG 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, CDFG 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.

7.3 Logbook Information

The CDFG Live Bait Log (Title 14, Section 158, California Code of Regulations: DFG 158, October 1989) requires only the estimated scoops taken daily of either anchovy or sardine be reported, and a check mark be made if other particular species were taken, with space for comments related to fishing. Other species noted, but not consistently enumerated in the live bait harvest, include white croaker (*Genyonemus lineatus*), queenfish (*Seriphus politus*), Pacific and jack mackerels (*Scomber japonicus and Trachurus symmetricus*), and various small fishes collectively known as "brown bait" that can include juvenile barracuda (*Sphyraena argentea*), Osmerids, Atherinids, and market squid (Table 12). Estimates of ancillary catch data has been documented in earlier reports, and in CPS FMP Amendment 9.

The CDFG Pelagic Fisheries Assessment Unit at the Southwest Fisheries Science Center (SWFSC) in La Jolla presently archives the CDFG Live Bait Logs. Preliminary estimates of the reported total live bait harvest in California through 2004 have been appended to previously reported estimates from Thomson *et al.* (1991, 1992, 1994) (Table 13). In 2005, CDFG will evaluate the current logbook structure, reporting requirements, and the information obtained in order to correct the data problems identified above, increase reporting compliance rates, and to better estimate the economics of the fishery.

7.4 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 (Table 13).

Through the years 1994 to 2004 the proportion of anchovy in the total reported harvest ranged from a high of 58% in 1994 to a new low in 2004 of 5%. The proportion of sardine ranged from a low of 42% in 1994, to a new high of 95% in 2004 (Table 14).

7.5 References:

Alpin, J. A. 1942. Bait records in The commercial fish catch of California for the year 1940. Calif. Dept. Fish and Game Fish Bull. 58: 20-23.

Maxwell, W. D. 1974. A History of the California Live-Bait Fishing Industry. Calif. Dept. Fish and Game Marine Resources Technical Report 27. 24 p.

Thomson, C. J., T. Dickerson, G. Walls, and J. Morgan. 1991. Status of the California coastal pelagic fisheries in 1990. NMFS, SWFSC Admin. Rep. LJ-91-22: 27 p.

Thomson, C. J., T. Dickerson, G. Walls, and J. Morgan. 1992. Status of the California coastal pelagic fisheries in 1991. NMFS, SWFSC Admin. Rep. LJ-92-95:46 p.

Thomson, C. J., T. Bishop, and J. Morgan. 1994. Status of the California coastal pelagic fisheries in 1993. NMFS, SWFSC Admin. Rep. LJ-94-14.

Title 14, California Code of Regulations.

California Fish and Game Code. 2000. Lexis Law Publishing, Charlottesville, VA. 553 p.

California Fish and Game Code. 2001. Gould publications, Altamonte Springs, FL. 568 p.

8.0 VESSEL SAFETY CONSIDERATIONS

In implementing any form of management, it is imperative to evaluate whether the strategy will impact the safety of fishing activities. 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 limited entry fishery is 32 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 restricting the ability of an older vessel to be replaced with a newer, safer vessel or by promoting fishing activity during potentially hazardous weather conditions.

In January 2003, NMFS published final regulations to implement Amendment 10 to the CPS FMP, which allows limited entry permits to be transferred to another vessel and/or individual.

As discussed in Section 2.2, NMFS recently implemented a regulatory amendment related to the CPS FMP. Under the regulatory amendment, this action is not expected to have a substantial adverse impact on public health or safety. However, for Pacific Northwest fisheries, the action is anticipated to enhance safety at sea by advancing the reallocation date from October 1 to September 1. Waiting until October 1 to reallocate has the potential of inducing fishermen to fish in unsafe weather conditions. Ocean conditions off Oregon and Washington become increasingly rough in October. Also, crossing the Columbia River bar, always a hazardous exercise, becomes very dangerous in this time of year.

The action alternatives for Pacific sardine allocation considered under Amendment 11 either include reallocation on September 1 or have mechanisms to allow Pacific Northwest fishers continued access to harvest opportunity in September. As a result, the proposed action under Amendment 11 will not affect safety in a manner substantially different from the interim allocation regime, and will not have significant impacts on safety.

9.0 SUMMARY OF STOCK STATUS AND MANAGEMENT RECOMMENDATIONS

The CPS FMP distinguishes between "actively managed" and "monitored" species. Actively managed species (Pacific sardine and Pacific mackerel) are assessed annually. HGs, fishing seasons, and other management controls are used. 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.

While this document focuses on U.S. fisheries, many CPS stocks are distributed coastwide, hence, catch information from Mexican fisheries is of interest. See Table 15 for information on commercial harvest of CPS finfish landed into Ensenada, Mexico (1978-2001) (Table 15, García and Sanchéz 2003).

9.1 Actively Managed Species

9.1.1 Pacific Sardine

The CDFG Code Section 8150.7 states that it was the intent of the Legislature that the Pacific sardine resource off California be rehabilitated, and that once the spawning population was estimated to reach 18,144 mt, a 907 mt directed fishery would be established. This happened in the 1980s and the quota was expanded as the population increased and extended its range northwards into waters off Oregon and Washington. Over the last two decades, the Pacific sardine has made a strong recovery in waters off the U.S. Pacific Coast. For example, sardine biomass has increased substantially since the early 1990s, with a ‘leveling off’ at approximately 1 million mt observed in recent years.

Conser *et al.* (2004) summarized the status of the Pacific sardine resource off the U.S. Pacific Coast and Baja California, Mexico. Total landings of Pacific sardine for the directed fisheries off California, Oregon/Washington (Pacific Northwest), and Ensenada, Mexico were roughly 105,000 mt in 2004. In 2004, landings in California (29,491 mt) and Ensenada (35,723 mt) declined considerably from the previous year (50,382 mt and 43,693 mt for California and Mexico landings in 2003, respectively). Landings in 2004 from the Pacific Northwest (39,861 mt) were incorporated in the assessment for the first time. Currently, the U.S. fisheries (California and Oregon/Washington) are regulated using a quota-based (e.g., HG) management scheme. Total annual harvest of Pacific sardine by the Mexico fishery is not regulated, but there is a minimum legal size limit of 165 mm. Since the mid 1990s, actual landings from the U.S.-based fisheries have been less than the recommended HGs. For example, in 2004, combined landings of sardine from California, Oregon, and Washington composed only 60% (roughly 70,000 mt) of the HG recommended for 2004 (approximately 123,000 mt).

Estimated stock biomass (ages >1) from the assessment conducted in 2004 indicated the sardine population has remained at a relatively high abundance level, with an estimate of roughly 1.2 million mt. Estimated recruitment (age-0 fish) in 2005 (4 billion fish) declined markedly from the historically high estimate in 2004 (over 9 billion). Further, given the inherent uncertainty surrounding estimated recruitment in recent years, definitive determinations regarding the apparent ‘plateau’ reached by the sardine population should be interpreted accordingly. See Table 16 for biomass and recruitment time series (1983-2005).

Finally, estimates of Pacific sardine biomass from the 1930s (Murphy 1966 and MacCall 1979) indicate that the sardine population may have been more than three times its current size before the stock decline and eventual collapse observed in the 1960s. Considering the historical perspective, it would appear that the sardine population, under favorable oceanographic conditions, may still have growth potential beyond its current size. However, per capita recruitment estimates show a downward trend in recruits produced per spawner in recent years, which may be indicative of a stock that has reached a threshold under current environmental conditions.

9.1.1.1 Harvest Guideline for 2005

The HG recommended for the U.S. Pacific Coast fishery for 2005 was 136,179 mt. Statistics used to determine this HG are discussed below. The HG for 2005 is based on the MSY control rule defined in the CPS FMP. This formula is intended to prevent Pacific sardine from being overfished and maintain relatively high and consistent catch levels over a long-term horizon. The CPS FMP harvest formula for sardine is:

$$HG_{2005} = (\text{TOTAL STOCK BIOMASS}_{2004} - \text{CUTOFF}) \bullet \text{FRACTION} \bullet \text{STOCK DISTRIBUTION},$$

where HG_{2005} is the total U.S. (California, Oregon, and Washington) HG recommended for the 2005 fishing season (i.e., January - December 2005), TOTAL STOCK BIOMASS2004 is the estimated stock biomass in 2004 (i.e., ages >1 on July 1st), CUTOFF is the lowest level of estimated biomass at which harvest is allowed, FRACTION is an environment-based percentage of biomass above the CUTOFF that can be harvested by the fisheries (see below), and U.S. DISTRIBUTION is the percentage of TOTAL STOCK $BIOMASS_{2004}$ in U.S. waters. CUTOFF (150,000 mt) and STOCK DISTRIBUTION (87%) are currently 'fixed' terms in the harvest control rule. Further discussion regarding parameters included in the harvest control rule is presented in section 4.0 of PFMC (1998).

The value for FRACTION in the MSY control rule for Pacific sardine is a proxy for F_{MSY} (i.e., the fishing mortality rate that achieves MSY under 'equilibrium' assumptions). Given F_{MSY} and the productivity of the sardine stock have been shown to increase when relatively warm-water ocean conditions persist, the following formula has been used to determine an appropriate (sustainable) FRACTION value:

$$\text{FRACTION or } F_{MSY} = 0.248649805(T^2) - 8.190043975(T) + 67.4558326,$$

where T is the running average sea-surface temperature at Scripps Pier, La Jolla, California during the three preceding years. Ultimately, FRACTION is constrained and ranges between 5% and 15%.

Based on the T values observed throughout the period covered by this stock assessment (1983-2004), the appropriate F_{MSY} exploitation fraction (FRACTION) has consistently been 15% and this remains the case under current oceanographic conditions (T_{2004} = 17.7 °C). However, it should be noted that the declines in T generally observed in recent years (2000-2004) may invoke an environment-based reduction in the FRACTION value in the near future if sea-surface temperatures off the southern extreme of the U.S. Pacific Coast continue to decline from those observed in the latter part of the 1990s.

The 2005 U.S. HG (136,179 mt) is roughly 11% greater than the 2004 HG (122,747 mt). Recent fishing practices and market conditions indicate that it may not be constraining with regard to U.S.-based fishery landings in 2005. However, recent recruitment levels are not well estimated, resulting in a high degree of uncertainty with respect to stock productivity over the last few years. If the actual recruitment in recent years is less than that estimated in the model and/or should the general sea-surface temperature decline even further, it is possible that HGs in the upcoming years will constrain U.S. fishery practices.

Further, when viewed on a larger spatial scale and considering the landings of Mexico and Canada as well as the U.S., adherence to an implied 'population-wide' HG may constrain fisheries even without potential declines in recruitment and/or water temperature. See Conser *et al.* 2003 for comparisons concerning recent international-based landings with the annual HGs that would have resulted from applying the CPS FMP harvest formula (see above) without the 'U.S. Distribution' term. Finally, should Oregon and Washington landings continue to increase at rates comparable to those observed over the past few years and/or Mexico landings continue to increase to historically high levels (i.e., those observed since the late 1990s), the implied population-wide HG will be exceeded again in 2005, as has been the case since 2002.

See Tables 18 and 19 for a retrospective of U.S. West Coast Pacific sardine landings, 1981-2004.

9.1.2 Pacific Mackerel

The Pacific mackerel population that inhabits waters off California and northern Baja California (Ensenada, Mexico) has continually declined in abundance since the late 1970s. The coastwide harvest of this species was characterized by a generally similar decreasing pattern over this time frame, although the decline was not as consistent year-to-year or as precipitous as that observed for population biomass. In particular, during the 1990s, the directed fisheries off California had average annual landings of roughly 37,000 mt, whereas since 2001, average yearly landings have decreased nearly 75% (10,000 mt), with harvest in 2004 declining to approximately 5,000 mt (the lowest level observed since the mid-1970s). This pattern of declining yields generally characterized all of the fisheries, including U.S. commercial and recreational fleets, as well as the commercial fishery of Mexico. Total annual harvest of Pacific mackerel by the Mexico fishery is not regulated, but there is a minimum legal size limit of 255 mm.

Determination of the status of the Pacific mackerel population (1929-2005) for the 2005 fishing/management season (i.e., July 2005 through June 2006) was based on the 'forward estimation' assessment model ASAP (see sections 3.1 and 3.2 above and Hill and Crone 2005). It is important to note that previous management advice regarding this species was based on 'backward estimation' VPA methods, which generated generally similar trends for time series associated with important management-based parameters (e.g., biomass, spawning stock biomass, and recruitment) as the newly implemented ASAP model, but magnitudes of these statistics did differ between these two modeling approaches for certain periods of the overall estimated time series (1929-2005) due essentially to estimation differences internal to each model (see Hill and Crone 2004), e.g., the range characterizing historically high and low levels of the estimated biomass trend was substantially wider based on VPA-related models than the ASAP models.

Pacific mackerel biomass peaked in 1986 at approximately 489,000 mt, declining steadily to 73,015 mt in 2002. The biomass (age 1+) is forecast to be 101,147 mt as of July 1, 2005 (Hill and Crone 2005; Appendix 3). The peak biomass observed during this time largely resulted from historically high levels of recruitment during the late 1970s. These recruitment pulses occurred after a decade of extremely low biomass observed from the mid-1960s to mid-1970s. The decline in biomass since the early 1980s has resulted from a steady decline in year class strength and relatively low reproductive success (recruits per spawning stock biomass) since that time.

9.1.2.1 Harvest Guideline for 2005-2006

In Amendment 8 to the CPS FMP (PFMC 1998), the recommended MSY-based harvest control rule for Pacific mackerel is:

$$HG_{2005} = (\text{TOTAL STOCK BIOMASS}_{2005} - \text{CUTOFF}) \bullet \text{FRACTION} \bullet \text{STOCK DISTRIBUTION},$$

where HG_{2005} is the total U.S. (California) HG recommended for the 2005 fishing season (July 2005 - June 2006), TOTAL STOCK $BIOMASS_{2005}$ is the estimated stock biomass in 2005 (i.e., 101,147 mt; ages 1+ on July 1^{st}), CUTOFF is the lowest level of estimated biomass at which harvest is allowed, FRACTION is an environment-based percentage of biomass above the CUTOFF that can be harvested by the fisheries, and STOCK DISTRIBUTION is the percentage of TOTAL STOCK BIOMASS2005 in U.S. waters. CUTOFF (18,200 mt), FRACTION (30%), and STOCK DISTRIBUTION (70%) are currently 'fixed' terms in the harvest control rule. See section 4.0 (PFMC 1998) and MacCall *et al.* 1985 for analyses applicable to parameters included in the harvest control rule.

Based on the harvest control rule, the 2005 fishing season HG for Pacific mackerel is 17,419 mt. The HG_{2005} is roughly 31% more than the 2004 HG (13,268 mt) and it is generally similar to average annual yields realized over the last few years.

9.2 *Monitored Species*

Figure 1 illustrates distribution of northern anchovy and jack mackerel eggs for areas surveyed off Southern California, April 2005.

9.2.1 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 until 2000. California landings of northern anchovy reported by Pacific Coast Fisheries Information Network (PacFIN) totaled 11,752 mt in 2000; 9,187 mt in 2001; 4,650 mt in 2002; 1,676 mt in 2003; and 6,877 mt in 2004. There are no reported landings of northern anchovy into Oregon from 1981 through 2001, with 3.1 mt reported in 2002; 39 mt in 2003; and 13 mt in 2004. Washington reported about 42 mt in 1988, but didn't land more until 2003 when 214 mt was landed; no landings occurred in 2004. Through the 1970s and early 1980s, Mexican landings increased, peaking at 258,700 mt in 1981 (Table 15). Mexican landings decreased to less than 2,324 mt per year during the early 1990s. There was an increase in Mexican landings to 21,168 mt in 1995, primarily during the months of September through November. Catches in Ensenada were 4,168; 1,823; 972; 3,482; 1,562; and 76 mt in 1996-2001, respectively. There have been no catches reported for 2002. Landings in 2003 were at similar levels as those in the late-1990's at 1,287 mt.

Jacobson *et al.* (1995, 1997) summarized the disposition of northern anchovy landed in California. Beginning in 1965, when a reduction quota was first established separately from non-reduction uses, statistics for each use became available. All non-reduction uses are combined and include fresh, frozen, processed for human consumption, and dead bait. Mexican landings data first appear for 1962.

Total age 1+ biomass of northern anchovy rose in the early 1970s to a maximum estimate of 1,598,000 mt in 1973, and decreased to 392,000 mt in 1994. Further estimates of spawning biomass (age 1+) peaked in 1975 at 1,069,000 mt, and declined to 388,000 mt in 1994. Fishing mortality estimates in 1990 to 1994 did not exceed 0.03%, and declined to zero in 1993 and 1994.

9.2.2 Jack Mackerel

Until 1999, jack mackerel were managed under the Council's Pacific Coast groundfish FMP. Jack mackerel are now a monitored species under the CPS FMP. There is no evidence of significant exploitation of this species on the Pacific Coast of North America, and accordingly, there have not been regular stock assessments or efforts to collect biological information. Management efforts to collect fishery-dependent age composition data, such as the CDFG 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. Previous discussions of jack mackerel, such as in the groundfish FMP, were brief:

> Available data indicate that the current, nearly un-used spawning biomass is about 1 million mt, the natural mortality rate is in the range of 0.1 to 0.2, a fishery located north of 39° N latitude would harvest fish that are mostly older than age 16, and the long-term potential yield for this age range is 19,000 mt. The [Council's Groundfish Management Team] recommends continuation of the 52,600 mt ABC on the basis of a constant exploitation rate (equal to natural mortality) applied to estimates of current biomass of ages 16 and over. Biomass and short-term yield are expected to slowly decline under this level of exploitation. If this level of exploitation reduces long-term biomass to approximately 30% to 50% of the current biomass, the long-term average yields for this age range would be near 19,000 mt. The GMT recommended close tracking of this fishery and the age composition of the harvested fish, particularly if catches are begun outside the exclusive economic zone (EEZ). (PFMC, 1998.)

Currently, most landings of jack mackerel are incidental to Pacific sardine and Pacific mackerel in California; however, pure landings do occur sporadically. In California, CDFG landing receipts for jack mackerel totaled 1,269 mt in 2000; 3,624 mt in 2001(these may be somewhat over-reported – the jump in jack mackerel landings in 2001 coincided with an early closure of the Pacific mackerel HG); 1,006 mt in 2002; dropped to only 189 mt in 2003; and 1,199 mt in 2004. Landings of jack mackerel in the California Pelagic Wetfish fishery 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.

Oregon reported 161 mt in 2000, 183 mt in 2001, 8.9 mt in 2002, 73.6 mt in 2003, and 125.8 mt in 2004. Washington reported 11.5 mt in 2002, and 1.8 mt in 2003, but none was specified in 2004.

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. Most of the contemporary catch is in small aggregations of young fish along rocky shores.

9.2.3 Market Squid

Currently, only limited information is available regarding market squid population dynamics and further, data concerning historical and current levels of absolute biomass are unavailable. A STAR Panel was convened in May 2001 to evaluate assessment methods for use in the management of the squid fishery and ultimately, to assess the appropriateness of defining MSY for this species. Preliminary attempts to estimate biological reference points (e.g., MSY, F_{MSY}, and B_{MSY}) from surplus production models were unsuccessful. In view of the difficulties in determining traditional estimates of MSY for market squid, and given new, albeit limited, information on reproductive biology was available, the STAR Panel focused attention on reference points based on "egg escapement" and its related concepts. Egg escapement is defined here as the number (or proportion) of a female squid’s potential lifetime fecundity that she is able to spawn, on average, before being harvested in the fishery. An Egg Escapement Method (see Appendix 3 in the 2002 SAFE document) based on conventional yield and spawning biomass "per recruit" models was fully developed by the STAT and the STAR Panel and subsequently, supported by the SSC, the CPSMT, and the CPSAS.

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 the fishing mortality that results in MSY (F_{MSY}). However, it is important to note that this approach does not provide estimates of historical or current total biomass and thus, a definitive yield (i.e., quota or ABC) cannot be determined at this time. Ultimately, the Egg Escapement Method can be used to assess whether the fleet is fishing above or below and a priori-determined sustainable level of exploitation and in this context, can be used as an effective management tool.

The STAR Panel provided general recommendations regarding analytical methods (i.e., the Egg Escapement Method) and left determination of specific model configurations and other management-related parameters to the CPSMT. In this context, the CPSMT provided guidance concerning four critical areas of the Egg Escapement Method, which was necessary to develop a pragmatic framework for monitoring/managing this species in the future, (1) selection of a "preferred" model scenario; (2) selection of a "threshold" level of egg escapement that can be considered a warning flag when tracking the status of the population; (3) fishery operations in (and after) El Niño/Southern Oscillation (ENSO) events; and finally, (4) necessary management-related constraints. Readers interested in details regarding assessment methods, STAR-related discussion and conclusions, and CPSMT decisions should refer to papers presented in Appendix 3 of the 2002 SAFE.

Finally, data collection programs and subsequent laboratory analysis has continued to the present in attempts to complement baseline sample information that served as the foundation for developing the Egg Escapement Method described above. That is, as discussed generally in CPS-related documents presented in Appendix 3 of the 2003 SAFE, further work surrounding the Egg Escapement assessment approach has addressed the following: (1) collecting much needed reproductive sample information from the fisheries to bolster the original source of data that was relied upon initially when developing the overall Egg Escapement Method–additional sample data span from 1999-2005; (2) critically evaluating spatial/temporal patterns of the overall fishery through stratified sampling and subsequent analysis 1999-2005; (3) in concert with the CPSMT, preparing preliminary analysis-related schedules that could be accommodated within the Council forum and meet the stipulations required for 'monitored' species (also see Section 6.1.1); and (4) conducting simulation modeling to further examine the relationship between critical biological reference points (i.e., 'threshold' levels) and absolute levels of squid population abundance off southern California–results from this research will be presented in a working paper that will be distributed (via CPSMT discussions) in 2005.

9.2.3.1 California's Market Squid Fishery

The California market squid fishery is separated at Point Conception into northern and southern fisheries. Historically, the northern fishery accounted for the majority of the catch. Since the early 1980s, the southern fishery has continually increased its landings and has been dominant since the mid-1980s. Typically, the northern fishery occurs during the summer months and the southern fishery in the winter months. In 1999, the southern California fishery began operating nearly year-round, because market squid was readily available during most of the year in southern California. This trend has continued to date, although landings generally decrease in the summer months as compared to the rest of the year.

In 2004, the market squid fishery continued to be one of the largest fisheries in the state, with landings estimated at 40,324 mt. This is 10% less than in 2003 (44,965 mt) and 66% less than the record high set in 2000 (118,827 mt). The ex-vessel price ranged from $150-$750/mt, with an average of $450/mt. The 2004 exvessel value was approximately $19.9 million, a 22% decrease from 2003 ($25.4 million).

The fishing permit season for market squid runs from 1 April through 31 March the following year. During the 2004/2005 season (as opposed to the 2004 calendar year), 46,211 mt were landed, 15% less than the 2003/2004 season (54,636 mt). The northern fishery continued to experience a decline in catch levels during the 2004/2005 season. Only 6,571 mt was landed, a 62% decrease from the 2003/2004 season (17,399 mt). The southern fishery once again surpassed the northern fishery with 39,640 mt landed (86% of the catch) during the 2004/2005 season. This was a 6% increase from the 2003/2004 season (37,237 mt).

Market squid remains an important international commodity. Squid is used domestically for food and bait and are packed and processed for export. In 2004, approximately 13,580 mt of market squid were exported for a value of $16.9 million. Asian countries were the main export market with China and Japan taking about 60% of the trade.

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

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 107,047 mt (118,000 short tons) 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 Gulf of the Farallones National Marine Sanctuary. Under this framework, the MSFMP provides the Commission specific guidelines for making management decisions. The Commission has the ability to react quickly 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 achieve the goals and objectives of the Marine Life Management Act and to be consistent with the management outlined in CPS FMP Amendment 10.

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10.0 EMERGING ISSUES

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

10.1 Pacific Sardine

In April 2003, the Council adopted an interim (through 2005 fishing season) allocation framework that seeks optimal use of the annual Pacific sardine HG with minimal impacts on all sectors of the West Coast sardine fishing industry and communities. The CPSMT generally agreed that the impacts of the interim allocation scheme used to partition the Pacific sardine HG were primarily socioeconomic. However, the development of a long-term allocation framework would require that the biological-based implications of different allocation schemes be further evaluated to provide management guidance regarding how the operations of the sectoral fisheries might affect the dynamics of the sardine population at large. Thus, a comprehensive analysis was conducted regarding alternative allocation frameworks, particularly in terms of long-term socioeconomic impacts; results from this analysis were presented to the Council over a series of meetings from 2004-2005.

Further, although this allocation issue primarily influenced socioeconomic factors associated with the fishery, there does exist broad biological questions that arise, given the relation between this species' biology and how quotas are implemented spatially and temporally across the state-based fishery sectors of Southern California, Northern California, and Pacific Northwest (PNW):

- What are impacts to the coastwide sardine resource from a fishery that targets older, mature fish vs. a fishery that targets younger, immature fish?;
- Are there indications of changes in sardine maturity rates (i.e., delayed maturity) in the southern fisheries resulting from density-dependent factors?; and
- Are there potential refinements to the sardine assessment and/or harvest control rule in response to new biological information?

To address these questions, biological information has been collected from NMFS research surveys off the PNW. That is, the PNW research surveys have occurred in July 2003, March and July 2004, and a survey is tentatively planned for winter 2005. These Southwest Fisheries Science Center-based surveys included sardine acoustic trawl and Continuous Underway Fish Egg Sampler (CUFES) surveys off the coast of Oregon and Washington. The surveys are designed to fill major gaps in knowledge of sardine populations, by measuring the age structure and reproductive rates, and assessing the extent the fishery is dependent on migration and on local production of sardine. The primary objective of the surveys is to accumulate additional biological data regarding the northern expansion of the population into waters off the PNW and ultimately, to include data directly (or indirectly) in ongoing stock assessments of both Pacific sardine and Pacific mackerel.

Finally, many review bodies (CPSMT, SSC, and STAR-related) have strongly recommended that synoptic research surveys be implemented to ensure results are representative of the entire range of this species (as well as other coastal pelagic species of concern). That is, developing and conducting such a survey will necessarily require considerable additions to current budgets, staff, and equipment (see Section 11).

10.2 Pacific Mackerel

At this time, emerging issues for Pacific mackerel are similar to those described for Pacific sardine. New assessment methodology for Pacific mackerel is included in the June 2004 CPS STAR.

As the Pacific mackerel abundance estimate has decreased over the past several years, the CPSMT discussed overfishing concerns related to this fishery. Based on the current modeling approach and the harvest control rules in the FMP, there is, currently, not a concern related to overfishing of Pacific mackerel. Historically, intermittent periods of high recruitment have supported relatively high amounts of fishing pressure. However, more recently, protracted periods of generally lower recruitment have contributed to lower levels of spawning stock and total biomass. Fishing pressure is largely influenced by availability of the resource to the fishery, as well as market factors. The U.S. West Coast Pacific mackerel fishery targets the mackerel in the northern parts of its overall range and in inshore waters. It is possible that mackerel abundance could be strong south of the U.S. border and/or in offshore waters beyond the range of the U.S. West Coast CPS fleet. Also, as in other CPS fisheries, market dynamics greatly influence total harvest. While mackerel is desirable it is not as important to the CPS fishery as Pacific sardine and market squid. In addition, most commercial harvest of Pacific mackerel occurs within the area under limited entry as defined by the CPS FMP. Under the limited entry system, overall effort on Pacific mackerel is constrained by a cap on harvest capacity. Thus, given the reasons above, the level of fishing effort relative to mackerel abundance should not give rise to immediate concern. However, model estimates of the spawning stock and recruitment relationship indicate little to no reproductive-related compensation at low levels of spawning stock biomass. Thus, issues surrounding recruitment-based overfishing should be monitored closely.

Overfishing for Pacific mackerel is defined in the CPS FMP as harvest exceeding ABC for two concurrent years. Recent landings have been well below ABC. Also, the cutoff value in the harvest control rule serves as a proxy for determining if mackerel is overfished. The cutoff value equates to a biomass estimate of 18,200 mt. The current biomass estimate of 101,147 mt is well above the cut off value.

10.3 Market Squid

Recently, it has been observed that the northern fishery (Monterey Bay) that exploits the squid resource off California does not operate in a similar manner as observed in the southern fishery, e.g., patterns of fishing in the day vs. the night (see Sections 6.1.1 and 9.2.3) and gear-related impacts to squid egg beds on or near the ocean floor. The differences between the two fisheries may have considerable influence to the state-wide monitoring programs currently in place, as well as results generated from the assessment method recently adopted for this marine resource. This issue should not be considered a trivial one, given that due to limited amounts of sample information, the population analysis recently developed for this species (i.e., the Egg Escapement method, see Section 9.2.3) was strictly based on rather broad stock distribution assumptions. That is, the recent observations regarding differences in fishery operations north and south of Point Conception necessarily dictate more detailed data collection programs and subsequent analysis to ensure that spatio-temporal patterns related to the squid population(s) are considered when assessing the overall status of the exploited resource. In this context, over the next year, the CPSMT will discuss, develop, and bring forth to the Council a workable monitoring/analysis schedule that is based on more detailed (stratified spatially and temporally) analysis of the accumulated data to date. Since fall 2003, the SWFSC and CDFG have coordinated research efforts that involve simulation modeling that will generally focus on important biological reference points included in the Egg Escapement method, such as the relationship between reproductive-based thresholds and absolute population abundance levels for this species (see also Section 4.3.4). Preliminary results from this research should be available in 2005.

10.4 Management Issues

Emerging management issues include krill management, market squid overfishing definition; international CPS fisheries; and standardized bycatch reporting, including at-sea observers in California-based CPS fisheries.

10.4.1 Krill Management

At the November 2004 meeting, the Council, initiated development of a formal prohibition on directed fisheries for krill and directed staff to begin development of management measures to regulate directed fisheries for krill within Council-managed waters. These measures are recommended to be incorporated into an amendment to the CPS FMP. The Council also included a specific alternative for analysis that would prohibit directed krill fisheries within waters of West Coast National Marine Sanctuaries.

This proposed action is 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, respectively. Thus, the action could provide for consistent federal and state management. There are currently no directed krill fisheries in Council-managed waters.

The NMFS has taken the lead on this proposed krill amendment and briefed the Council and advisory bodies on progress at the March and April 2005 Council meetings. The Council anticipates an update by NMFS at the September 2005 meeting including a review of draft regulatory and environmental compliance documents. Council final action and regulatory implementation are tentatively scheduled for spring and summer 2006 respectively.

10.4.2 Bycatch Reporting and Observer Programs

The CPS FMP may not currently fully comply with bycatch provisions of the Magnuson-Stevens Act. The States of Oregon and Washington have had observers on vessels indicating there is not a bycatch problem to the north (see Chapter 6), but very little field information is available for the California fishery. While CDFG port sampling suggests there is not a bycatch problem, port sampling alone is insufficient to demonstrate with assurance that there is not a bycatch problem. Therefore, NMFS is planning to place observers on some California-based CPS vessels in a pilot project intended to provide better information on the extent to which there is bycatch in this fishery (see Section 11.6). NMFS will work with the CPSMT to consider the need for additional field observations and possibly consider alternative ways to address any bycatch issues identified, as required by the Magnuson-Stevens Act.

10.4.3 Market Squid Overfishing Definition

With respect to market squid, it appears that there is a need to address further the prospective use of the egg escapement value as a proxy for maximum sustainable yield and as a value for determining if the stock is overfished or is subject to overfishing (i.e., minimum stock size and maximum fishing mortality threshholds). Based on the most recent review for the annual NMFS Report to Congress on the status of fish stocks, NMFS notified the Council that the current FMP language is ambiguous. However, because NMFS is considering amendments to National Standard 1 Guidelines and changes could affect the way in which this issue might be addressed. Nonetheless, NMFS believes it would be prudent for the Council to direct the CPSMT to consider this issue and to be prepared to advise the Council as to possible revisions once any changes to the Guidelines have been proposed.

10.4.4 International CPS Fisheries

Second, there has been interest in coastwide management for the Pacific sardine fishery which would entail a more consistent forum for discussion between the U.S. and Mexico. Recent U.S.-Mexico bilateral meetings indicated a willingness from Mexico to continue scientific data exchange and cooperation on research, and has expressed a willingness to engage in some discussions of coordinated management. Mexico suggested that the Trinational Sardine Forum would be a good venue for starting that discussion. Mexico also agreed to host a Mexico-U.S. scientific meeting to discuss CPS. The meeting is slated to take place in Ensenada, Mexico in November of 2005.

11.0 RESEARCH AND DATA NEEDS

Several recent developments highlight the need to enhance current assessment procedures in order to meet the requirements of the FMP. These include (1) the development of a high-volume fishery for Pacific sardine in Oregon and Washington; (2) increasing recognition of the importance of CPS as principal forage for many salmon and groundfish stocks that are currently at low abundance levels; (3) the importance of CPS biomass estimates to the Council's annual determination of allowable coastal pelagic harvests; and (4) the need to monitor status of the market squid stock using data-intensive techniques. A pressing need exists for stock assessments that accurately reflect the reproductive characteristics of CPS stocks throughout their geographic range and for additional stock assessment personnel in NMFS and the three Pacific Coast states to carry out these assessments.

The highest priority research and data needs for CPS are:

- 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.
- There is a need to develop a formal review process for the harvest control rules for Pacific sardine and Pacific mackerel. Currently this review is not part of the stock assessment process.
- 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 scientists.
- Evaluate the role of CPS resources in the ecosystem, the influence of climatic/oceanographic conditions on CPS and define predatory-prey relationships.
- Collect detailed cost-earnings data to facilitate analyses for long-term changes to the sardine allocation structure.

11.1 Pacific Sardine

The Trinational Sardine Forum (Mexico, U.S., and Canada) met again in 2004 to discuss issues related to the rapidly recovered sardine population and fishery along the West Coast of North America. The Forum has identified several issues for priority work. Issue 1 is developing cooperative relationships with the fishing industry to provide fishing vessel platforms for critical studies of the life history of sardine. Issue 2 is to standardize fishery-dependent data collection among agencies, particularly age and size data, and improve exchange of this data in summarized form to stock assessment scientists. Issue 3 is the need to assemble mutually compatible fishery assessments off of the West Coast of Mexico, U.S., and Canada to form a baseline of stock status and variability of possibly more than one interbreeding stock of sardines, or a temperature-derived phenotype with radically heterogeneous population parameters influencing HGs. Coastwide sea surveys which include egg and adult samples are viewed as a top priority. Otolith microchemistry and DNA analyses are promising tools to improve our knowledge of sardine stock structure.

11.2 Pacific Mackerel

California's Pacific mackerel fishery has been sampled by CDFG for age composition and size-at-age since the late-1920s. The current stock assessment model incorporates a complete time series of landings and age composition data from 1929 onward. Ensenada (Baja California) landings have rivaled California's over the past decade, however, no biological information is readily available from Mexico's fishery. Landings are accounted for in the assessment, but size and age composition are assumed to be similar to the San Pedro, California fishery. Like sardine, there is a need to establish a program of port sample data exchange with Mexican scientists (INP, Ensenada) to fill this major gap in the stock assessment.

Fishery-independent survey data for measuring changes in mackerel recruitment and spawning biomass are generally lacking. The current CalCOFI sampling pattern provides information on mackerel egg distributions in the Southern California Bight, the extreme northern end of the spawning area. Mexican scientists have conducted a number of egg and larval surveys off of Baja California in recent years (e.g., IMECOCAL program). Access to these data would enable us to continue the historical CalCOFI time series, which begins in 1951. This information could be directly incorporated into the assessment model. Night-light surveys for newly recruited Pacific mackerel should be re-instituted in the Southern California Bight. Surveys following protocols employed during CDFG Sea Survey cruises (1950-1988) could allow splining the new recruitment data set to the historical time series. The new time series would represent the only recruitment index in the mackerel stock assessment and would strengthen the ability to accurately forecast age zero and total stock abundance for each coming fishing season.

Pacific mackerel biomass has been declining since the early 1980s, but recent El Niño events have concurrently extended their northern range to British Columbia. Pacific mackerel are caught incidentally in the Pacific whiting and salmon troll fisheries. Pacific mackerel are regularly caught in triennial survey trawls off the Pacific Northwest. A simple reporting system is needed to document incidental take of mackerel in fisheries to the north. Presence-absence information may allow us to detect southward movement or further decreases in biomass.

11.3 Market Squid

Currently, there exists only limited understanding of market squid population dynamics, which necessarily has hampered assessing the status (health) of this valuable marine resource found off California. 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. However, at this time, there is considerable variability (uncertainty) surrounding many of these estimated parameters. In this context, the CPSMT strongly advises that extensive monitoring programs continue for this species, including tracking fishery landings, collecting reproductive-related data from the fishery, and obtaining fishermen-related logbook information.

Although some information exists on coastwide squid distribution and abundance from fishery-independent midwater and bottom trawl surveys largely aimed at assessing other finfish species, there is no reliable measure of annual recruitment success beyond information obtained from the fishery. Given 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. That is, 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 remain largely 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. Additionally, fecundity, egg survival, and paralarvae density estimates are needed from different spawning habitats and oceanographic conditions associated with the population. Furthermore, information describing mechanisms and patterns of dispersal of adults (as well as paralarvae) along the coast is required to clarify how local impacts might be mitigated by recruitment from other areas inhabited by this short-lived species.

Although some fishery effort information is now being collected with a newly-implement 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. Continuation and/or establishment of annual surveys using midwater trawls, bottom trawls, remotely operated vehicles (ROVs), and satellite and aerial surveys would also provide useful information for developing alternative indices of abundance other than those derived from logbook data.

Potential impacts to essential fish habitat (EFH)-related issues would most likely arise in concert with fishing activity by the purse-seine fleet on spawning aggregations in shallow water when gear potentially makes contact with the sea floor (see Section 6.1.1). 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.

Currently, market squid fecundity estimates, based on the Egg Escapement Method (see Section 9.2.3), are used to assess the status of the stock and evaluate biological reference points, such as 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, it is imperative that each receive further 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 CDFG port sampling program currently in place will provide information on the age and maturity stages of harvested squid. Also, the CDFG logbook program should be maintained (and bolstered) for purposes of developing alternative tools for assessing the status of the resource. Further, laboratory work concerning general mantle condition, especially the rate of mantle 'thinning,' will likely benefit the current understanding of squid life history and subsequently, help improve the overall assessment of this species. Finally, other biological-related parameters that are currently poorly understood generally surround spawning and senescence, (e.g., life history strategies concerning spawning frequency, the duration of time spent on spawning grounds, and the period of time from maturation to death).

11.4 Live Bait Fishery

Although tonnage of CPS and squid taken in the live bait fishery is minimal compared with volume taken in the commercial fishery, better estimates of live-bait landings and sales of sardine, anchovy and squid is essential as it pertains to estimates of the overall economic value of these fisheries. Outdated estimates have previously shown that the value of the live-bait fishery for sardine has equaled that of the commercial catch. In the case of squid, there is no documentation of the dramatic expansion of live-bait sales in southern California made by commercial light vessels in recent years.

The live bait fishery supplies product for several recreational fisheries along the Pacific Coast, primarily in southern California, but as far north as Eureka. Live bait catch is generally comprised of both Pacific sardine and northern anchovy; the predominant species depends on biomass levels and local availability. Recent landings estimates range between 5,000 mt and 8,000 mt annually statewide, with effort increasing in summer months. However, these estimates are based only on logbooks provided by a limited number of bait haulers, and estimates provided by the CPFV industry. Since the sale of live bait in California is not permitted in a manner similar to that used for the commercial sale of CPS, estimates of tonnage and value are imprecise. Therefore, no estimates of volume or value for the sale of market squid for live bait are available at this time. However, in 2005 the CDFG will reexamine reporting requirements and data needs to better estimate landings and value.

11.5 Socioeconomic Data

Economic analyses of management actions effecting coastal pelagic fisheries requires detailed, representative cost and earnings data for the sardine harvesters and processors making up each fishery sector. Experience with the long-term allocation of the Pacific HG emphasizes this need, and moreover underscores the necessity to collect these data on a routine basis. Collecting such data as needed to address an issue at hand makes them suspect in a number of regards particularly in terms of strategic bias.

A step in this direction has been taken with the advent of a bycatch observer program for coastal purse seine vessels participating in CPS fisheries. Observers will be collecting economic data on the vessel's fishing operations during observed trips. The key will be designing the program to provide observer coverage that satisfy the requirements in terms of obtaining representative bycatch data as well as vessel economic data. This data collection effort would have to be supplemented with an onshore complement to obtain comprehensive economic data for harvesting vessels.

A parallel effort will need to be taken with regard to processors. To be able to fully evaluate the economic impacts of proposed management actions detailed, representative cost and earnings data for west coast sardine processors will also be needed on a routine basis. This will entail periodic surveys of CPS processors to collect representative economic data on their processing operations.

11.6 California Observer Program

Bycatch in the California contingent of the CPS fishery has been qualitatively monitored by the CDFG's dockside monitoring program since the mid-1980s (Sweetnam and Laughlin, Pers. Comm., 2005). CDFG only gives qualitative descriptions of bycatch meaning they do not document the amount or quantity of bycatch but rather only document the species or type of bycatch encountered at the fish processing plant. In order to confirm bycatch rates derived from CDFG's dock-side sampling, NMFS started a pilot observer program in July 2004 on the California purse seine fishing vessels landing CPS in the limited entry fishery. The pilot observer program's main focus is to gather data on total catch and bycatch, and on interactions between their fishing gear and protected species such as marine mammals, sea turtles, and sea birds. From July 20, 2004 to May 4, 2005, observers have observed approximately 56 vessel trips. The trips range from San Diego, California, in the south to Moss Landing, California, in the north. Out of 56 trips, 19 targeted Pacific sardine, 32 targeted market squid and 5 targeted northern anchovy. NMFS will be producing a detailed report on bycatch and protected species interactions for the November 2005 Council meeting.

11.7 References

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12.0 ECONOMIC STATUS OF WASHINGTON, OREGON, AND CALIFORNIA CPS FISHERIES IN 2004

This section briefly summarizes economic data presented in the Economic Appendix – Economic Status of Washington, Oregon, and California CPS Fisheries in 2004. Pacific Coast landings of CPS totaled 141,191 mt in 2004, a 19% increase from 2003. Market squid landings, all in California, were 31,596 mt in 2004, down 12% from 2003. Pacific sardine landings increased in 2004, rising to 89,623 mt, up 25% from 2003. The exvessel value of 2004 CPS landings was $31.2 million in 2004, down 9% from 2003 (2003 converted to 2004 dollars). Market squid accounted for 28%, and Pacific sardine 63% of total landings in 2004. Landings of Pacific mackerel decreased 12%, and landings of northern anchovy rose 268% from 2003 to 2004. Real exvessel market squid revenues (2004 $) decreased 25% from 2003; decreased landings were accompanied by a 14% decrease in exvessel price from $575 to $492 per mt (2004 $). Aggregate CPS finfish landings increased 39% from 2003; exvessel revenue rose 38% and the overall finfish exvessel price went up 6% in 2004. In 2004, market squid made up almost 6% of the exvessel value of total Pacific Coast landings, and CPS finfish accounted for almost 3%. California accounted for 63% of coastwide CPS landings in 2004, down from 68% in 2003.

California sardine landings were 44,555 mt in 2004 up 34% from 2003, 33,139 mt. Market squid ranked second in exvessel value among California commercial fisheries in 2004, with exvessel revenue of, $19.5 million, 51% less than that for Dungeness crab, the most valuable California fishery in 2004. Landings of Pacific sardine ranked seventh highest in California exvessel value in 2004 at $4.0 million. California Pacific mackerel landings were 3,576 mt in 2004, down 10% from 2003. California landings of Northern anchovy were 6,849 mt in 2004, up 341% from 2003, 1,553 mt.

Pacific sardine landings in Oregon increased 43% in 2004, from 25,258 mt in 2003 to 36,111 mt in 2004. Sardine generated $4.9 million in exvessel revenue for Oregon in 2004, 5% of total exvessel revenue, ranking it fifth behind Dungeness crab in total exvessel value. Washington landings of Pacific sardine decreased 25% from 11,920 mt in 2003 to 8,934 mt in 2004. With an exvessel revenue of $1,2 million, 1% of the Washington total in 2004, sardine ranked 14th behind Dungeness crab in exvessel value.

Oregon landings of Pacific mackerel fell from 160 mt in 2003 to 106 mt in 2004. Washington landings of Pacific mackerel decreased from 54 mt to 22 mt and anchovy landings remained unchanged from 2003 at 229 mt.

In 2004, the number of vessels with Pacific Coast landings of CPS finfish was 195, down from 179 in 2003. With the increase in vessels and an increase in total CPS finfish landings, finfish landings per vessel, 521 mt in 2004, increased 20% from 2003. Of the CPS finfish vessels active in 2004, 37% depended on CPS finfish for the largest share of their 2004 exvessel revenues. From 2003 to 2004, the number of vessels with Pacific Coast landings of market squid increased from 188 to 206, with 21% of these vessels dependent on market squid for the largest share of their total 2004 exvessel revenue. Market squid landings were 192 mt per vessel in 2004, down 12% from 2003. Market squid total revenue shares for vessels that depend mainly on market squid have been higher on average than average finfish total revenue shares for vessels that depend primarily on CPS finfish, suggesting that market squid vessels tend to be more specialized than CPS finfish vessels. Roundhaul gear accounted by far for the largest share of total CPS landings in 2004, dip net gear was a far distant second.

The major West Coast processors and buyers of CPS finfish are concentrated in the Los Angeles, Santa Barbara-Ventura, Monterey and Oregon-Washington Columbia River port areas. The exvessel markets for market squid are mainly in the Los Angeles, Santa Barbara-Ventura and Monterey port areas.

In 2004, 29,533 mt of market squid were exported through West Coast customs districts with an export value of $37.0 million; a 34% increase in quantity, and a 28% increase in the real value of West Coast market squid exports from 2003. The primary country of export was China, 33% of the total, which received 11,050 mt, 6% less than the quantity exported to China in 2003. Seventy-six percent of market squid exports went to China and four additional countries: Japan (5,090 mt), Spain (2,774 mt), Philippines (1,930 mt), and Mexico (1,612 mt). Domestic sales were generally made to restaurants, Asian fresh fish markets or for use as bait.

Seventy-seven percent, 68,951 mt, of Pacific sardine landings were exported in 2004, exports were up 23% from 2003; most of the remaining landings were consumed domestically as canned Pacific sardine. Pacific sardine exports were valued at $60.7 million in 2004, up 49% from 2003. Almost 80% of Pacific sardine exports were in the frozen form, the balance was in the preserved form. Japan was the primary export market in 2004, receiving 31,197 mt, up 12% from 2003, and 45% of total exports. Australia was second with 9,896 mt, 14% of the total a 14% increase from 2003. Japanese demand for Pacific sardine is for both human consumption and use as bait in its longline fisheries. West Coast Pacific sardine exports to Australia are primarily for feed in Australia's bluefin tuna farming operations.

13.0 ESSENTIAL FISH HABITIAT

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-Stevens Act, the federal law that governs U.S. marine fisheries management. The re-named Magnuson-Stevens Act mandated the identification of EFH for managed species as well as measures to conserve and enhance the habitat necessary to fish to carry out their life cycles. The Magnuson-Stevens Act requires cooperation among 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.”*

Each Council and NMFS are expected to review the EFH components of FMPs. Each FMP EFH identification recommendation and amendment should include a provision to review and update EFH information and prepare a revised FMP amendment if new information becomes available. 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 (62 *FR* 66531, December 19, 1997).

In order to comply with the provisions of EFH, NMFS sent a letter to the Council on April 30, 2004, describing the need for a five-year review of EFH provisions of all FMPs. NMFS SWR sent a letter to the Council (May 18, 2004) asking the Council to direct the CPSMT to initiate the reassessment of EFH for CPS. In order to help guide the CPSMT in their documentation and process of their five-year EFH review the SWR Sustainable Fisheries Division (SFD) contacted the Office of Habitat Conservation (HC) at NMFS Headquarters (Silver Spring, Maryland). An initial conference call between SFD and HC was held on September 8, 2004, with the goal of providing the CPSMT with a detailed description of the documentation needed (see 13.2) to perform a five-year EFH review.

13.1 Procedures for five-year Review of CPS EFH

The approach that NMFS and the Council agreed upon was to have the CPSMT write a detailed report of their five-year review of CPS EFH in this SAFE document and to have the Council officially adopt this SAFE document at their June 2005 Council meeting. Below are the details to be included in the CPSMT’s five-year CPS EFH review.

1. Ask the CPSMT write a detailed description of the five-year CPS EFH review in the 2005 CPS SAFE document including the following details:

    A. Address whether the original data used to identify and describe CPS EFH continues to be accurate.
    B. What, if any, new data is available that may help describe CPS EFH.
    C. Address whether the original fishing gear impacts analysis is consistent with any new data, including any analyses of similar gear used in other fisheries.

D. Address how the HG control rule in the CPS FMP uses a "cutoff" to provide adequate forage for dependent species.
E. State what data was used to define the current CPS EFH as being defined by dynamic temperature gradient of 10-26 degrees Celsius. Address why the existing EFH description could not be refined to a specific area as a result of using historical temperature data.
F. Document that the CPSMT is represented by a distinguished group of biologists from NMFS and from the states of California, Oregon, and Washington.
G. Document that the stock assessment process, model and input data were formally reviewed by a Council-sponsored STAR Panel in June of 2004.

2. Have the Council officially adopt the EFH five-year review conclusions of the CPSMT (as reported in the 2005 CPS SAFE document) at their June 2005 meeting.

13.2 Documentation of Five-year Review of EFH

All discussions of the five-year review of CPS EFH have been documented in order to keep a record of the review process performed by the CPSMT. The review process was triggered when the Assistant Administrator for NMFS, Dr. William Hogarth, sent a letter to the Council on April 30, 2004, describing the need for a five-year review of EFH provisions of all FMPs. The SWR then sent a letter to Council on May 18, 2004 asking the CPSMT to initiate the reassessment of EFH for CPS. At the same time the CPSMT was conducting their review, the SWR consulted with NMFS Headquarters Habitat Office of Conservation in a September 8, 2004 conference call which resulted with the process and documentation procedure (Section 13.1) for the five-year CPS EFH review. The SWR emailed the approved procedures to the Council on November 9, 2004, and received a letter (December 29, 2004) from the Council to Dr. Hogarth detailing the CPSMT's initial conclusions about the current EFH information and their approval to use the process recommended by NMFS for formal Council review.

The CPSMT reviewed CPS EFH at their August 5, 2004 CPSMT meeting in Portland, Oregon. At the September 13-17, 2004 Council meeting in San Diego, California, the CPSMT concluded in their report concluding that they were "not aware of any new information that could warrant modification of current EFH designations for CPS. Moreover, there appears to be no evidence to support development of static definitions of CPS EFH as opposed to the current dynamic definition. That is, CPS EFH is linked to ocean temperatures, which shift temporally and spatially, providing a dynamic definition of EFH."

The CPSMT consists of a top-notch group of biologists from state (Oregon, Washington, and California) fisheries departments and NMFS. All members have many years of experience and education that make them experts in their field and on CPS issues. Further, the some of the members of this CPSMT are also members of the STAT from the SWFSC that produce the stock assessments of Pacific sardine and Pacific mackerel. Their stock assessments, the stock assessment model, data input and the work of the CPSMT were all formally reviewed by a Council-sponsored STAR Panel in June of 2004. The STAR Panel was made up of outside (non NMFS) reviewers from California Department of Fish and Game (Tom Barnes), University of Washington (Andre Punt), Chile (Rodolfo Serra), and Department of Fisheries and Ocean, Canada, (John Wheeler). The STAR Panel directed the STAT to use the new stock assessment model and concluded that the STAT produced stock assessments that provide good management advice.

13.3 Description of EFH

Because the CPSMT concluded that there are no reasons to substantiate a change to the definition of EFH at this time, the description of EFH will remain the same as that identified as EFH by Amendment 8 to the FMP (PFMC, 1998). A detailed description of EFH for CPS may be found in Appendix D of the CPS FMP (PFMC 1998). In determining EFH for CPS, the estuarine and marine habitat 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. 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.

13.4 Effects on EFH

No regulatory actions have effected EFH for CPS fisheries since the inception of the CPS FMP (Amendment 8). No new data on the CPS species biology or CPS fisheries has come to light to change the definition EFH since the December 1998 CPS FMP. EFH for CPS is based on biological aspects of the 5 species managed or monitored under the CPS FMP, thus the original identification still remains the best description of current EFH. CPS species are an important source of forage for species not managed by the FMP; therefore, the HG formula in the FMP provides for adequate forage for these dependent species (by using a “cutoff” which is the lowest level of estimated biomass at which a directed harvest is allowed). In June 2004, the Pacific Sardine and Pacific Mackerel stock assessment processes, models and input data were formally reviewed by a Council-sponsored stock assessment review. Additionally, fishing for CPS is not likely to effect EFH because fish removals will not reduce the prey species and the gear type is not likely to effect the bottom habitat as contact between purse seine gear and substrate has been identified as rare in fishing for Pacific sardine because fishing usually occurs in waters deeper than the height of the net (CPS FMP, 1998). Thus, the only opportunity for damage to benthos or EFH for any species in fishing for CPS is from lost gear. To further substantiate the conclusion that fishing for CPS using purse seines is not likely to be impact EFH, NMFS, Northeast Fisheries Science Center (NEFSC) produced a draft environmental impact statement (DEIS) that concluded that purse seines do occasionally contact the seafloor and may impact benthic habitats utilized by a number of species, however, after reviewing all the available information, NMFS concluded that if the quality of EFH is reduced as a result of this contact, the impacts are minimal and/or temporary and, pursuant to Magnuson-Steven Act, do not need to be minimized (NOAA Fisheries, 2004).

13.5 References

NOAA Fisheries, Northeast Fisheries Science Center. 2004. Draft Environmental Impact Statement for minimizing impacts of the Atlantic herring fishery on essential fishing habitat. Glouchester, MA. 290 pp.

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