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 fifth *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 stocks assessments for Pacific mackerel and Pacific sardine, Appendix 2), 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 (NMFS); Mr. Brian Culver (WDFW); Dr. Kevin Hill (NMFS); Ms. Leeanne Laughlin (CDFG); Ms. Jean McCrae (ODFW); and Mr. Dale Sweetnam (CDFG). Ms. Tonya Ramsey (NMFS), Mr. Dan Waldeck (Council staff), Ms. Michele Robinson (WDFW), Ms. Heather 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 (which would have resulted 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, 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

Amendment 8

Development of Amendment 8 to the northern anchovy FMP[1/] 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

1/ This document was subsequently re-titled the Coastal Pelagic Species Fishery Management Plan. References to Amendment 8 and CPS FMP refer to the same document.

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.

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 of Commerce (Secretary) approved Amendment 9 on March 22, 2001, and the final rule implementing Amendment 9 was published August 27, 2001 (66*FR*44986).

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).

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, CA) to 39° N latitude (Point Arena, CA), (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 will be in place for the 2003 and 2004 fishing seasons. It could also be used in 2005 if the 2005 harvest guideline is at least 90% of the 2003 harvest guideline.

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

2.3 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 62 vessels (Table 3). The LE vessels range in age from 3 to 67 years, with an average age of 32 years (Table 4). Average vessel age has decreased by approximately 3 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 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 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 88.1 GT (Tables 3 and 4). Total fleet GT decreased from 5,775.2 GT to 5,462.9 GT during 2003. This decrease was due to the permanent loss of two permits (numbers 6 and 16) and the loss of the "Miss Juli" (permit 27; sank in 2001), which is yet to be replaced by the owner. The "Jenny Lynn" (permit 46) sank in 2003 and the permit was transferred by owner to the "Corva May", which has a slightly smaller GT. 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 5,462.9 GT, well within the bounds of the capacity goal.

2.3.2 Northern Fisheries

In Oregon, Pacific sardine is managed as a developmental fishery. In 2003, 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 5 landings of sardines of at least 500 pounds each, or one landing of at least 5,000 pounds.

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 harvest guideline 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.

2.3.3 Treaty Tribe Fisheries

As of June 2004, no treaty tribe fisheries for CPS have occurred.

3.0 Stock Assessment Models

3.1 Pacific Sardine

Conser *et al.* (2003) summarized the status of the Pacific sardine resource in California and Baja California, Mexico. An age-structured stock assessment model (CANSAR-TAM, Catch-at-age ANalysis for SARdine - Two Area Model; see Hill *et al.* 1999a) is applied to fishery-dependent and fishery-independent data to derive estimates of population abundance and age-specific fishing mortality rates. In 1998, the original CANSAR model (Deriso *et al.* 1996) was modified to account for the expansion of the population northward to waters off the Pacific northwest. The model is based on a "forward-simulation" approach (see Megrey 1989) for a description of the general modeling approach), whereby parameters (e.g., population sizes, recruitments, fishing mortality rates, gear selectivities, and catchability coefficients) are estimated after log transformation using the method of nonlinear least squares. The terms in the objective function (to be minimized) include the sum of squared differences in (log_e) observed and (log_e) predicted estimates from the catch-at-age and various sources of auxiliary data used for "tuning" the model; e.g., indices of abundance from survey (fishery-independent) data. Bootstrap procedures are used to calculate variance and bias (95% confidence intervals) of sardine biomass and recruitment estimates generated from the assessment model. The CANSAR-TAM model is based on two fisheries (California, U.S., and Ensenada, Mexico); and semesters within a year are used as time steps, with ages being incremented between semesters on July 1 and spawning that is assumed to occur on April 1 (middle of the first semester).

Fishery-dependent data from the California and Ensenada fisheries (1983 through the first semester of the most recent year) are used to develop the following time series, (1) catch (in mt); (2) age distributions (catch-at-age in numbers of fish); and (3) estimates of weight-at-age (fishery- and population-specific). Fishery-independent data (time series) from research surveys include the following indices, which are developed from data collected from Area 1 (*Inside Area*, primarily waters off southern California) and used as relative abundance measures; (1) index (proportion-positive stations) of sardine egg abundance from California Cooperative Oceanic and Fisheries Investigations (CalCOFI) survey data (*CalCOFI Index*; see Deriso *et al.* 1996); (2) index of spawning biomass (mt) based on the Daily Egg Production Method survey data (*DEPM Index*; see Lo *et al.* (1996); (3) index of spawning area (Nmi^2) from CalCOFI and DEPM survey data (*Spawning Area Index)*; and (4) index of pre-adult biomass (mt) from aerial spotter plane survey data (*Aerial Spotter Index*; see Lo *et al.* 1992). Time series of sea-surface temperatures recorded at Scripps Pier, La Jolla, California are used to determine appropriate harvest guidelines (*Sea-surface Temperature Index*), see the Coastal Pelagic Species Fishery Management Plan, Option J, Table 4.2.5-1, PFMC (1998).

3.2 Pacific Mackerel

A modified virtual population analysis (VPA) model "ADEPT" (Jacobson 1993), based on Gavaris' (1988) ADAPT procedure, is used to estimate biomass of Pacific mackerel. The ADEPT model has been used to assess Pacific mackerel for the past eleven years and is described in detail in Jacobson (1993), Jacobson et al. (1994), and Hill et al. (1999b). Conventional VPAs back-calculate age-structured abundance utilizing catch-at-age and weight-at-age data, as well as assumptions regarding both age-specific natural mortality in each year of the time series and fishing mortality (F) estimates for the most recent year (referred to as "terminal F"). The ADEPT model improves upon a conventional VPA by evaluating terminal F and other parameters to obtain the best statistical fit between VPA output and survey indices of relative abundance. The crux of the statistical procedure lies in the model's ability to estimate terminal F based upon the survey indices, using them to adjust the conventional VPA output.

The ADEPT model uses a standard suite of subroutines to estimate parameters in a VPA model, based on a slightly modified simplex algorithm and subroutine from Press et al. (1990). The standard program for parameter estimation is similar to that described by Mittertreiner and Schnute (1985). The ADEPT approach is based on the estimation method of maximum likelihood. Parameters are estimated by minimizing an objective function, which in the case of ADEPT, is the negative log-likelihood of the data, given the model and parameter estimates (rather than the equivalent sums of squares used by Gavaris 1988). Two types of parameters are estimated in the ADEPT model: observation parameters (survey-based q's and exponents) and terminal F parameters. Observation parameters are used to interpret index data, which are used in turn to estimate terminal F values. Terminal F parameters are highly influential for estimating population biomass for recent years. Natural mortality is assumed to be 0.5 yr for all ages in all analyses (Parrish and MacCall 1978).

The assessment model uses an annual time step and now incorporates 75 years (1929-2003) of fishery data, including landings, age composition, and mean estimates of weight-at-age. Fishery data for the early historical period (1929-1965) were obtained from previously published assessments (Parrish and MacCall 1978; Prager and MacCall 1988). Abundance estimates from the VPA are adjusted by the model to better match trends in the survey data, which includes aerial spotter sightings (Lo *et al*. 1992), CalCOFI larval data, recreational fishery catch-per-unit-effort information, triennial shelf survey data, and power plant impingement rates. Component likelihoods for most surveys are weighted equally to a value of 1.0. The power plant impingement index (age-0 mackerel caught in cooling water at San Onofre Nuclear Generating Station) represents a small portion of the coastline and is down-weighted to 0.1. The ADEPT model also accommodates weighted annual survey observations based on coefficients of variation (CVs) associated with the individual estimates.

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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 CFR §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 F_{MSY} 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 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:

$$H = (\text{BIOMASS}-\text{CUTOFF}) \times \text{FRACTION}$$

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 F_{MSY}, then the MSY control rule harvest rate will not exceed F_{MSY}. 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 F_{MSY} (i.e., the fishing mortality rate for deterministic equilibrium MSY). FRACTION depends on recent ocean temperatures, because F_{MSY} and sardine stock productivity are higher under ocean conditions associated with warm water temperatures. An estimate of the relationship between F_{MSY} for sardine and ocean temperatures is:

$$F_{MSY} = 0.248649805\ T^2 - 8.190043975\ T + 67.4558326$$

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 F_{MSY}, except that FRACTION is never allowed to be higher than 15% or lower than 5%, which depends on recent average sea surface temperature.

Although F_{MSY} 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, F_{MSY} and environmental conditions are technical questions and estimates or approaches may be revised by technical teams (e.g, the CPSMT) to accommodate new ideas and data.

4.3.3 MSY Control Rule for Pacific (chub) 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," which represents a rate of escapement that can allow the population to realize "sustainable" levels of abundance into the future, i.e., given favorable environmental conditions exist for this species. It is important to note that 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. In this regard, the CPSMT recognizes that there exists too little information at this time to define the threshold in more detailed terms and further, recommends treating the 30% escapement rate as one that is more in line with "MSY," rather than "minimum stock size," points of reference. Finally, 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 U.S. Secretary of Commerce 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 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 are commonly used in Oregon and Washington fisheries to sort larger non-CPS from the catch, at-sea observers record discard in these fisheries. Incidental harvest of non-prohibited larger fish are often taken home for personal use or processed.

Historically, market squid have been fished at night with the use of powerful lights, which cause squid to aggregate, 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 is developing an FMP for the state-managed fishery. California's market squid FMP would establish 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 proposed 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 and 8b.

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 the school, 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 into fish holds aboard the fishing 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 ferried away to processors or to a conveyor belt leading into a processing facility.

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, and recorded 343 fish, items or animals that were not the targeted species (Table 7a). These included 210 finfish (61%), 44 elasmobranchs (sharks or rays) (13%), and 89 incidents of vegetation, invertebrates, and various debris (26%). Seventy three incidents (21% of total) represented other CPS finfish that were not the target species of that trip.

In 2002, there was a similar result to 2001 observations, with 181 non-targeted finfish, 37 elasmobranchs, and 150 incidents of invertebrates, vegetation, or other non-fish items noted by CDFG port samplers in CPS landings (Table 7b). Of incidental catches observed, finfish comprised 49%, sharks and rays 10%, and invertebrates, vegetation, or other items occurred as 41% of non-targeted catches.

In 2003, there were 365 incidents of bycatch in CPS landings in the Los Angeles County area. Finfish accounted for 201 incidents (55%), elasmobranchs 64 incidents (18%), and invertebrates and vegetation 100 incidents (27%). In Monterey, bycatch was also enumerated for the first time. There were 106 incidents of bycatch in the Monterey region. Finfish accounted for 69 incidents (65%), elasmobranchs 16 incidents (15%), and invertebrates/vegetation 21 incidents (20%). All of these incidents occurred in the first semester of landings. None were recorded after July in Monterey.

Kelp (specifically holdfasts), 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 7% of round haul squid landings included “incidental” catch of CPS species (Table 8a) and in 2003, there were 9%. Squid also occurred as incidental catch (about two tons in 2002 and 2003) 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 the CDFG 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 2002, bycatch was present in slightly more than half 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.

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 2003, squid egg bycatch was 10.9% statewide, which represents more than a six-fold increase from 2001 in the amount of squid egg cases taken as bycatch in this fishery. 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 2003) is summarized in Table 9.

In 2003, Oregon and Washington agreed on a similar season opening date of June 22; landings continued through mid October. Seventeen vessels made 712 landings for a total of 25,253 mt, averaging over 35 mt per trip, with nine vessels making over 80% of the landings. Based on logbook data, 65% of the pounds landed were taken off Oregon and 35% 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 2003, due to budget restriction, Oregon did not hire a seasonal employee in 2003 to ride along on sardine vessels and observe bycatch of non-target 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 92% 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 0.8 salmon per trip, with 63% being released alive. The estimated total catch of salmon for the fishery, based on logbook data, was 500 salmon (0.020 salmon/mt) (Table 11).

Incidental catch recorded on fishtickets consisted of 158.3 mt of Pacific mackerel, 3.2 mt of jack mackerel, 0.1 mt of Pacific whiting, and 0.3 mt of thresher shark, for a total of 0.6% of the total catch.

Washington's purse seine fishery in previous years has opened on May 15, although landings typically have not occurred until around the second week of June. However in 2003, the season was delayed until June 22 as a result of an agreement with Oregon Department of Fish and Wildlife and the northwest sardine industry. Reasons for the delay included a desire to avoid an early closure in late August as a result of attaining the northern harvest guideline, and to promote fishing during a time when the fish had higher oil content and greater market value. The 2003 season also marked the first year of effort limitation in Washington; 17 permits were issued, however only 10 vessels participated in the fishery. The fishery opened on June 22 and continued through October 17 when the allocation to the northern area was attained.

Landings for the year totaled 11,604 mt, which is a decrease from the 15,212 mt landed in 2002. Average landing size was approximately 40 mt. The majority of the catch (67%) was taken in waters adjacent to Washington. In 2002, 57% of the catch was taken off the Oregon coast. There were a total of 288 landings for the season and most of the catch (88%) was delivered into the port of Ilwaco.

As part of the limited entry permit in the experimental fishery regulations, WDFW requires fishers to carry at-sea observers, primarily to collect bycatch information. 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 the fish were alive, dead, or in poor condition. Overall observer coverage was 27% of the total catch, up slightly from the 24% coverage in 2002. Based on observer data, the bycatch of non-targeted species was fairly low. Bycatch included chinook and coho salmon, Pacific and jack mackerel, spiny dogfish, blue shark, and other species (Table 12a). A complete list of non-targeted species and the amounts observed (numbers of individuals) compared with amounts reported in logbooks is contained in Table 12b.

7.0 Live Bait Fishery (California)

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 13). 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 2003 have been appended to previously reported estimates from Thomson et al. (1991, 1992, 1994) (Table 14).

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 14).

Through the years 1994 to 2003 the proportion of anchovy in the total reported harvest ranged from a low of 13% in 1998, to a high of 58% in 1994. The proportion of sardine ranged from a low of 42% in 1994, to a high of 87% in 1998 (Table 15).

References for Section 7:

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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.

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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.

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. Harvest guidelines, fishing seasons, and other management controls are used. Other CPS species (northern anchovy, jack mackerel, 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. For information on commercial harvest of CPS finfish landed into Ensenada, Mexico (1978-2001) (Table 16, Eva-Cotero 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. The Pacific sardine has made a strong recovery in waters off the U.S. Pacific Coast since the late 1980s. The sardine biomass increase approximately 30% annually through the late 1990s, with a leveling off at approximately 1 million mt observed in recent years. Estimates of sardine biomass in waters off Oregon were greater than 50,000 mt in 1994 (Bentley *et al.* 1996), and greater than 100,000 mt in waters around Vancouver Island, B.C. in 1998 (S. McFarlane, Canada Department of Fisheries and Oceans, personal communication, 1999).

Conser *et al.* (2003) summarized the status of the Pacific sardine resource off California and Baja California, Mexico. Total landings of Pacific sardine for the directed fisheries off California, U.S., and Ensenada, Mexico were generally similar to levels observed in the previous year, with a total harvest of approximately 94,000 mt in 2003. Note that landing values presented here differ slightly than those presented in Conser *et al.* (2002), given semester 2 landings from 2002 used in the previous analysis were projected estimates based on landing patterns observed in the fisheries over the last decade. Total landings in California in 2003 (50,382 mt) declined slightly from the previous year (63,444 mt), while landings in northern Mexico in 2003 (43,693 mt) were similar to the harvest in 2002 (43,437 mt). Currently, the U.S. fishery (California landings) is regulated using a quota-based (e.g., harvest guideline) management scheme, whereas the Mexico fishery (Ensenada landings) remains largely unregulated. Since the mid 1990s, actual landings from the California fishery have been less than the recommended harvest guidelines. Further, as was the case generally observed in recent years, landings from the U.S. coastwide (i.e., California, Oregon, and Washington) sardine fishery composed just under 75% (roughly, 82,000 mt) of the harvest guideline recommended for 2003 (111,000 mt).

Estimated stock biomass (age 1+ fish on July 1, 2003) from the assessment conducted in 2003 indicated the sardine population has remained at a relatively high abundance level, with a bias-corrected estimate of roughly 1 million mt. Estimated recruitment (age-0 fish on July 1, 2003) in

2003 was nearly 13 billion recruits, which translated to a relatively strong year class when evaluated over the entire time series from 1983-2003. However, it should be noted that recent recruitment was not estimated precisely (i.e., 95% confidence interval of 5-37 billion recruits) and thus, definitive determinations regarding the apparent "plateau" reached by the sardine population should be interpreted accordingly, given the inherent uncertainty surrounding estimated recruitment (see below). See Table 17 for biomass and recruitment time series, 1983-2003.

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 2004

The harvest guideline recommended for the U.S. Pacific Coast fishery for 2003 was 110,908 mt. Statistics used to determine this harvest guideline are discussed below. The harvest guideline for 2004 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:

$$HG_{2004} = (\text{TOTAL STOCK BIOMASS}_{2003} - \text{CUTOFF}) \bullet \text{FRACTION} \bullet \text{U.S. DISTRIBUTION},$$

where HG_{2004} is the total U.S. (California, Oregon, and Washington) harvest guideline recommended for 2004, TOTAL STOCK $BIOMASS_{2003}$ is the estimated stock biomass (age 1+ fish) from the assessment conducted in 2003, 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 $BIOMASS_{2003}$ in U.S. waters.

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 (1983-2003), the appropriate F_{MSY} exploitation fraction (FRACTION) has consistently been 15% and this remains the case under current oceanographic conditions (T_{2003} = 17.5 °C). However, it should be noted that the decline in T generally observed in recent years (2000-2003) 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 2004 U.S. HG (122,747) is 11% greater than the 2003 HG (110,908). Recent fishing practices and market conditions indicate that it may not be constraining with regard to U.S.-based fishery landings in 2004. 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 continue, it is likely that HGs in the upcoming years will constrain USA fishery practices and removals to some degree.

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 the current sardine assessment (Conser *et al.* 2003) in Appendix 2 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 2004, as has been the case since 2002.

See Tables 18 and 19 for a retrospective of U.S. West Coast Pacific sardine landings, 1981-2003.

9.1.2 Pacific Mackerel

The coast-wide harvest of Pacific mackerel decreased 35% in calendar year 2003. The directed fisheries off California and northern Baja California (Ensenada, Mexico) had a combined yield of 8,341 mt, compared to 12,778 mt in 2002. California’s directed fishery for calendar year 2003 landed 5,185 mt – an increase of about 14% from the 2002 yield. The Ensenada fishery experienced a 65% decrease in yield, from 7,963 mt in 2002 to 2,815 mt in 2003 (Celia Eva Cotero, INP-Ensenada, pers. comm.). The RecFIN estimate of recreational harvest was 341 mt in 2003, up from 279 mt in 2002. The U.S. commercial fishery was provided a 10,652 mt HG for the 2003-2004 (July-June) season, based on a July 1, 2003 biomass forecast of 68,924 mt (Hill *et al*. 2003). Through the PFMC management process, it was determined that in order to stay within the HG, there would be an initial directed fishery of 7,500 mt, with 3,152 mt set aside for incidental catch in other CPS fisheries. The 2003-2004 season has progressed slowly, with only 5,545 mt of the directed HG allocation being landed from July 2003 through March 2004. The directed fishery will likely remain open through June 30, 2004.

Status of the Pacific mackerel population was assessed using the modified VPA model “ADEPT” (see section 3.0). An executive summary of the latest assessment (Hill and Crone 2004), including tables and figures, may be found in Appendix 2 of this SAFE document. The ADEPT model recalculates biomass and recruitment for all years in the 75-year time series. Differences in biomass estimates among assessment years can be caused by changes in landings, shifts in fishery age compositions, trends in fishery-independent surveys, and assumptions regarding terminal year fishing vulnerability. As is true for all age-structured population models, abundance-at-age estimates are the least certain for the most recent years when the youngest year classes have not yet become fully vulnerable to, or utilized by, the fishery. Compounding this uncertainty is the general lack of fishery or survey data for Pacific mackerel outside the Southern California Bight and the lack of fishery-independent information on recruitment. Catch-at-age and weight-at-age data are not yet available from the Ensenada fishery, which is comparable in volume to California's commercial fishery.

Pacific mackerel biomass peaked in 1982 at approximately 1.39 million mt, declining steadily to a low of 10,438 mt in 2001. The peak biomass observed twenty years ago was primarily built by exceptional year classes in the late 1970s and early 1980s. These recruitment pulses occurred after a decade of extremely low biomass from the mid-1960s to mid-1970s. The decline in biomass since 1982 has resulted from a steady decline in year class strength and relatively low reproductive success (recruits per spawning stock biomass) since that time. Model estimates of 2001 and 2003 year class abundance are slightly higher than for the previous few years and recent reproductive success (recruits per spawning stock biomass) is more optimistic relative to the past 18 years.

The recent trend in age 1+ biomass for the current assessment was similar to that estimated in the 2003 stock assessment (Hill *et al*. 2003). A precipitous decline in biomass was observed from 1997 to 2001. This decrease is attributed to relatively weak year classes in 1998 to 2000, combined with high fishing mortality during the 1998 fishery (i.e., keeping in mind that environmental conditions are also believed to strongly influence abundance associated with coastal pelagic stocks in general). The 1998 fishery was the second largest on record (71,355 mt), with the majority (50,726 mt) of the total harvest being landed in Ensenada, Mexico. Despite the lower overall estimates of biomass compared with Hill *et al.* (2003), the current time series indicates a stabilization in biomass in the past two years. This may be attributed to what appears to be a relatively strong 2001 year class that contributes substantially to the exploitable biomass. Finally, this stabilization should be interpreted in the context of the historical estimated abundance levels and thus, the population remains at relatively low levels compared with that realized during the 1980s and early 1990s.

The July 1, 2004 biomass projection, used to calculate the 2004-2005 HG, was based on ADEPT outputs and certain assumptions about recruitment and fishing mortality during the first half of 2004. Estimates of year class strength (age-0 abundance) for the terminal year (2003) are included in the forecast. The projected estimate of July 1, 2004 population biomass (age 1+ fish) is approximately 81,383 mt.

9.1.2.1 Harvest Guideline for 2004-2005

In Amendment 8 to the CPS FMP (PFMC 1998), the recommended maximum sustainable yield control rule for Pacific mackerel was:

HARVEST = (BIOMASS-CUTOFF) x FRACTION x STOCK DISTRIBUTION

where HARVEST is the U.S. HG, CUTOFF (18,200 mt) is the lowest level of estimated biomass at which harvest is allowed, FRACTION (30%) is the fraction of biomass above CUTOFF that can be taken by fisheries, and STOCK DISTRIBUTION (70%) is the average fraction of total BIOMASS in U.S. waters. CUTOFF and FRACTION values applied in the Council's harvest policy for mackerel are based on analyses published by MacCall *et al*. (1985). BIOMASS (81,383 mt) is the estimated biomass of fish age 1 and older for the whole stock as of July 1, 2004. Based on this formula, the 2004-2005 season HG would be 13,268 mt. The recommended HG is 2,616 mt higher (+25%) than the 2003-2004 HG, and comparable to the average yield (~12,000 mt) realized by the fishery since the 1992-1993 season.

HARVEST GUIDELINE = (BIOMASS - CUTOFF) X FRACTION X STOCK DISTRIBUTION
= (81,383 mt - 18,200 mt) x 0.30 x 0.70
= 13,269 mt of HG for 2004-2005

9.2 Monitored Species

Figure 1 illustrates distribution of northern anchovy and jack mackerel eggs for areas surveyed off of Southern California, April 2003.

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; and 4,650 mt in 2002. Minor landings (< 1 mt annually) of northern anchovy into Oregon were reported from 1981 through 2001, with 3.1 mt reported in 2002 and 39.1 mt in 2003. During the 1980s and 1990s, Washington landings of northern anchovy ranged from 10 to 130 mt. In 2002 and 2003, landings increased to over 200 mt, annually. Through the 1970s and early 1980s, Mexican landings increased, peaking at 258,700 mt in 1981. 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 since 2001.

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. 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.)

In California, CDFG landing receipts for jack mackerel totaled 1,269 mt in 2000; 3,624 mt in 2001; and 1,006 mt in 2002. Oregon reported 161 mt in 2000, 183 mt in 2001, 8.9 mt in 2002, and 73.6 mt in 2003. 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.

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 Stock Assessment Review (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 references 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 Stock Assessment Team (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 an a priori-determined sustainable level of exploitation and in this context, can be used as an effective management tool. See also Sections 4.3.4 and 10.3 for further discussion concerning an MSY Control rule and future research activities, respectively, for this species.

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 continued throughout 2003 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 from 2000-2001; (2) critically evaluating spatial/temporal patterns of the overall fishery through stratified sampling and subsequent analysis; (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 (see also 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 in early 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.

A moderate El Niño event in 2002 and 2003 (Venrick et al. 2003) likely contributed, to some degree, to an overall decrease in landings coastwide (44,965 mt). However, this oceanographic phenomenon continued to bring high landings to the northern market squid fishery, while hampering the southern fishery. In the 1990s, landings for the northern fishery averaged just less than 7,000 mt. Since 1999, the northern fishery has landed higher amounts, with the 2003 landing estimate of 17,359 mt. This increase in landings for the northern fishery has been largely an outcome of expanding market opportunities as well as expansion of the fleet's fishing grounds, both north and south of Monterey Bay.

During ENSO events, the availability of squid to the fishery is greatly reduced and this was evident in landings for the southern fishery, where only 27,606 mt of squid were harvested in 2003. The previous ENSO event that occurred in 1998 resulted in landings that plummeted to 2,894 mt. It is generally believed that movement out of established spawning grounds into favorable habitat and reduced reproduction by the population are responsible for the changes in availability. Further, there is no clear indication of short-term detrimental effects to the squid population (i.e., as evident in the relatively high landing amounts that have immediately followed ENSO-related events observed over the last decade or so).

La Niña conditions in 1999 contributed to record-high market squid landings of 91,517 mt for California, surpassing the previous high in 1996 of 80,402 mt. This record took place primarily in the southern California fishery, which accounted for 99.7% of all landings that year. Landings for the northern California fishery were only 289 mt during this time period. In 2000, an abundance of squid and somewhat favorable market conditions contributed to another record-high for market squid landings (117,962 mt). New landing records were set six times since 1990, reflecting a continued expansion of the southern California fishery and increased international demand for this marine resource. In 2001, market squid landings were 86,186 mt, a 27% decrease from 2000. The immediate reason for the decline in landings is not known, but anecdotal information suggests that squid were not as available at typical spawning sites, and fishers had to go to alternate areas to locate good quality squid. The lower harvest might be reflective of pre-El Niño conditions, when the abundance of market squid at known fishing areas is likely strongly affected by environmental conditions.

In 2001, legislation transferred the authority for management of the market squid fishery to the California Fish and Game Commission (Commission). Legislation requires that the Commission adopt a market squid fishery management plan and regulations to protect and manage the squid resource. CDFG has prepared a draft market squid fishery management plan (April 12, 2004) with management recommendations for the market squid fishery which should be in place for the April 1, 2005 squid fishing season. The management plan takes into account the level of fishing effort and ecological factors, including, but not limited to, the species' role in the marine ecosystem and oceanic conditions. The plan includes a limited entry program geared to maintain the long-term economic viability of the fishery and seeks to match the level of fishing effort to the health of the resource. The management alternatives recommended by CDFG are intended to provide sustainability of the market squid resource both as a forage item and for those that rely upon squid for their livelihood. The management alternatives are based on precautionary principles and utilize the best science available. Starting in 1998, vessels participating in the squid fishery were required to possess one of two permits: the first requires a commercial market squid vessel permit to land more than two short tons daily; the second permit is to operate a light boat for the purpose of attracting market squid by light. Participants must have purchased a permit the previous year to renew their permit. A moratorium placed on the number of vessels in the squid fishery (starting in 1998) continues until adoption of the management plan. Originally, there were 248 vessel permits and 54 light boat permits during the 1998-1999 season. For the 2003-2003 season, 173 market squid vessel permits and 39 light boat permits were sold. Permit fees were set at $2,500 for three years beginning with the 1998-1999 fishing season after which time they were dropped to $400 annually. The sale of market squid permits during the initial three years provided funds for biological assessment of the resource and development of management recommendations, which were provided by the CDFG to the State Legislature in April 2001.

In developing a restricted access program, the CDFG supports a "moderately productive and specialized" fleet capacity goal of 52 round-haul vessels, 34 light boats, and 18 brail boats. These goals are within the range of the number of vessels actively participating in the fishery in a given year and maintains a ratio of one round haul vessel to one vessel attracting squid (both light boats and brail boats) currently observed in the fleet. The recommendations include establishing limited entry permit criteria based on prior catch or fishing history and provide for full transferability of vessel permits only between vessels of comparable capacity.

Additionally, CDFG recommends enacting a seasonal catch limitation to prevent expansion of the fishery beyond current limits and limit future participation by vessels of a significantly larger size. The proposed project recommends a statewide seasonal catch limitation of 107,047 mt (118,000 short tons) and restricts transferability of permits to vessels of similar capacity (within 10%). A seasonal landings catch limit of 113,400 mt (125,000 short tons) was adopted in 2001 and was in place for the 2003-2004 season.

In response to potential negative effects on nesting seabirds on several of the Channel Islands of vessels using lights to attract squid and to reduce potential light impacts on coastal communities, interim regulations went into effect May 2000 restricting lights to a maximum of 30,000 watts and requiring that lights be shielded. However, in April 2002, a petition was filed with the U.S. Fish and Wildlife Service and Commission to consider listing of Xantus's murrelets under the Endangered Species Act, citing high predation on nesting birds in 1999 "almost certainly resulted, in part, from high light levels caused by squid fishing boats." Xantus's murrelets are small nocturnal seabirds, 80% of the U.S. breeding population nest in the Channel Islands, primarily at Santa Barbara Island (also found at San Miguel, Santa Cruz, and Anacapa islands). On February 5, 2004, the Commission voted to list the Xantus's murrelet as a threatened species under the California Endangered Species Act (CESA), with implementation of the listing scheduled for the fall of 2004. The proposed project in the market squid management plan includes a recommendation by CDFG to close Anacapa and Santa Barbara islands to squid fishing using attracting lights from February 1 through September 30 to mitigate potential fishery impacts on the nesting seabirds while recommending that the existing interim wattage and shielding regulations be maintained. An additional recommendation to reduce the maximum wattage is being considered by the Commission.

In the State of California's draft management plan, CDFG recommends a general habitat closure area from Pillar Point in central California to the Oregon border. A general habitat closure is intended to prevent squid fishery interactions in areas that have not been traditionally utilized for commercial squid fishing and where there is the potential for interactions with non-target species such as salmon, seabirds and marine mammals. It would also provide a forage reserve for species that utilize the squid resource. In 2003, a network of marine reserves at the Channel Islands went into effect. A total 132 square nautical miles of the Channel Islands National Marine Sanctuary have been set aside in April 2003. Preliminary analysis of logbook data from the three fishing seasons prior to the closure suggest that 14-19% of southern California landings were reported from the closed areas although reporting.

Maintaining the closure of the fishery on weekends statewide in the spirit of precautionary management is the preferred alternative in the management plan. In the absence of conclusive biological information upon which to base a quota or other management approach, a two-day, per week period provides assurance that there is some uninterrupted spawning in areas where squid are present. Unlike a seasonal quota or seasonal closure, this measure spreads escapement of squid throughout the year, rather than concentrating it at the beginning or end.

Continuing squid research and fishery monitoring is also strongly encouraged. This includes sampling efforts conducted at ports statewide, requiring logbooks for all permitted vessels participating in commercial squid fishing, monitoring of catch information and continuation of independent research contracts, especially those focused on developing population models useful for management. Finally, in their draft plan, CDFG recommends the permit fee be increased to offset the costs of squid research and monitoring programs.

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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[2/] allocation framework that seeks optimal use of the annual Pacific sardine harvest guideline with minimal impacts on any sector of the West Coast sardine fishing industry and fishing communities. The CPSMT generally agreed that the impacts of the interim allocation scheme used to partition the Pacific sardine harvest guideline 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 effect the dynamics of the sardine population at large. To this end, while coastwide the species is genetically homogenous, as pertains to a long time scale, it is divided into habitat groups which may be important to the contemporary management time horizon. Therefore, a more comprehensive analysis of alternative allocation frameworks in terms of long-term socioeconomic and biological impacts is warranted.

The biological questions relating to allocation and differential impacts on the coastwide resource from the Southern California, Northern California, and Pacific Northwest fishery sectors generally include:

- Impacts to the coastwide sardine resource from a fishery that targets older, mature fish.
- Impacts to the coastwide sardine resource from a fishery that targets younger, immature fish.
- Recent indications of changes in maturity rates (i.e., delayed maturity) in the southern fishery resulting from density-dependent factors.
- Potential refinements to the Pacific sardine assessment and/or harvest control rule in response to new biological information

To address these issues, future biological information will include NMFS research surveys off the Pacific Northwest (PNW). PNW research surveys occurred in July 2003 and March 2004, and are scheduled for similar periods during summer 2004 and winter 2005. Additional information will be available from a CPS stock assessment review scheduled for June 2004.

PNW research cruises are designed to conduct sardine acoustic trawl and Continuous Underway Fish Egg Sampler (CUFES) surveys off the coast of Oregon and Washington in summer and winter (acoustic-trawl only). Information from these surveys should 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 objective of the surveys is to estimate the biomass present at these two times of the year, with the ratio of the two values

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2/ The interim measure will be in place for 2003, 2004, and conditionally for 2005.

providing an estimation of the relative proportion and size and age structure of the sardine stock that over-winters off the coast of Oregon and Washington.

A CPS STAR workshop is scheduled for June 2004. The goals and objectives for the CPS assessment and review process are: ensure that CPS stock assessments provide the kinds and quality of information required by all members of the Council family; satisfy the Magnuson-Stevens Act and other legal requirements; provide a well-defined, Council oriented process that helps make CPS stock assessments the "best available" scientific information and facilitates use of the information by the Council. In this context, "well-defined" means with a detailed calendar, explicit responsibilities for all participants, and specified outcomes and reports; emphasize external, independent review of CPS stock assessment work; increase understanding and acceptance of CPS stock assessment and review work by all members of the Council family; identify research needed to improve assessments, reviews, and fishery management in the future; and use assessment and review resources effectively and efficiently.

As data become available, this information, along with more robust economic information on producer profit and surplus, will be considered in crafting longer-term management alternatives for annual allocation of the Pacific sardine harvest guideline.

The current Harvest Control Rule (HCR) for Pacific sardine directly considers both environmentally- (e.g., sea-surface temperature, SST) and biologically-based (e.g., distribution of stock in U.S. waters) parameters that have received little scrutiny since the HCR went into with implementation of the CPS FMP in 1999. That is, the CPSMT recommends that this HCR be re-evaluated in efforts to: (1) get a better understanding of how recent estimates of productivity (particularly, this species' stock-recruitment relationship over the last decade) influence the current hypothesis regarding the relationship between absolute population abundance/distribution and oceanographic conditions (i.e., SSTs); and ultimately, (2) provide management the best available information for determining sustainable allocation strategies in the future.

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 will be 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 fishery management plan (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, 81,383 mt is well above the cut off value.

10.3 Market Squid: Development of Long-Term Monitoring/Analysis Schedule for Market Squid off California

Recently, it has been observed that the northern fishery 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 early 2005.

10.4 Management Issues

Emerging management issues include market squid overfishing definition; international CPS fisheries;, review of CPS FMP environmental impact statement (EIS), including essential fish habitat provisions (EFH); and standardized bycatch reporting, including at-se observers in California-based CPS fisheries.

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.

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. At the recent U.S.-Mexico bilateral meetings Mexico indicated a willingness 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 Mexico City, in October of 2004.

Third, an environmental impact statement (EIS) for the CPS fisheries management program was prepared with Amendment 8, which established the CPS FMP. That occurred more than 5 years ago. There have been major changes in the fishery since then. Therefore, it may be appropriate for the Council to initiate scoping to determine if a full EIS process is warranted for the next amendment to the CPS FMP. Moreover, NMFS has asked regional councils to review and assess the need for changes in essential fish habitat (EFH) designations under their fishery management plans. This review of EFH information likely would include the CPS FMP. Thus, it would seem prudent for the CPSMT to at least complete an initial reassessment to determine if there are any major problems with the current EFH designations.

Fourth, 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, 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. NMFS would 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.

Finally, recent reports from Ft. Bragg, California indicate interest in developing a small sardine fishery in Northern California, above 39° N lat. If this fishery were to occur it would be prosecuted in the open access area (i.e., outside of the limited entry fishery area). Under the current allocation framework, landings from this fishery would count against the northern subarea allocation. The CPSMT will continue to monitor this situation.

11.0 Research and Data Needs

There is an ongoing need to enhance current assessment procedures to meet the requirements of the FMP. Recent issues 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:

- Strengthen and broaden laboratory-related research activities in support of all CPS population assessments, i.e., federal research Centers (SWFSC) and state fishery agencies (WDFW, ODFW, and CDFG) will need additional support to meet ongoing work, as well as establish new research areas, as stipulated in current (and future) FMPs.

- 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.

- 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.

- Develop socioeconomic profiles and data bases for West Coast communities for which CPS make an important contribution to the local economy.

11.1 Pacific Sardine

The Trinational Sardine Forum (Mexico, U.S., and Canada) met again in 2003 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 harvest guidelines.

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. The final report of the Trinational Forum 2003 will be available soon.

http://swfsc.ucsd.edu/frd/Trinational/text/lj-03-05.pdf

There is currently a need to formalize the Trinational Forum. This would provide a means to seek more secure funding and organizational support. The next meeting is scheduled for November 15.

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 this 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 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 6 to 7 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 voluntary logbooks provided by some bait haulers, and estimates provided by the CPFV industry. Since the sale of live bait in California is not documented in a manner similar to that used for the commercial sale of CPS, estimates of tonnage and value are imprecise. No estimates of volume or value for the sale of market squid for live bait are available at this time.

11.5 Socio-Economic Data

Economic or social welfare evaluation of options for a long-term, north-south sardine allocation framework will entail a cost-benefit analysis focusing on the economic values of the incremental production of sardine products, under each allocation option as measured by changes in short-run profits or producer surplus (Regulatory Impact Review (RIR) requirement). This analysis will require detailed, representative cost and earnings data for the sardine harvesters and processors making up each fishery sector (Southern California, Northern California, and Pacific Northwest).

In addition to the social welfare considerations, the impact of allocation alternatives on the private profitability of harvesting and processing operations will also be evaluated (Regulatory Flexibility Act [RFA] requirement). Estimating the impacts on firm profitability entails a financial analysis based on the concept of private financial profit. The financial analysis would nonetheless rely on the same cost-earnings data required of the C-B analysis.

The economic impacts of options for a long-term, sardine allocation framework on CPS fishing communities will also be taken into account (community impacts, National Standard 8 requirement). Community impacts will be evaluated using various economic impact "multipliers" to gauge the affects of allocation options on the level of economic activity within a particular area; i.e., if you increase/decrease sardine landings in a particular area, how much does the level of economic activity increase/decrease in that area. Some of the applicable multipliers are available in the Council's "Draft Communities Document" and from the West Coast Fisheries Economic Assessment Model. Others will have to be researched and developed from socioeconomic profiles and data bases compiled for West Coast communities in which CPS make an important contribution to the local economy.

12.0 Economic Status of Washington, Oregon, and California CPS Fisheries in 2003

This section summarizes economic data presented in the Economic Appendix – Economic Status of Washington, Oregon, and California CPS Fisheries in 2003. Pacific Coast landings of CPS totaled 118,800 mt in 2003, a 34% decrease from 2002. Market squid landings, all in California, were 41,078 mt in 2003, down 44% from 2002. Pacific sardine landings decreased in 2003 to 71,478 mt, down 6% from 2002. The exvessel value of 2003 CPS landings was $32.4 million in 2003, up 5% from 2002 (2002 converted to 2003 dollars). Market squid accounted for 35%, and Pacific sardine 60% of total landings in 2003. Landings of Pacific mackerel increased 13%, and landings of northern anchovy fell 63% from 2002 to 2003. Real exvessel market squid revenues (2003 $) increased 29% from 2002; decreased landings were accompanied by a 129% increase in exvessel price from $255 to $583 per mt (2003 $). Aggregate CPS finfish landings decreased 27% from 2002; exvessel revenue dropped 31% and the overall finfish exvessel price fell 5%. In 2003, market squid made up slightly over 7% of the exvessel value of total Pacific Coast landings, and CPS finfish accounted for almost 3%. California accounted for 68% of coastwide CPS landings in 2003, down from 77% in 2002.

California sardine landings were 34,300 mt in 2003 down 41% from 2002, 58,353 mt. Market squid ranked second in exvessel value among California commercial fisheries in 2003, with exvessel revenue of, $23,943,030, 32% less than that for Dungeness crab, the most valuable California fishery in 2003. Landings of Pacific sardine ranked eighth highest in California exvessel value in 2003 at $2,939,372.

Pacific sardine landings in Oregon increased 9% in 2003, from 23,126 mt in 2002 to 25,258 mt. Sardine generated $2,944,988 in exvessel revenue for Oregon in 2003, 4% of total exvessel revenue, ranking it eighth behind Dungeness crab in total exvessel value. Washington landings of Pacific sardine decreased 25% from 15,933 mt in 2002 to 11,920 mt. With an exvessel revenue of $1,469,888, 1% of the Washington total in 2003, sardine ranked 13th behind Dungeness crab in exvessel value.

Oregon landings of P. mackerel fell to 160 mt from 248 mt in 2002. Washington landings of mackerel decreased from 248 mt to 54 mt and anchovy landings fell from 229 mt to 214 mt from 2002 to 2003.

In 2003, the number of vessels with Pacific Coast landings of CPS finfish was 179, down from 198 in 2002. With the decrease in vessels and a decrease in total CPS finfish landings, finfish landings per vessel, 434 mt in 2003, decreased 19% from 2002. Of the CPS finfish vessels active in 2003, 19% depended on CPS finfish for the largest share of their 2003 exvessel revenues. From 2002 to 2003, the number of vessels with Pacific Coast landings of market squid decreased from 207 to 187, with 37% of these vessels dependent on market squid for the largest share of their total 2003 exvessel revenue. Market squid landings were 219 mt per vessel in 2003, down 37% from 2002. 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 over the period 1981-2003, 74% vis a vis 63%, 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 2003, 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.

In 2003, 21,954 mt of market squid were exported through West Coast customs districts with an export value of $29 million; a 67% decrease in quantity, and a 45% decrease in the real value of West Coast market squid exports from 2002. The primary country of export was China, 47% of the total, which received 10,385 mt, 65% less than the quantity exported to China in 2002. Eighty percent of market squid exports went to China and four additional countries: Japan (4,111 mt), Greece (1,589 mt), Mexico (1,320 mt), and Spain (1,030 mt). Domestic sales were generally made to restaurants, Asian fresh fish markets or packaged for use as frozen bait.

Seventy-eight percent, 56,080 mt, of Pacific sardine landings were exported in 2003, down 5% from 2002; most of the remaining landings were consumed domestically as canned Pacific sardine. Pacific sardine exports were valued at $40.7 million in 2003, up 12% from 2002. Almost 76% of Pacific sardine exports were in the frozen form, the balance was in the preserved form. Japan was the primary export market in 2003, receiving 27,902 mt, 50% of total exports, down 9% from 2002. Australia was second with 8,719 mt, 16% of the total a 10% drop from 2001. 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.

In 2003 approximately 80% of the Oregon and Washington sardine exports were to Japan for human consumption or for longline bait. Only the highest quality sardine is eligible for use in the longline fishery. The amount destined for human consumption is expected to grow as additional food markets are developed, and the longline bait market becomes saturated. A very small amount of Pacific northwest sardine was sold for the domestic human consumption market (i.e., restaurants in Portland).

California sardine landings declined in 2003 due to a variety of factors. These included weather limitations, the continued presence of small fish on the grounds during most of the year, and the virtual absence of fish from both Monterey and southern California in November, an anomalous phenomenon occurring at a time when larger fish are usually available. In addition, an extended domoic acid advisory statewide beginning May 18, and another advisory in Monterey in September, curtailed sales of non-eviscerated sardine for human consumption and animal food. Exports to Australia declined due to a significant increase in the quota for Australian sardine fishery. However, California exports for human consumption and bait increased to Japan, South America, the Philippines, China and the EU. Demand for sardines increased in Japan, due to reduced production from their domestic fishery.

Pacific mackerel landings increased in the 2002-2003 fishery to 4,602 mt, virtually all caught in Southern California Large mackerel appeared in Southern California landings in August and September; mackerel dominated CPS landings in Southern California in September, with sardines an incidental catch. Southern California mackerel was exported primarily for human consumption to markets worldwide, with a smaller amount destined for tuna feed and bait. About 20 percent of Southern California mackerel exports went to South American countries, 25 percent went to Europe, 15 percent went to the Philippines for canning and 29 percent to Australia.

California landed 1,495 mt of Northern anchovy in 2003, with 747 mt from Southern California Southern California anchovy was utilized primarily for bait purposes in domestic and export markets.